A Post-Keynesian Paradox: Reducing Investment for Sustainable Growth

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Abstract

This paper critically reviews and builds upon the state of the art in a rapidly evolving collection of post-Keynesian and heterodox approaches to understanding the economy as subsystem of nature. Attempts to incorporate environmental limits in heterodox economics are growing, yet it seems additional research has merely brought about further questions. Specifically, the feasibility of dematerializaion is analyzed given the "paradox of growth": greater output has historically meant increasing impact on the environment, yet reducing investment or consumption results in unemployment. A stock-flow-consistent (SFC) model is developed to study the shift to higher consumption of services and low-energy intensive goods rather than higher investment in new green technology. It is found that dematerialization can best be achieved through a significant rebalancing of national priorities, away from energy-intensive production and material consumption and towards low-impact, low productivity services of clear social and environmental benefit. Ultimately, the most important question to be answered for Ecological Macroeconomics, and post-Keynesians in general, is how to best define sustainability and balance planetary and social well-being given the irreversibility of human development and fundamental uncertainty about what may happen in the future.

keywords: dematerialization, post-keynesian, ecological macroeconomics, well-being, energy, productivity, consumption, sustainability, climate change

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1 Introduction: The Ecological Crisis and Limits to Growth

With the publication of the last UN International Panel on Climate Change (IPCC) report, it has become painstakingly clear that human activity has caused an unprecedented amount of change to the Earth's natural processes, yielding significant impacts on both current and future generations (IPCC 2014). Both the pace of global warming due to greenhouse gas (GHG) emissions and the extent of its effects appear to have been vastly underestimated. Conservative estimates now put likely warming scenarios at between 3.7 and 4.5 °C this century, far beyond the supposedly "manageable" 2 °C warming limit set by international experts. Additional stress augurs poorly for already strained ecological systems, as well as economic growth and social stability. As the IPCC report states,

"...climate-change impacts are projected to slow down economic growth, make poverty reduction more difficult, further erode food security, and prolong existing and create new poverty traps, the latter particularly in urban areas and emerging hotspots of hunger." (IPCC 2014, p. 20)

Climate change, however, is just one of many biophysical limits that are being pushed or surpassed at this time – ranging from biodiversity loss to soil erosion to disruption of nitrogen and phosphorous cycles - and the future costs of accruing such ecological debts are likely to rise as global leaders fail to make serious commitments to stay within planetary boundaries (Rockström et al. 2009). As the world's population continues to grow, along with an ever-expanding middle class, the availability of both renewable and non-renewable resources are likely to face a number threats that will ripple through the economy. However, despite the overwhelming evidence of natural limits to continued economic growth, economics has been slow to shed old orthodoxies which overlook economic dependence on the natural world.

Both the landmark "Limits to Growth" (Meadows et al. 1972) publication by the Club of Rome and further research by Nicholas Georgescu-Roegen (1970; 1971; 1976) over the limits continued growth, given finite material inputs and increasing energy needs to transform such resources, began a flurry of controversy and responses by the economic mainstream in the early 1970's.

Neoclassically trained economists, believing in perfect rationality, and perfect substitutability of natural inputs "adopted mathematical models of optimising behavior, assuming micro-economic axioms, regarding humans as self-interested utility maximisers, pricing externalities and conducting trade-offs" (Spash & Ryan 2010, p. 2). Their unflinching optimism in price signals to bring about technological change allow even the most catastrophic environmental disasters to be easily overcome. Even modern ecological economics has largely been complicit in merely appropriating neoclassical and mainstream models of production with moderate alterations to include externalities, bringing about only negligibly different results rather than drastic ideological, behavioral, or political change (Spash 2012, Holt 2005).

While they have been slow to pick up the mantle on this subject (Mearman 2009), a growing number of heterodox economists are beginning to set their sights on ecological issues and work across disciplines to bring new perspectives and a more realistic analysis to an old debate that needed reviving (Berg et al. 2015, Foley & Taylor 2014, Victor and Jackson 2014). Post-Keynesians have been especially active in this field, bringing traditionally mico-based insights from environmental science into a decidedly "macro" framework (Rezai et al. 2012). The foundations of the post-Keynesian paradigm - historical time, fundamental uncertainty, and effective demand - figure prominently in what is now being called "ecological macroeconomics".

This paper provides a brief overview of the dilemma faced by post-Keynesians as they search for new ways to redefine the growth path towards a greener and more equitable future. Achieving socially sustainable full employment without increasing demand for material and energy inputs presents a difficult hurdle for economists who are often criticized for being growth-centric (Mearman 2009). Building upon some previous post-keynesian ecological models, a simple Stock-Flow Consistent (SFC) model is developed which incorporates the prospect of increasing sustainable "green" consumption low material- and energy- intensive services. This is done in opposition to previous models which seek to increase investment in green technology to ameliorate climate change, as

there are several reasons to be skeptical that such a plan is either ecologically or socially efficient.

It is found that the post-Keynesian lens has proven fruitful to better understand some ecological issues, much more must be done to understand the role that the drivers of growth play in finding a sustainable production path. Increasing efficiency and productivity growth alone are likely insufficient to achieve the drastic dematerialization of production needed to avoid catastrophic human and environmental damage from climate change, and in some cases may even be counterproductive.

The uncertainty involved in predicting future climate scenarios, and human adaptability to them, should act as a catalyst for more radical solutions, rather than doubling down on technological optimism. A truly sustainable economic path will require a decrease in energy- and material-intensive production, as well as a counterbalancing increase in socially beneficial services with low environmental impact. Achieving this in the limited time available will require a significant cultural shift towards *sufficiency*, rather than efficiency, a more equal distribution of wealth, and government policies that focus less on growth and more on well-being.

Going forward, post-Keynesian economists will need to adopt a coherent definition of sustainability founded in the fundamentals of uncertainty, irreversible time and the double-edged sword of effective demand in a finite world (Berr 2009). While certainly a subject to be debated, such issues beg for a complementary normative theory of social progress to better understand how to ensure inter-and intra-generational well-being and advance the shift of values away from growth-centric dogma. Well-being for current and future generations, without compromising natural processes or access to them, must hold primacy over growth.

This paper is structured as follows: Section 2 delves into the "paradox of growth" and the role of productivity, investment and consumption in achieving sustainable environmental and social goals. This raises a number of questions for the field of ecological macroeconomics, and post-Keynesians in general. Section 3 explores the possibility of dematerializing growth by increasing consumption, highlighting under what circumstances this may be possible. Section 4 gives the outline of a Stock-Flow Consistent model which can be used to determine the economic effects of a low-energy intensive, service based economy. Section 5 pushes further into the meaning of growth and consumption

Section 6 briefly concludes to research and looks to the future of post-Keynesian ecological economics. The need to develop a new theory of sustainability and development must be developed which recognizes the irreversibility of actions, uncertainty about the future, and a desire for improving both social and planetary well-being over considerations of growth.

2 Ecological Macroeconomics and The Paradox of Growth

While some mainstream authors, even environmentalists themselves, have justifiably considered ecological constraints in the past, rigid and unrealistic assumptions within the neoclassical growth model preclude any serious environmental concerns, requiring a new method for accurate analysis.

Post-Keynesian economics is poised to help in this respect, recognizing the importance of historical time, path dependence, irreversibility, uncertainty and effective demand. While there exists no universally accepted set of principles within the camp, post-Keynesians have also adopted more realistic set of microeconomic fundamentals that can similarly help to shed light on environmental issues (Lavoie 2009b).

Post Keynesians are now beginning to search for methods to accurately imbed the economy within the environment and research various ways that growth and distribution are affected by supply limits or production "externalities" (Rezai et al. 2012, Victor & Jackson 2015, Dafermos et al. 2017). It is clear, however that there are still many stones left unturned in the field. The following section will discuss what is likely one of the greatest dilemmas for post-Keynesians who study environmental issues: the "paradox of growth". More specifically, effective demand and investment growth are highly correlated with an increasing the ecological footprint, yet they are a social necessity for maintaining stable employment in Keynesian economics. The extent of the paradoxical relationship will be developed, noting the difficulty of relying on technological/efficiency fixes while emphasizing the role of consumption in creating a culture of unsustainable livelihoods.

2.1 Consumption, Investment and Productivity

The vast majority of heterodox literature focusing on environmental limits to growth are centered around supply constraints resulting either from direct resource overuse or indirectly, as a result

of global warming. Eventually, either because firms begin to realize their limits to production or because yields begin to fall and costs rise, animal spirits will dampen and investments will fall alongside as they become less profitable. If a lower rate of private investment is expected, the main concern is to how to make sure that what investments are made - both privately and publicly - are directed towards sustainable production, and how to compensate for any drop-off in capital accumulation.

The literature thus almost unilaterally recommends demand-management policies in order to adopt new resource-efficient technologies to reduce greenhouse gases and constrain unsustainable economic growth. From a post-Keynesian perspective, such policies make sense because investment demand is what drives growth and maintains employment levels. Investment is also a much more politically expedient component of growth to alter, since it does not directly alter individual liberties for personal consumption choices.

The importance of the consumption in driving unsustainable demand and furthering "brown" (as opposed to "green") investment should not be underestimated, however (Kronenberg 2010a). Indeed, many authors have suggested that consumption should increase to improve environmental sustainability. This section will review post-Keynesian literature discussing the link between savings, consumption, government spending, and private investment in order to find a sustainable solution to the present ecological crisis and the "paradox of growth". Typically, the solution is viewed as three-fold: 1) direct private and public investment towards sustainable "green" avenues that increase productivity, 2) reduce working time to reap the benefits of added productivity, and 3) increase consumption to accommodate a fall in investment, maintain employment, and work towards a low-investment "steady state". It will be shown, however, that neither policy is as simple as is typically presented, and must be qualified with serious amendments to avoid potentially making matters even worse.

First, any investments in green technology to raise productivity or efficiency necessarily increase output, incomes, and in some cases energy use. Though some of the negative feedback effects of "green" investment policies are only partial, given the gravity of reaching critical environmental limits - be they climate-related or scarcity-induced - policymakers cannot and should not rely solely on technical fixes to the ecological problems that lie ahead. What is likely needed is a decrease in productive investments, especially in material and energy intense sectors throughout the world. Much of this decrease will have to occur to make room for necessary growth that must take place where consumption does not meet minimum objective thresholds for human well-being.[1]

Second, while reducing working time could be a useful tool in increasing employment and reducing material inputs needed for production, its benefits may be overstated. Finally, though consumption must increase to either a) make up for a fall in investment and maintain employment and/or b) make way for a steady state of low growth and investment, there are serious limitations to accomplishing this. Raising consumption in the current social and economic paradigm is neither welfare increasing nor environmentally sustainable given limitations to dematerializing production and shifting towards a fully "service-based" economy.

The most important question, therefore, becomes how to define and encourage sustainable consumption. It will be argued here that for consumption to be sustainable, it must be coupled with new cultural values of sharing and sufficiency, and focused much more strongly on low-productivity services with a clear social benefit rather than environmentally destructive material goods or socially damaging services.

2.2 Investment, Efficiency and the Productivity Trap

Using the accounting identity $G - T = S - I - NX$, where G is government spending, T tax revenue, S private savings, I private investment and NX net exports, Fontana and Sawyer (2013, p. 260; 2014) draw two conclusions about the effects of a slowdown in investment resulting from unsustainable economic growth. Given that global net exports cannot rise, socially sustainable lower growth - that is, an economic situation that maintains employment and capacity utilization with less investment - requires either expansionary fiscal policy (meaning greater budget deficits) or a reduced savings rate (meaning higher consumption) to substitute for a fall in private investment.

[1] This argument is often stated recognizing the North-South divide in consumption patterns between "rich" and "poor" countries (Jackson 2011), but it should be qualified that the problem of overconsumption/production and insufficient consumption exists throughout the developed and developing world. Making room for growth to achieve the goal of meeting basic needs may be better thought of as distributive justice. The point should not be growth itself, but achieving a minimum standard of well-being.

In theory, a steady state could be achieved with a low savings and profit rate, as only minimal investment would be needed to replace depreciated capital stock and maintain productive capacity (Rezai et al 2012; Keynes 1936, chpt 24).

Fontana and Sawyer (2013, 2014) therefore argue that strict financial regulation can help to direct private credit towards sustainable enterprises, and an expanded public sector can provide subsidies or finance infrastructure projects as both an employment backstop and a means of incentivising new green investment channels. On the other hand, consumption may increase if it is invested in service industries that are not resource intensive, like advertising or marketing.

With regards to the first policy recommendation, there is reason to believe that expanding government deficits to replace a fall in private investment alone will fall short of sustainability objectives without being implemented alongside other coordinating policies. Barker et al. (2009), for example, point out that government sponsored "decarbonization" programs, funded via a carbon tax, can end up expanding output and increasing carbon emissions over and above reductions achieved from efficiency gains. Aggregate rebound effects can be shown to grow over time as real incomes grow and systems adapted to greater purchasing power, implying that policies should not focus on energy saving investments alone "but on portfolios of policies that complement behavioural changes to ensure reductions in GHG emissions as living standards improve." (Barker et al. 2009, p. 426)

The relationship between mitigation efforts and output can be explained using a simple accounting framework $Y = C + I + Y\mu$ which yields $Y = \frac{C+I}{1-\mu}$ when solving for output Y (Rezai et al. 2012, p. 11). If total investment is made up of both private investment I and some share of output devoted to mitigation μ, given S savings equals investment, increasing the amount of money directed towards mitigation further increases growth. By definition, absolute dematerialization cannot take place since a greater mitigation effort will bring about more energy-intensive production. Aggregate emissions could even paradoxically rise as a consequence of the decarbonization investment if the corresponding increase in energy efficiency is insufficient to overcome the added energy consumption resulting from economic expansion. The legacy of environmental policies and their ability to promote sustainability will therefore depend on the cultural and institutional setting in which they take place and the ability to adapt to changing behaviours of energy consumption.

Similarly, the "Jevons Paradox" has both microeconomic and macroeconomic effects on energy use (Rezai et al. 2012, p. 10). At its most basic level, the Jevons Paradox describes a situation in which an increase in energy or resource efficiency of a good or service makes its use more inexpensive. The reduced cost then allows for further use by more people, partially or fully compensating for the greater efficiency.[2] In a macroeconomic context, technological advances increase output, which then raises incomes and leads to further consumption. Increasing the efficiency of automobiles, for example, makes them cheaper to use, thus allowing a larger portion of the population to drive for a longer period of time. The increase in efficiency also boosts economic output and incomes, allowing for those same drivers to potentially drive even more or spend the additional money on other energy-intensive consumption goods. As such, the Jevon's paradox all but precludes the possibility of absolute material and energy decoupling from growth.

Energy consumption per dollar of GDP has fallen significantly throughout the world, but GDP continues to grow, in most cases outpacing reductions in energy use to meet growing demand from rising incomes, and the energy needs of exploding urban populations in the developing world (Sadorsky 2013).

The paradox of efficiency advances creating greater material throughput has significant bearing on whether increasing labor productivity is a sustainable political or environmental objective without complementary actions. In fact, energy use and labor productivity are inextricably linked by definition. The "kaya identity" establishes the relationship between labor productivity λ, energy

[2]See York (2006), Sorrell (2009), and Polimeni, et al. (2012) for a comprehensive review and analysis. Efficiency gains after accounting for direct and indirect rebounds tend to be mixed and product-specific. There are, however, ample evidence to suggest that rebounds in energy use are common, and may even result in full "backfire" (a rebound of larger than 100%)

productivity *epsilon*, and energy intensity e, as shown in the following equations.

$$\text{Labor Productivity} = (\text{energy productivity})(\text{energy intensity}) \tag{1a}$$

$$\frac{\text{Output}}{\text{Labor}} = \frac{\text{Output}}{\text{Energy}} \text{x} \frac{\text{Energy}}{\text{Labor}} \tag{1b}$$

$$\lambda = \epsilon e \tag{1c}$$

Differentiating for growth rates gives the following:

$$\hat{\lambda} = \hat{\epsilon}\hat{e} \tag{1d}$$

Growth in labor productivity depends on the growth in both energy productivity and energy intensity. This theoretical relationship has been proven in various empirical studies, and demonstrates that economic growth achieved through an increase in labor productivity implies higher energy use (Taylor 2009, Lee 2005). Figure 1 shows the growth of energy intensity and labor productivity over time in select regions, showing a clear, increasing correlation. Though the arrow of causation has been a subject of great debate, these results suggest that efficiency gains are highly dependent on rising energy use.

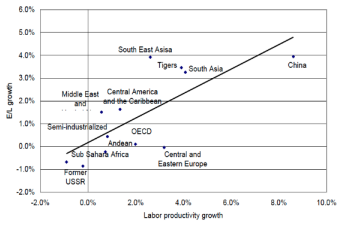

Figure 1: Energy Intensity and Labor Productivity

With this in mind, it is natural to question the source of perceived energy reductions throughout the world. As will be discussed later on, the vast majority of the gains in input efficiency are more a result of sectoral shifts towards services in the developed world and changing international trade patterns than actual throughput reduction. Since broad efficiency increases in the developed world have occurred largely as a result of shifting the problem of carbon-intensive production from one place to another, efficiency gains must be achieved through a globally coordinated effort.

Given even conservative estimates of income and population trends, the carbon-intensity of production would have to decrease by 21-fold within the next 2-3 decades in order to stay within the UN IPCC recommended limit of 2°C (see Figure 2 for more details).[3] However, the sharpest known fall in energy intensity in modern history, which occurred in Russia in the early 1990s, was just 1/3 of this, and was attained only through massive industrial collapse and a sharp rise in imports of carbon-intense goods (Hoffman 2011, p. 3). Additionally, there is reason to believe that even with efficiency gains, there may not be enough energy supply to meet the requirements of a growing world economy and population (Brown et al 2011, Foley 2012), or infrastructural capabilities to capture the energy collected, even if clean energy technologies could be developed (Hoffman 2011).

As such, while efficiency increases may play a role in dematerialization, they should be offset by decreases in investments elsewhere so as not to continue raising output and energy use, and to allow energy growth for those that still have yet to achieve a level of material well-being necessary to secure a dignified life (Jackson 2011). Lambert et al (2014) find that per-capita energy use is highly correlated with human development indicators up to a certain point, after which its effect becomes negligible. Their findings imply a minimum required per-capita energy expenditure to achieve a certain level of well-being, as well as a maximum beyond which increasing energy use adds little to benefit livelihood. The vast inequalities of energy use, and the universal need for rapid decline in aggregate energy consumption, give rise to calls for radically rebalancing modes of resource production and consumption.

[3] Jackson (2011) adds that the limit of 450ppm carbon emissions represents a 50-85% absolute reduction in GHG outputs.

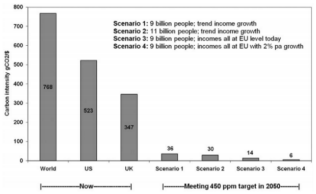

Figure 2: Carbon Intensities Now Required to Meet global 450 ppm Target
[4]

A number of economists have called for economic "de-growth" (decroissance) or "a-growth" to reallocate energy priorities and alter the social and political logic away from merely increasing investment, growth, and reliance on purely technological solutions to ameliorate ecological dilemmas (Martinez-Allier 2009; Van den Bergh 2011; Jackson 2009, 2011; Kallis et al. 2012). Decreasing growth is politically contentious, and there is an ongoing debate about the feasibility of reducing growth within a capitalist system or whether it is even a necessary objective in the first place.

The correlation between GDP and energy consumption is quite apparent, but energy consumption per dollar has clearly fallen over time. The question being debated is whether a global effort can sufficiently reduce the embodied energy per dollar such that, even with increasing incomes, aggregate world energy use falls year-to-year (decoupling energy growth from GDP or "absolute dematerialization" of growth). Uncertainty about future climate scenarios, the extent to which carbon emissions must decrease to stay within acceptable boundaries, and the ability of new technologies to develop make support for degrowth or green growth largely a question of optimism or personal belief.

Because of future uncertainties, it is likely both socially beneficial and ecologically prudent to redirect economic institutions to favor low- (or no-) growth, which will necessarily mean a reduction in investment in some sectors and an increase in others. Reducing investments that provide little social benefit, or even actively impede our capacity to stay within planetary boundaries can be both welfare increasing (Jackson 2008) and a boon to wages and employment (Young 2011, 2015), as will be discussed in Section 3.

2.3 The Prospects of Sustainably Reducing Working Time

Intimately linked with the prospects for reducing the amount of energy embodied in economic output while still increasing social well-being are calls for a reduction in working time. Not only does a universal cut in hours worked allow society to reap the benefits of productivity gains, but it also can improve welfare and potentially reduce overall energy use (Jackson and Victor 2011, Foley 2012, Fontana & Sawyer 2013). Employment growth depends heavily upon labor productivity, participation rates and population growth, but is also determined by the number of hours needed to work. Changes to the labor market such as shorter work hours, or age of entry into and exit from the labor market can help to reducing work time across the lifecycle, and might sustainably allow the benefits of productivity gains to be spread "widely and thinly" (Foley 2012).

Rezai et al. (2012, p. 8), however, have argued that working time reductions tighten the labor market, increasing the bargaining power of workers. With greater bargaining power, workers can demand higher wages, which lead capitalists to search for new technologies that improve productivity and thus reduce the number of employees. Any decrease in working time, therefore, may backfire to both increase unemployment and raise the energy intensity of production as output expands. Maintaining the employment gains from reduced working time would require constant reductions over and above increases in productivity.

Kallis (et al. 2013) review the relevant literature and find additional reasons to be suspicious. For one, if work is shared because of work-time reductions, but not reduced in the aggregate, it means more people will simply enter workforce. The environmental benefit in this case is therefore relative to the consumption habits of newly hired workers. Minimizing unemployment is a socially valuable goal, yet the added growth of spending may be environmentally unsustainable if added workers have a high propensity to consume resource-intensive goods.

Reducing working time is only truly sustainable if work is decreasing and people are using the extra free time in low-impact ways that do not increase productive demand. As such, the environmental benefits of the policy will depend on the cultural milieu in which it occurs, as well

as the relative prices of leisure activities against high-impact forms of consumption. Governments may have to step in to provide support for convivial activities and low-impact services that support community engagement without placing additional need on resources.

In general, evidence from panel data as to the effectiveness of work-time reductions in limiting resource use are hard to verify because cuts in emissions could be the result of sectoral shifts that occur simultaneously. Reducing work hours may thus be good social policy, but it is not the panacea it is often made out to be and must be coupled with a new set of policies that reinforce non-consumptive values to be truly effective.

3 Dematerialization of Consumption

Given the problem of reducing working time, and having already reviewed the difficulty of reducing energy use with rising labor productivity, it becomes imperative that the work that is done be done in the least energy intensive way possible. It would seem though, that while a worthy cause, focusing purely on improvements in productive efficiency will not fully counteract the environmental woes currently confronting the planet. Even without significant rebound effects, the increase in efficiency that would be needed to achieve a sustainable carbon footprint before catastrophic and irreversible damage occurs far surpasses anything achieved in the past (Jackson 2011). As such, one must turn from merely focusing on the efficiency of investments and pay close attention to consumption and savings as the other side of the economic coin.

The most obvious policy choice for dematerializing the economy is to reduce the amount of materials purchased, yet the paradox of lowered consumption is almost immediately apparent. If $Y - C = S = I$, any rise in savings must be offset by a rise in investment to maintain employment, bringing one back to the previously discussed dilemma of growth and energy use. Though the carbon intensity of each dollar spent may decline with efficiency investments, a larger economy likely means more energy, as has been discussed (Jackson 2011). In order to reduce investment growth and still maintain employment levels, savings would therefore have to decrease, meaning an increase in consumption (Rezai et al. 2012). In this case, dematerialization could seemingly be achieved through consuming non-resource intensive goods and services.

3.1 The Reality of "Green" Consumption

Significant research has been done touting the possibilities for "green" consumerism to bring about lasting change in production. A growing level of consciousness among consumers, as seen through the "fair trade" and "cage-free/organic food" movements, could bring about more equitable and sustainable practices if enough consumers are sensitized to bring about economies of scale. Whole supply chains could conceivably be revamped to become more socially equitable and environmentally friendly (Prothero et al. 2010).

Yet there are any number of reasons to believe that "green consumerism" could not adequately compensate for growing material and energy resource use. For one, supposedly ethical consumption is nearly impossible to guarantee given the highly disaggregated nature of production networks. Without global environmental and social regulations and parallel enforcement mechanisms, the prospects of a true commitment to sustainability throughout supply chains - and an understandable method for guaranteeing such commitment to potential consumers - are bleak (Dauvergne 2010). Furthermore, the movement advocating acts of virtuous consumption as a legitimate form of environmental stewardship has grown out of a larger cultural process based upon the commodification of individual identities (Hamilton 2010). Rather than meeting material needs, consumption has become an unhealthy form of "psychological reproduction, and the identities so created are relinquished only reluctantly...any demand to change consumption patterns asks the consumer to experience a sort of death" (Hamilton 2010, p. 574).

The creation of a purchasable individual identity serves to not only increase consumption, but reinforces the breakdown of larger social organizations (such as union membership) and collective actions that would otherwise act as a counterweight to growing corporate political power, wage inequality, and environmental degradation (Hamilton 2010, Pettit & Sheppard 1992, Bauman 2001). Identity creation through individual consumption may be the ultimate tool both for stifling collective calls for change while simultaneously increasing profits by attaching self-identification and even morality with commodities, balkanizing political protest (Naderi & Strutton 2013).

Finally, though some sustainable consumption, aided by non-profit groups and social marketing, may bring some positive change, it obscures the fact that a growing population with ever greater wants and needs will require growing environmental inputs to support. The paradox of socially conscious or dematerialized consumption raises a number of economic quandaries. Savings must decrease to make up for lost investment in a lower growth society, yet consumption remains a large part of reinforcing unsustainable production by reproducing 1) inequality, 2) financial instability, 3) individualistic economic values, and 4) social dissolution.

3.2 Dematerialization Through "Green" Services

If consumption cannot be dematerialized by efficiency only, then the type of consumption must be altered to include more non-material goods and services. Fiscal policy could then be tailored not just to policies that facilitate green innovation and technical efficiency gains - which, as previously discussed, can rebound and induce greater material throughput - but those that depend on social interaction or physical labour that are best left unmediated by massive capital investments. Most importantly, however, the increase in labor-intensive, low-input goods and services must be of clear social benefit.

As already discussed, Fontana and Sawyer (2014) mention that consumption could be directed towards services that are less material intensive, like marketing or advertising. Advertising and marketing services are odd choices to expand on for the purpose of dematerialization, since they largely exist for the purpose of increasing material demands. When one includes the psychological stress associated with the "keeping up with the Joneses" mentality so prevalent in Western culture and the negative physical health effects - from obesity to anorexia, tobacco and alcohol consumption, etc. - of advertising, the suggestion is not only counterproductive from an environmental standpoint but untenable if the goal of economic policy is to improve social well-being (Lavoie 2009a, p. 55). Marketing and advertising services are far more likely to exacerbate inequality and destabilize the economy, pushing citizens to go into debt to fund economically and environmentally unsustainable lifestyles, rather than reduce material throughput (Barba & Pivetti 2009; Frank et al. 2010).

Foley (2012) adds that the financial services industry has grown markedly in the last 40 years, and software development can seemingly be produced and sold infinitely without adding to material consumption. Foley admits, however, that both come with clear caveats. Expansion of the financial services industry has not directly used more resources, but has gone hand in hand with increased inequality, been a major factor in permitting greater indebtedness of individuals and businesses, and increased financial instability (Hein & van Treek 2011). And while software can be developed and sold with little inputs, its value is derived from monopoly rents on intellectual property that obscure its actual value to society.

It may be doubtful that a meaningful portion of global consumption can be dematerialized through such services in the current market environment (Ayres & Warr 2004, Kallis 2011). The "Environmental Kuznets Curve", which postulates that material throughput of economic growth follows an inverted parabolic shape over time - increasing in the beginning with industrialization and manufacturing growth and then decreasing as technological efficiencies and higher incomes give rise to a cleaner production and a service-based economy- has been seriously questioned as of late (Stern 2014). Notably, the ability of some countries to develop service-based economies has been wholly dependent upon their import of manufactured goods from abroad. The explanatory power of the Environmental Kuznets Curve drastically decreases when consumption of materials, not production is scrutinized (Rothman 1998, Bagliani et al. 2008).

In fact, Bruns and Gross (2012) suggest that much of the observed declines in energy intensity have been more a result of non-recurring structural changes of production towards services, especially in the rich world. As both incomes and the energy intensity of production continue to grow in developing countries, services can expand alongside but will hit an asymptotic global maximum since all final consumption goods - be they material- or service- based - depend on physical resource inputs of production (Kemp-Benedict 2014). The structural movement towards services may actually mask the true energy intensity of economic development since the value of services is often inflated compared to the value of material goods (Bruns & Ross 2012, p. 5).

3.3 Evidence for Dematerialization

Kronenberg (2010a) provides one of the most in-depth analyses of the effects of dematerialization from a post-Keynesian perspective using input-output analysis of with data from Germany. His study shows that while dematerialization can be achieved through a service-based economy in theory - that is, both production and consumption increase with fewer resource inputs needed - there are a number of caveats: First, his results confirm that dematerialization in Germany would be exclusive. Inequality is likely to increase, though his model does not consider the consequence of inequality feeding back to spur consumption of more status goods and increasing material/energy use. Additionally, he shows that inequality increases largely as a result of both higher value-added in the services sector and a smaller relative percentage of earnings dedicated to wages than the manufacturing sector, rather than any change in the capital-output ratio.

Second, imports will decrease, since most services can only be consumed at home, which may exacerbate persistent global imbalances. Third, and most importantly, there is little or no evidence to suggest that consumers will choose a consumption path which privileges services over production. Indeed, the growth of the service economy in the developed world can only exist in part by moving manufacturing to the developing world, and any meaningful movement towards large-scale dematerialization would require significant cultural shift in consumer behavior (Kronenberg 2010a, p. 17, Jackson 2011).

What is also left out of this analysis is whether increasing services will be enough to reduce materials and energy throughput in the time required to meet the required greenhouse gas limitations proposed by the UN. Since most post-Keynesian stock-flow consistent models have principally measured the cost and effectiveness of mitigation programs on reducing carbon emissions, new research would be needed which includes policies bringing about a sectoral shift in the economy. The effectiveness of a move towards a lower productivity economy as part of a mitigation effort to reduce carbon emissions and materials use should be tested against investments in new technologies and productive capacities.

3.4 Modeling and Implications of a Service-Based Economy

Though the absolute physical limit to the extent that economies can dematerialize towards services is a subject of debate, the ability of a country to replace "brown" investment and material consumption with "green" investment and consumption of low-input services will necessarily play a strong role in the massive social and economic changes that must occur to meet the demands of climate scientists. As the market is likely to undervalue the necessity of many of the services that need offering, government budgets will have to swell to provide the necessary backing and shift both production and consumption towards low-impact avenues.

In a macroeconomic sense, dematerialization will therefore depend on sectoral changes in both the products that are consumed, and the way they are produced. If there is a shift from manufacturing to service sectors, the output of the service sector will increase, thus altering the way value-added is divided between capitalists (who depend on profits and financial income) and workers (who earn wages), because of differential profit shares. Government budgets will also be affected since services are taxed differently from industrial production (Kronenberg 2010a, p. 2). The resulting change in income distribution will therefore alter consumption once more, as capitalists and workers have different propensities to consume. If the aggregate level of consumption increases enough, it may even overcome the positive effects of dematerialization and backfire. Though such a result could be presently beneficial from a social standpoint - decreasing unemployment - its long term social and environmental sustainability are questionable.

4 SFC Model: Dematerialization Through Consumption

Recently, post-Keynesian ecological economists have been using demand-driven Stock-Flow Consistent (SFC) models to show environmental interactions within complex systems to better understand the dynamics of energy and materials use on growth and distribution over time. SFC models have traditionally been used to understand building debt dynamics and financial flows. They are particularly useful for following Victor and Jackson (2015) for example, have integrated multiple industrial sectors and financial variables along with scenarios for different demographic changes to model intergenerational distribution issues. Fontana and Sawyer (2014) show the relevance of

finance directed through "green" loans as a part of sustainability policy. Berg et al (2015) note the temperature increases as a result of human production, while Dafermos (2017) models the extraction and flows of both material (mineral) and energy resources to production, as well as the waste absorption capacity of the Earth. Godin (2012) includes an "employer of last resort" mandate in the form of green jobs in his model to show how full employment can be compatible with meeting efficiency needs.

The following model depicts a simplified economy comprised of the following sectors with all flows to and from them represented by their respective superscripts:

(a) disaggregated households made of either workers h or capitalists ca,

(b) Four production sectors:

- energy e
- capital producing firms k,
- sustainable "Green" goods and services s
- non-sustainable "Brown" consumption goods and services n,

(c) commercial banks b, and

(d) the Government g.

Figure 3, shows the links between workers who receive wages from the production sectors, capitalists who retain profits, banks which provide loans and the government, which can spur investment, purchase goods, or provide unemployment benefits. All productive sectors, including the government, require energy, which releases emissions into the environment. The circulation of flows in the economy are detailed in the Social Accounting Matrix (SAM), below.

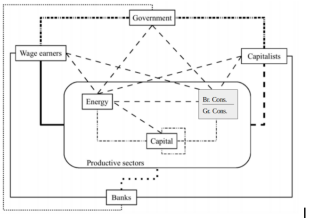

Figure 3: Flow Diagram, Green Consumption Model

	Energy	Green G/S	Brown G/S	Investment	Workers	Capitalists	Govt.	Banks	Total
Energy		$C_{s,e}$	$C_{n,e}$	$C_{I,e}$	$C_{h,e}$	$C_{ca,e}$	$C_{G,e}$	$+\Delta L_e$	Y_e
Green G/S					$C_{h,s}$	$C_{ca,s}$	$C_{G,s}$	$+\Delta L_s$	$Y_g r$
Brown G/S					$C_{h,n}$	$C_{ca,n}$	$C_{G,n}$	$+\Delta L_n$	$Y_b r$
Investment	I_e	I_s	I_n	I_i				$+\Delta L_n$	Y_i
Workers	$N_e W_e$	$N_s W_s$	$N_n W_n$	$N_i W_i$			$G_T U$	F_b	Y_{ca}
Capitalists	F_e	F_s	F_n	F_i			$r_b B_{ca,t-1}$	F_b	Y_{ca}
Government					$T_h + \Delta B_h$	$T_h + \Delta B_{ca}$		ΔB_b	$T + \Delta B$
Banks	$r_l L_{e,t-1}$	$r_l L_{s,t-1}$	$r_l L_{n,t-1}$	$r_l L_{e,t-1}$		$+\Delta M_{ca}$	$r_b B_{b,t-1}$		Y_b
Total	Y_e	Y_s	Y_n	Y_i	Y_h	Y_{ca}	G	Y_b	

Table 1: Social Account Matrix

The Balance Sheet Matrix in 2 represents the distribution of stocks between each sector. The net worth of firms, for example, sums to zero since all wealth is ultimately owned by capitalists. Banks similarly have no net worth as they balance assets and liabilities by paying interest on loans and money deposits and buying treasury bills from the government. Private net worth is derived from both financial wealth in the form of cash and bonds from households (mostly held by capitalists), and real wealth in the value of capital.

The transaction flows matrix 3 also makes sure that flows ultimately sum to zero. Pluses indicate inflows and minus signs indicate outflows. While wages are an outflow (-) for the productive sectors, for example, the wage bill is an inflow (+) for wage earning workers. By combining the different tables, one can see more clearly the distribution between profits and wages to capitalists

	Energy	Green G/S	Brown G/S	Cap. Goods	Workers	Capitalists	Govt.	Banks	Total
Fixed Capital	$+K_e$	$+K_s$	$+K_n$	$+K_k$					$+K$
Deposits						$+M_{ca}$		$-M$	0
Loans	$-L_e$	$-L_s$	$-L_n$	$-L_k$				$+L$	0
Inventories	$+INV_e$	$+INV_s$	$+INV_n$	$+INV_k$					$+INV$
Advances							$-A$	$+A$	0
Balance	0	0	0	0	0	$-V_{ca}$	$-V_g$	0	$-V$
Σ	0	0	0	0	0	0	0	0	0

Table 2: Balance Sheet Matrix

and workers respectively. The government acts as both central bank and the fiscal government in this model. Thus, it consumes energy and goods and services, provides unemployment benefits to jobless workers. Any changes in stocks can be seen in the second part of the matrix table.

	Energy		Green G/S		Grown G/S		Investment		Workers	Capitalists	Govt.	Banks		$\sum$
	Current	Capital	Current	Capital	Current	Capital	Current	Capital				Current	Capital	
Consumption						$+S$		C_h	C_{ca}		$-G$			0
Energy	$-EB_s$		$-EB_n$		$-EB_k$		$+E$							0
Wages	$-WB_s$		$-WB_n$		$-WB_k$		$+WB_e$							0
Transfers									$+G_TU$		$-G_TU$			0
Taxes									$-T_h$	$-T_{ca}$	$+T$			0
Investment		$-I_e$		$-I_s$		$-I_n$		I	$-I_k$					0
ΔINV	$+\Delta INV_e$	$-\Delta INV_e$	$+\Delta INV_s$	$-\Delta INV_s$	$+\Delta INV_n$	$-\Delta INV_n$	$+\Delta INV_k$	$+DeltaINV_k$						0
Profits	$-F_e$		$-F_s$		$-F_n$		$-F_k$			$+F$		$-F_b$		0
Loan Interest	$-r_lL_{e_{t-1}}$		$-r_lL_{s_{t-1}}$		$-r_lL_{n_{t-1}}$		$-r_lL_{k_{t-1}}$					$+r_lL_{t-1}$		0
$\Delta Loans$		$+\Delta L_e$		$+\Delta L_s$		$+\Delta L_n$		ΔL_k					$+\Delta L$	0
$\Delta Deposits$										$+\Delta M$			$-\Delta M$	0
$\Delta NetWorth$		$+\Delta VK_e$		$+\Delta VK_s$		$+\Delta VK_n$		$+\Delta VK_k$		$-\Delta VK$				0
$\sum$	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3: Transaction Matrix

4.1 Households

4.1.1 Wage Earners

A list of all variables, parameters and equations can be found in the Appendix. In the household sector, employed wage earners ("workers") N earn a salary W_h from the productive firms and pay a portion of their income in the form of taxes θ_h to the government leaving disposable income YD_h. The unemployed U receive a salary from the government. The number of unemployed is the difference between the population λ and the workers demanded N.

$$U = \lambda - N \tag{2}$$

Both workers and the unemployed consume all of their income. While this is an oversimplification, it is a common assumption in post-Keynesian analysis and leaves the fundamental dynamics of the model unchanged.

As such consumption C_h of wage earners must be equal to total disposable income. The bundle of goods from both "green" and "brown" firms consumed is determined by a simple behavioral equation.

$$W_h N_h = W_e N_e + W_s N_s + W_n N_n + W_k N_k \tag{3}$$

$$YD_h = (1 - \theta_h) W_h N_h + \bar{G_T} U \tag{4}$$

$$YD_h = C_h \tag{5}$$

All household consumption is split between a minimum autonomous amount of energy use, and brown goods and services which can increase with time and income. Green consumption begins with 0 (all consumption is "unsustainable"), but increases to a greater portion of available disposable income once the climate threat becomes more clear. The government also influences social consciousness of green issues by privileging spending on sustainable goods and services, boosting an environmental ethic through cleaning pollution, maintaining parks, opening new wilderness preserves, health and education, etc. Governments can even spend money on advertising and marketing that specifically privilege sustainable values and community, outdoor play and local consumption, etc. $\beta_{s,h}$ is thus a function of emissions ($EMIS$) and sustainable government spending on green goods and services (G_s). Equation 8 shows that z is the ratio of a sector's propensity to consume sustainable vs. nonsustainable goods.

$$C_h = (1 - \beta_{s,h}) YD_h \qquad where\ 0 \leq \beta_{s,h} < 1 \tag{6}$$

$$\beta = f(EMIS, G_s) \tag{7}$$

z represents

$$z_t = \Sigma z_{i_t} = \frac{\beta_{s,i_t}}{\beta_{n,i_t}} \tag{8}$$

4.2 Capitalists

Capitalists, however, are able to save a portion of their income, and are assumed to be concerned with increasing wealth holdings. While workers earn wages and spend their income, capitalists take in profits the sum of profits from all productive and financial industries F_{ca}, allocating a portion of their post-tax income and accumulated wealth from the previous period $M_{ca_{t-1}}$, while saving the rest as deposits. This grossly underestimates the rise of financial wealth as an important reason for both economic growth and rising inequality (CITE), but does not change the fundamental principles of this model.

$$F_{ca} = F_e + F_s + F_n + F_k + F_b \tag{9}$$

$$Y_{ca} = F_{ca} + r_d(M_{ca_{t-1}}) \tag{10}$$

$$YD_{ca} = (1 - \theta_{ca}) F_{ca} + r_d(M_{ca_{t-1}}) \tag{11}$$

Since all wealth is held as bank deposits in this economy, total wealth at time t is equal to the money holdings. This can be derived from the difference between total disposable income and total expenditures in the period.

$$V_{ca_t} = M_{ca_t} = YD_{ca_t} - C_{ca_t} \tag{12}$$

Consumption by capitalists is based on a decision about how much they should consume out of real income and real wealth held from the previous period, represented by α_1 and α_2, respectively. Lowercase letters will hereby signify real values and uppercase letters will imply nominal values.

$$c_{ca_t} = \alpha_1 yd_t + \alpha_2 M_{t-1} \tag{13}$$

With the addition of the behavioral marker $\beta_{s,ca}$, one can determine the percentage of consumption spending going towards sustainable activities by capitalists.

$$c_{s,ca_t} = (1 - \beta_{s,ca_t})c_{ca_t} \tag{14}$$

4.3 Industry

4.3.1 Energy

Total energy required for output E is a function of the output in each sector (i) and the energy intensity of production ϵ for that sector. For the purposes of this paper, the energy sector is assumed to require no energy in itself but merely faces the cost of extraction. Energy is then required as an input in all other sectors. If the energy intensity of production declines, sustainability increases as there is less energy required to make a given unit of output. Energy productivity for the economy $pr_{e,y}$ is therefore the total amount of energy used divided by output.

$$E = \epsilon Y \tag{15}$$

$$pr_{e,y} = \frac{E}{Y} \tag{16}$$

Emissions and the Environment are not fully endogenized in this model, as there exists no supply constraint to energy (i.e. infinite resources) or demand constraint in the form of damage from excessive C02 output. Emissions $EMIS$ are a function of the previous year's accumulated emissions (reduced by an exogenous C02 absorption ratio ϕ) plus the portion of energy released as emissions. The emissions to output ratio of the economy can then be defined by the energy to output ratio (energy intensity) and the emissions produced per unit of energy used $\frac{EMIS}{E}$

$$EMIS_t = EMIS_{t-1}(1 - \phi) + \omega E_t \tag{17}$$

$$\xi_{EMIS,Y} = \frac{E}{Y}\frac{EMIS}{E} \tag{18}$$

4.4 Firms

Firms each sector earn revenue Y from sales to households, the government, and other firms. Capital depreciates at a specified rate δK with time. Firms also pay wages to workers $N_h w_h$, interest on loans $r_l L_i$ to banks. Regardless of the firm, all products are sold at a markup rate μ above production costs. Profits F can then be realized and distributed back to capitalists.

$$F_i = Y_i - N_{h,i} w_{h,i} - r_{l,i} Li_{t-1} - \delta K_{i_{t-1}} \tag{19}$$

4.5 investment

Investment growth takes is a function of animal spirits, actual capacity utilization and targeted utilization.

$$g_k = \gamma_0 + \gamma_1(u_{t-1} - u^T) \tag{20}$$

Capacity utilization u is the fraction of realized output to potential output Y^P. Potential output is itself made up of the total capital stock multiplied by the productivity of capital.

$$u = \frac{y}{y^P} \tag{21}$$

$$y^P = K\xi_k \tag{22}$$

Real investment depends on desired capital growth and the rate of depreciation of capital.

$$i = MAX[g_k + \gamma\, 0]k_{t-1} \tag{23}$$

$$\Delta k = i - \gamma k_{t-1} \tag{24}$$

4.6 Costs

For the purpose of simplifying the model we assume no intermediate inputs or vertical integration of sectors. In reality, prices are mutually determined because of the nature of integration (Berg et al. 2015). All productive sectors require electricity as an input, determined through its energy productivity $pr_{e,i}$. Following Godin (2012), until full capacity, a firm's unit cost structure is a linear decreasing function of output y, capital stock k and debt L. Afterwards, unit costs become a quadratic increasing function while approaching full potential output.

Unit labor costs are represented by the ratio of wages W to labor productivity pr_n. The previous equation can complimented with the previous investment behaviour equations to see that firms do not replace depreciated capital when $u < u^T - \frac{\delta+\gamma_0}{\gamma_1} = u_{min}$

4.7 Prices

Having determined costs, one can now turn to prices. In standard kaleckian fashion, prices p are a markup μ on unit costs UC. The markup rate can be split in two, as a certain percentage is typically either to be distributed as profits μ_1 or used to pay interest on loans μ_2 giving

$$p = (1 + \mu_1 + mu_2)UCy^e \tag{25}$$

where y^e is expected sales. Total dividends are considered to be comprised of the desired rate of return on capital r_s, given the capital stock.

$$F = p_{k_t-1} r_s k_{t-1} \tag{26}$$

CONTINUE

4.8 Commercial Banks

Commercial banks hold money deposits from capitalists M and give pay out an interest $r_d M$. At the same time, banks make loans L to firms and receive an interest rate r_l

$$\Delta M = \Delta M_c a \tag{27}$$

$$\Delta L = \Delta L_e + \Delta L_s + \Delta L_n + \Delta L_k \tag{28}$$

Banks also balance their holdings by buying bonds from the government at rate r_b

$$F_b = r_l L_{t-1} - r_d M_c a + r_b B_{t-1} \tag{29}$$

4.9 Government

The government has a fundamental role to play in the economy as it 1) acts as the central bank by setting interest rates for banks to distribute loans 2) spends money on green $C_{g,s}$ and brown $C_{g,n}$ goods and services, and 3) provides a guaranteed minimum salary to unemployed workers UB.

The government collects taxes on both wages and wealth as shown in the following equation.

$$T = \theta_h(N_h W_h) + \theta_{ca}(F_{ca}) \tag{30}$$

Governments then spends money in the diverse sectors for various goods and services, with different propensities to consume. First, it consumes an exogenously defined amount of goods and services, such that

$$C_{g,t} = \omega p_t \tag{31}$$

Some level of government consumption is constant. Total government spending, though, includes unemployment benefits paid out to the non-working population.

$$G = C_{g,s} + C_{g,n} + G_t U \tag{32}$$

The government therefore also has a decision to make as to spending between green and brown consumption goods and services $\beta_{g,s}$, much like households. With time, it is assumed that a "green ethic" is incorporated into government policy and sustainable consumption increases i.e. there is an increase in z.

$$z_g = \frac{\beta_{g,s}}{1 - \beta_{g,s}} \tag{33}$$

Total government spending minus income gives the budget deficit BD.

$$BD_t = G_t - T_t \tag{34}$$

So far this is just a rough sketch of what an SFC model with an additional consumption sector will look like. Preliminary results are forthcoming.

4.10 Dematerialization through Sufficiency

As has been shown above, changing the type of consumption - be it through dematerialized services or green products - is unlikely to bring about lasting change without drastically altering consumer culture and a massive expansion of the public sector into private modes of production and consumption. What is left, then is a necessary shift away from the quantity of what is consumed, with an aim towards quality; sufficiency should be sought over efficiency. In his treatise on the "Economic Possibilities of our Grandchildren", Keynes (1933) had presaged that technological advancements and growing wealth would be so great in the future that once basic needs and a certain level of material comfort had been met, consumption and productive investments would level off and people would begin choosing leisure over material goods. While incomes and productivity have certainly grown, the wealth gains achieved since Keynes' writing have not been spread evenly; income inequality has worsened in many parts of the world, especially in the last several decades (Piketty 2014, Stockhammer 2014).

Additionally, Keynes had overlooked a fact of consumption that has long been established in sociological literature, both theoretically and empirically. Needs are not exogenously set but endogenously developed over time and in relation to reference groups of social peers, media, and institutions (Veblen 1899; Dusenberry 1949; Lavoie 2009a; Frank et al 2010). As such, while Keynes had envisioned a future steady state in which investment had fallen to a level that would merely replace capital depreciation, and consumption would increase only to some point of satiety, there has been no movement towards such a society. Though there are a number of other institutional and historical factors to be blamed, this can be partially explained because of constantly evolving preferences (Stiglitz 2008). If anything, new consumption norms, spurred on by advertising, deregulation of the financial services industry and exacerbated by stagnant wages over the last 40 years, may have permitted a vicious cycle of greater consumption and rising debt (Barba & Pivetti 2009).

Post-Keynesian authors have contributed greatly to better understand the effects of a fall in both the wage share and declining, even negative savings rates in the era of financialization. Given the role that debt-led consumption played in inflating the pre-crisis bubble, it is striking that financial, social, and ecological sustainability of consumption remain disparate fields of inquiry within most economic analyses. Increasing the quantity of consumption for the sake of consumption is hardly a goal that post-Keynesians or environmentalists can justifiably rally behind when considering its destabilizing financial capabilities, its association with psychological illness and social deterioration, and the vast amounts of resources used and physical waste produced as a consequence.

While consumption has markedly increased since the time of Keynes' writing, there is little evidence that improvements in well-being in the developed world have kept pace. In fact, most studies show that consumption is poorly linked with personal happiness, and that which is most appreciated - eg. leisure time and social connectedness - are often undermined by individual consumption desires (Deleire & Kalil 2010). Empirical evidence tends to confirm that beyond a certain level of basic needs being met, higher levels of income and consumption do not breed a concomitant rise in well-being (Ahuvia 2007, Easterlin et al. 2010).

A number of economists have suggested, therefore, that rather than focusing on the type of consumption (ie. how resource or energy intense it is) or the quantity of what is consumed (which is poorly correlated with well being), society should be more concerned with the quality of what is being consumed and the values that such consumption propagates. The dominant economic paradigm has tended to privilege individual benefit over collective goals and action, and given preference to more, over better consumption, often to the detriment of both the individual and the group (Haberl, et al. 2010). As Jackson (2011, p. 163) explains, "structural change must lie at the heart of any strategy to address the social logic of consumerism. And it must consist in two main avenues. The first is to dismantle the perverse incentives for unproductive status competition. The second must be to establish new structures that provide capabilities for people to flourish — and particularly to participate meaningfully in the life of society — in less materialistic ways."

A host of post-consumerist policies that appeal to a new set of communitarian social values may be necessary to reverse individualistic tendencies, the unending search for acquisitive power, and achieve some equilibrium level of sufficiency (Schneider 2011, Latouche 2007, Jackson 2009). For high levels of consumption to be economically sustainable, it will have to be financed through income rather than credit, which will require strict regulations on both credit lending and advertising to reverse the common trend of rising consumer debt. The fall in what is deemed "unsustainable" consumption will have to be compensated by opportunities for higher quality sustainable consumption and investment which support alternative lifestyle choices like car sharing, work sharing, and co-housing that breed community-building and foster communitarian values (Schneider et al. 2011). Some of these will mean a drop in paid services, thus reducing private consumption; but other activities - education, cultural services, locally produced organic food, personalized home health care - could be high-value added because of the artistry, knowledge and labor intensity involved (Dullien et al 2011, p. 193). Governments, acting as the employer of last resort can step in to ensure that the values and opportunities provided in the marketplace are those which contribute to sustainable goals, stepping once more behind the steering wheel to procure a green future. Low-energy, labor-intensive jobs can be a net boon to both employment and the environment by accomplishing socially necessary tasks with little material throughput (Forstater 2003, 2006). Rather than new infrastructural developments into previously wild territories, governments can focus on updating existing systems that have become dilapidated or can be retrofitted to new needs and efficiency standards. A "Green Corps" could help maintain or build new parks and public spaces to encourage communal gathering, promote recycling and creative reuse of waste, and institute community and rooftop gardening schemes. Whether in open green spaces or on city sidewalks, a dedicated sector of laborers could provide a universal social benefit by beautifying surroundings and cleaning pollution from where it is needed most. Such policies can lead to a virtuous cycle of appreciation for the natural world, as well as endear communitarian values, all while providing the backstop of full employment.

5 Conclusion

Thus far, it has been established that 1) counting on expanding investments in sustainable technology alone in order to dematerialize the economy is likely misguided. Not only can such efficiency-

only policies backfire and increase resource use and greenhouse gases, but the scale of the problem at hand may be too large for technical fixes alone to meet sustainability needs. 2) While consumption expenditures must rise to compensate for a fall in investment to reach a steady state, it is neither socially nor environmentally preferable for material consumption to increase and 3) dematerialization under the current market paradigm will not occur without a significant change in social values and associated government intervention. As such 4) consumption of material goods should fall in favor of policies promoting sharing, cooperative action and an expansion of the commons. 5) While these policies will necessarily decrease material consumption, they open up the opportunity for high quality consumption services that use less resource inputs, are far less likely to incite a rat-race of conspicuous consumption, and instead lead to a virtuous increase of individual, social, and environmental well-being.

The non-linearity of poorly understood environmental processes, their importance in economic production and in determining well-being, mean that post-Keynesians will have to consider a broader range of policy recommendations that can accommodate global concerns yet be adaptable to local needs and changing situations. Ecological macroeconomics has only scratched the surface of topics yet to be covered, and the field still lies on the margins of general post-Keynesian research agendas.

Non-renewable resource use has been covered at length, for example, but natural resources once thought renewable, like fresh water availability and agricultural biomass, are also in peril if massive mitigation efforts are not undertaken. Population growth in water-scarce regions, climate change, and soil degradation from excessive fertilizer use, monocultures and desertification could create a "perfect storm" of crises in the future that will go far beyond impacting economic growth (Gomiero, et al. 2011; Telles, et al. 2011). Confronting these issues will require new analytical tools and a more holistic understanding of how disparate natural and man-made systems interact (Ropke 2015).

Economics must recognize that human development sits precariously atop a fragile socio-ecological system, and social goals are inevitably tied to ecological sustainability. The resilience of political and social systems will be dependent on their ability to offer meaningful, high-quality livelihoods to growing numbers while using less resources, more evenly distributing them, and constantly adapting to new climate challenges.

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