

Article

## Monetary and Fiscal Policies for a Finite Planet

Joshua Farley <sup>1,2,\*</sup>, Matthew Burke <sup>1,2</sup>, Gary Flomenhoft <sup>2</sup>, Brian Kelly <sup>1,2</sup>, D. Forrest Murray <sup>2</sup>, Stephen Posner <sup>2</sup>, Matthew Putnam <sup>1,2</sup>, Adam Scanlan <sup>2</sup> and Aaron Witham <sup>3</sup>

<sup>1</sup> Department of Community Development and Applied Economics, University of Vermont, 617 Main Street, Burlington, VT 05405, USA; E-Mails: mburke2@uvm.edu (M.B.); bkelly4@uvm.edu (B.K.); meputnam@uvm.edu (M.P.)

<sup>2</sup> Gund Institute for Ecological Economics, University of Vermont, 617 Main Street, Burlington, VT 05405, USA; E-Mails: gflomenh@uvm.edu (G.F.); fmurray@gmail.com (D.F.M.); sposner@uvm.edu (S.P.); adambscanlan@gmail.com (A.S.)

<sup>3</sup> Green Mountain College, One Brennan Circle, Poultney, VT 05764, USA; E-Mail: withama@greenmtn.edu

\* Author to whom correspondence should be addressed; E-Mail: jfarley.uvm@gmail.com; Tel.: +1-802-656-2989; Fax: +1-802-656-1423.

*Received: 15 April 2013; in revised form: 29 May 2013 / Accepted: 30 May 2013 /*

*Published: 20 June 2013*

---

**Abstract:** Current macroeconomic policy promotes continuous economic growth. Unemployment, poverty and debt are associated with insufficient growth. Economic activity depends upon the transformation of natural materials, ultimately returning to the environment as waste. Current levels of economic throughput exceed the planet’s carrying capacity. As a result of poorly constructed economic institutions, society faces the unacceptable choice between ecological catastrophe and human misery. A transition to a steady-state economy is required, characterized by a rate of throughput compatible with planetary boundaries. This paper contributes to the development of a steady-state economy by addressing US monetary and fiscal policies. A steady-state monetary policy would support counter-cyclical, debt-free vertical money creation through the public sector, in ways that contribute to sustainable well-being. The implication for a steady-state fiscal policy is that any lending or spending requires a careful balance of recovery of money, not as a means of revenue, but as an economic imperative to meet monetary policy goals. A steady-state fiscal policy would prioritize targeted public goods investments, taxation of ecological “bads” and economic rent and implementation of progressive tax structures. Institutional innovations are considered, including common asset trusts, to regulate throughput, and a public monetary trust, to strictly regulate money supply.

**Keywords:** monetary; fiscal; public; policy; steady-state; ecological; biophysical; macroeconomics; money; debt

---

## 1. Introduction

A steady-state economy must follow clear rules: renewable resource extraction cannot exceed the regeneration rate, pollution outflows cannot exceed absorption capacity, neither extraction nor pollution can threaten essential ecosystem functions, and essential non-renewable resources cannot be depleted faster than we develop substitutes. Current levels of throughput exceed all these rules. De-growth, defined as decreasing levels of throughput, is therefore an essential first step towards a steady-state economy.

The current interest-bearing, debt-based system of money creation stimulates the unsustainable growth economy; it exacerbates boom and bust cycles, while systematically transferring wealth and resources to the financial sector. In addition, this system disproportionately favors investment in the creation of market goods and services, while underinvesting in public goods. With interest rates exceeding economic growth rates, this monetary system is inherently unsustainable, even if it existed on an infinite planet.

The restoration of the money creation system to the public sector, with built-in mechanisms for reducing the money supply over time as the economy contracts, is a necessary part of the transition to a steady-state economy. Section 2 discusses the constraints that govern our physical, ecological and monetary systems on a finite planet. Section 3 discusses the necessary components of monetary and fiscal policy concordant with a steady-state economy. Section 4 discusses transition, while Section 5 concludes with potential areas of future investigation.

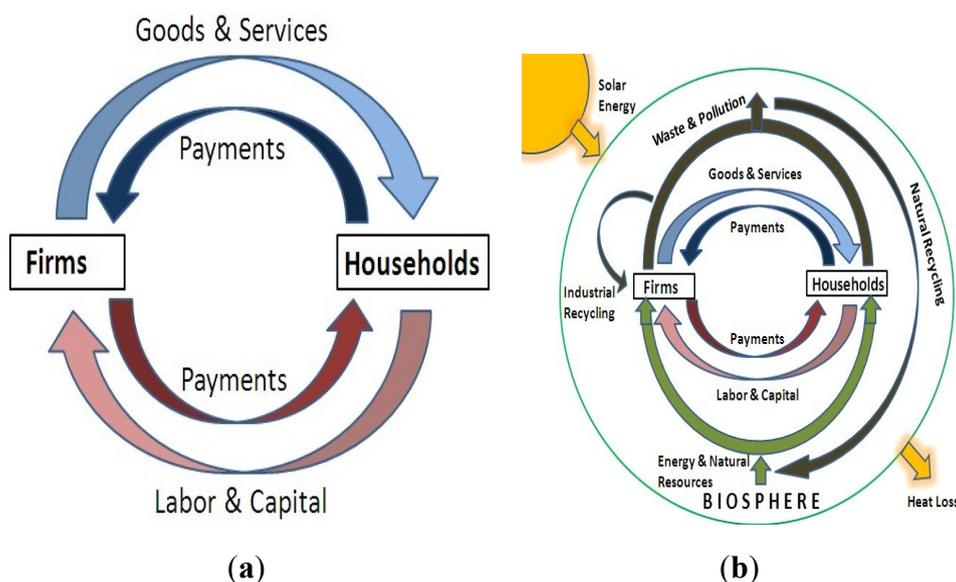
## 2. Biophysical Limits on a Finite Planet

Conventional economic theory emerged just as the concentrated energy of fossil fuels was unlocking previously inaccessible mineral resources, dramatically increasing our capacity to capture and utilize biological resources and powering an unprecedented increase in economic output. For the first time in human history, ordinary people could expect their children's lives to be better than their own. Surplus economic production allowed society to devote ever-greater resources to scientific and technological advances that further alleviated short-run resource constraints. Seventeenth century Newtonian physics drove many of these advances, and neoclassical economists eager to transform economics from moral philosophy into objective science consciously adopted its reductionist, mathematical methods. Rather, they could focus on their perception of human beings as rational actors and the study of them as an objective, rather than subjective, science.

However, it was not long before economists concluded that human ingenuity could provide substitutes for all natural resources and focused almost entirely on labor and capital as the only factors of production. They, therefore, modeled the economy as a circular flow, in which firms purchased the factors of production from households and households used the resulting income to purchase final products from the firms, as seen in Figure 1a. Resource inputs and waste outputs were increasingly

ignored. This economic model was treated as the whole system, in which money circulates in one direction, while real physical commodities circulate in the other, in a self-renewing process capable of growth without limit. A biospherically-contextualized circular flow diagram is presented in Figure 1b, which provides the backdrop for the analysis provided in this paper.

**Figure 1.** (a) The conventional view of the economy. (b) A view of the economy contextualized within the biosphere (adapted from GDAE learning module [1]).



The power of fossil fuels, however, has allowed us to deplete natural capital stocks and increase waste emissions to levels that diminish the ecosystem's capacity to reproduce itself and to sustain other ecological functions critical for society. It is now increasingly evident that economic growth is the driving force behind climate change, biodiversity loss and natural resource depletion, the most serious problems that society now faces. The tangible suffering of the 2008 financial crisis can also be attributed to the pursuit of economic growth. Transition to a steady-state is similar to the slowing of growth rates during ecological succession: young, rapidly-growing economies or ecosystems benefit from high rates of growth, while mature economies or ecosystems must dedicate more resources to maintaining their existing structure, and cannot sustain net growth [2]. Economics can no longer ignore the laws of physics and ecology and the natural resource base on which society and the very existence of an economy depends.

### 2.1. The Laws of Physics

The first law of thermodynamics says that it is impossible to create something from nothing. All economic products result from the transformation of raw materials provided by nature. Furthermore, it is impossible to create nothing from something. All human-made products break down, wear out and eventually fall apart, returning to the environment as waste. The extraction of raw materials from nature and the return of disordered waste are known as throughput. Simply maintaining existing capital stocks in the face of entropy requires continuous flows of throughput [3]. This physical throughput is essential to nearly all economic processes, including electronic and information transactions, which depend on some combination of power in the form of electricity, gasoline or food

and tools in the form of paper, pens, computers or phones, all of which depend on throughput. What's more, the money exchanged can then be used on more physically intensive goods and services and all but ensures at least another comparable transaction, which ensures another, and so on. In short, the economic system inextricably depends on a flow of throughput.

The second law tells us that transformation of raw material inputs into economic products and waste requires low entropy energy, irreversibly converted through use into high entropy waste. Money is still money after it is used, but this not true for resource inputs or economic outputs: we can no more feed our economy on its own waste products than an animal could survive off its own excrement. Recycling energy is impossible [4]. While the flow of solar energy is vast relative to human needs, it also strikes the earth at a fixed rate over time and is difficult to capture and store. Finite stocks of fossil fuels account for nearly 90% of all energy used for economic production. We can use fossil fuels almost as fast as we like, but once used, they are gone forever. Production of the most valuable of these fuels, petroleum, has likely reached a plateau already en route to inevitable decline. From January 2005 to July 2008, a 350% price increase was unable to increase output by even 4% [5], as seen in Figure 2. The renewable alternatives to fossil fuels are available in vast quantities, but most are highly diffuse, difficult to capture, transport and store and flow at a fixed rate over time [6,7], which does not afford us the luxury of using them at whatever rate we like. Sustainability demands that we deplete fossil fuel stocks no faster than we master the technologies required to bring alternative energy sources on line [3].

**Figure 2.** Oil production and oil prices from 2003 to 2010.



The very simplest laws of physics and mathematics tell us that exponential growth of any physical subsystem of a finite system is impossible. Since all economic production consumes raw materials and generates waste, the economy is a physical system. Therefore, we must develop a steady-state economy, characterized by a constant rate of throughput compatible with the planet's carrying capacity. Throughput already vastly exceeds the planet's carrying capacity [8,9]. A prerequisite for a steady-state economy is, therefore, a dramatic reduction in current levels of throughput and, hence, the physical size of the economy.

## 2.2. The Laws of Ecology

The laws of ecology impose even tighter constraints on economic activity than the laws of physics. Many of the raw materials physically transformed into economic products alternatively serve as the structural building blocks of ecosystems. Society can largely determine how fast to deplete available stocks, like forests and fish. However, when ecosystem structure is removed and waste returned, often in novel forms to which ecosystems have not had an opportunity to adapt, ecosystem functions are affected. A particular configuration of ecosystem structure creates an ecosystem fund that generates a flux of services over time. The ecosystem fund is not physically transformed into the services it provides, but humans have little direct control over the rate at which these services are provided [10]. Many of these services are essential to sustaining life, including the capacity for ecosystems to regenerate [11,12].

Ecosystems are highly complex and subject to the non-linearities, positive and negative feedback loops, surprises and emergent behavior characteristic of complex systems [13]. They are also poorly understood, so we rarely know in advance the long- (or even short-) term impacts of our activities [14]. Many ecosystem services are likely characterized by critical thresholds, beyond which they will flip into entirely different states, potentially far less amenable to the survival of humans and other species [12].

A steady-state economy demands resilient ecosystems capable of transforming solar energy into a continuous flow of ecosystem goods and services. There are, therefore, two ecological requirements for a steady-state economy. First, humans cannot degrade or deplete any element of ecosystem structure (e.g., fish, forests or fresh water) faster than it can restore itself without eventually crossing some threshold beyond which that component of the structure is gone or, else, the ecosystem itself crosses an irreversible threshold. Enough structure must be left intact to maintain the flux of ecosystem services upon which humans and other species depend.

Second, humans cannot emit waste into any finite system at rates greater than it is absorbed or, else, waste stocks will accumulate, eventually harming humans and/or the ecosystem. Unfortunately, economists' and decision makers' failure to acknowledge the importance of natural resources has led us to surpass these limits [15]. It is now essential to reduce resource extraction below regeneration rates and waste emissions below absorption rates until stocks are restored to levels compatible with ecosystem resilience and the continued provision of ecosystem services.

## 2.3. The Laws of Money

Herman Daly has pointed out that anyone who thinks they really understand money probably has not studied it enough [15]. We do not claim we fully understand the role of money in the complex ecological economy, but do believe we have important insights that explain why the current approach to money creation and circulation is incompatible with a steady-state economy and how alternative systems could help us achieve one.

Money functions as a lubricant that greases the gears of the economy. When economies grow, they require more money to chase more goods and services. When money becomes too scarce, the engine of economic growth can grind to a halt, typically causing serious misery in the process. However, the rise in misery is not the result of a no-growth or de-growth economy, but rather, the result of poorly constructed economic institutions, in general, and the monetary system, in particular.

Modern economies use fiat currencies, which are not backed by any physical commodity, but, nonetheless, can serve as a means of exchange, a store of value and a unit of account. Fiat money, at its core, is an information system [16]. Money retains its value due to mutual trust in its usefulness. If people lose faith in a particular currency, its value will decline or people will switch to other representations of wealth or mediums of exchange. Historically, many currencies were at least partially backed by commodities, meaning that at any point in time, at least some portion of the currency could be exchanged for a specific amount of a particular commodity (e.g., gold). In the modern era, national fiat currencies are backed largely by the taxation power of the government. Everyone accepts government currency, because the government requires it for paying taxes. However, when everyone accepts money for goods and services, those goods and services then also back the money supply. A fiat currency can exist with no taxes, which is the case for many complementary currencies, but it only makes sense for someone to accept it if everyone else does. Taxes trigger the initial acceptance, but the money supply is then backed by the productive capacity of the economy. As the official currency of Ecuador, Liberia and Panama and global petroleum markets, the US dollar is backed by a lot of productive capacity. The productive capacity of the economy, of course, is sustained by the planet's finite stocks and flows of natural capital.

Modern monetary theorists (e.g., Warren Mosler, Bill Mitchell, James Galbraith, L. Randall Wray, Rodger Mitchell), who publish much of their work on the topic in on-line blogs, make a convincing case that in fiat monetary systems, there are two main sources of money. The national government (including the treasury and central bank) [17] ultimately has a monopoly on national currencies, which are known as vertical money that they can simply spend or loan into existence. Governments print and spend actual notes and coins, but primarily create money through electronic deposits directly into bank accounts in payments for goods and services or as direct transfers. Central banks increase money supply by purchasing government bonds with money created for that purpose. Since 2009, the US government sold \$1.5 trillion (net) in government bonds to the Fed [18], which credited government accounts with newly created money. When governments collect taxes or other fees or when the central bank or government sells bonds to the public, money is destroyed (though selling bonds creates an obligation to create more money in the future). When the government repays the Fed with tax income, the money will be destroyed. By law, 94% of the Fed's profits are returned to the government, so when the Fed purchases bonds directly from the government, it is roughly equivalent to spending money into existence then taxing it back.

In spite of the popular notion that governments must tax or borrow before they can spend, logically, governments must first create and spend fiat currencies before they can tax or borrow them back. Lincoln, for example, created "greenbacks", a fiat currency, to finance the Civil War, followed by an income tax just a few months later [19].

There is net creation of vertical money when national government expenditures exceed government revenue collection and net destruction when the opposite is true. Vertical money is created debt-free and the vast majority of it ultimately ends up in bank deposits.

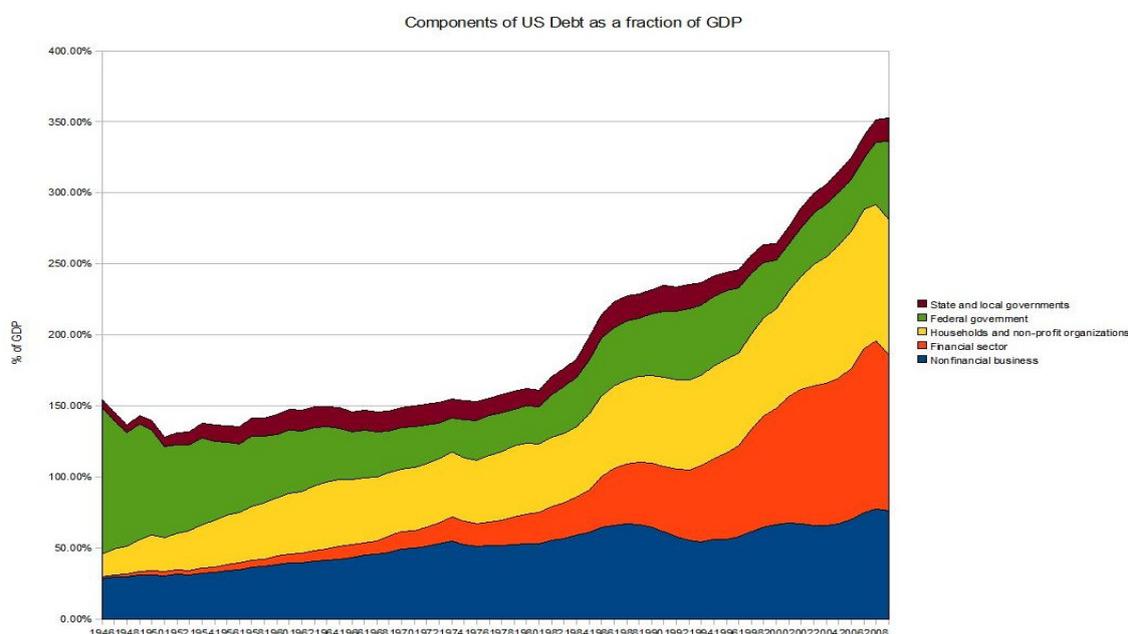
Vertical money, however, is only a small fraction of the total money supply. The bulk of the supply is horizontal money, created when banks loan the vertical money they hold to producers and consumers. Under fractional reserve banking, banks are required to keep only a small percentage of deposits on hand, say 5%. The rest can be loaned out, but ultimately ends up deposited in another

bank, which can again loan out 95%, *ad infinitum*. With a 5% reserve requirement, horizontal money can increase the monetary base by 20-times over vertical money alone.

There is considerable debate over whether or not fractional reserve requirements actually determine how much money banks can create. An alternative view, known as endogenous money theory, argues that banks will actually make any loan they believe is likely to prove profitable. At the end of the day, banks that have loaned too much can borrow from those who have excess reserves or from the central bank itself, in order to comply with reserve requirements. When the demand for such loans grows, it drives up interest rates. If central banks are targeting interest rates, they will be forced to increase the money supply, typically by buying government bonds from bond traders and crediting their bank accounts with money that banks can then loan out. From this perspective, the amount of money in the economy is largely determined by how much banks want to lend and firms and households want to borrow. Investments by firms, of course, increase the productive capacity of the economy. Though an over-simplification, we can think of vertical money as being backed by government taxes, while horizontal money is backed by the productive capacity of the economy.

Regardless of whether fractional reserves or banks and firms determine the horizontal money supply, horizontal money is created as interest bearing debt. Total interest bearing debt in the US, adding together consumers, businesses and the government, was about \$50 trillion dollars in 2009, as depicted in Figure 3. Banks loan only principle, but demand repayment of principle plus interest. Firms want to make a profit on their investment, which requires selling their output to households, other firms and government. Most household income comes from firms and is used to purchase output by firms, but they also set some aside as savings. The only way each of these actors can achieve their goals is through the continuous creation of new money, either vertical or horizontal. A constantly increasing supply of real money (*i.e.*, of real purchasing power) is only possible in a continually growing economy. Failure to grow leads to massive default on debts, which are inevitably accompanied by misery, poverty and unemployment.

**Figure 3.** Components of US Debt as a fraction of GDP (with data retrieved from Federal Reserve Flow of Funds data) [20].



Though the modern money supply is not a physical system, our current debt-based currency represents a lien on future production. Debt grows exponentially, obeying the abstract laws of mathematics. Future production, in contrast, confronts ecological limits. Interest rates on debt exceed economic growth rates even in good times. Eventually, the exponentially increasing debt must exceed the value of current real wealth and potential future wealth, and the system collapses. The economy cannot grow forever as a physical system [21–23]. Even if we lived on an infinite planet, the interest rate on a debt-based monetary system could not exceed the growth rate of the economy (both measured in real terms) over the long term without inevitably causing a major default on debt [24].

In our current system, we face an unacceptable choice between ecological catastrophe and human misery. Unfortunately, our existing monetary system is not compatible with a steady-state economy. The monetary system today is not linked to the physical and ecological systems upon which our economies are based. We need to design both monetary and fiscal policies compatible with a steady-state economy.

The transition to a steady-state will require not only a new monetary system, but also new goals for monetary and fiscal policy. This paper describes what this new monetary system would look like and how macroeconomics would need to be changed. Simply put, the goal of ever-increasing material consumption must be replaced by the goal of sustainable well-being for humans and other species, which, in turn, requires ecological sustainability, just distribution and economic efficiency, defined as maximizing economic services created per unit of natural capital transformed. As Herman Daly said, “Growth chestnuts have to be placed on the unyielding anvil of biophysical realities and then crushed with the hammer of moral argument. The entropy law and ecology provide the biophysical anvil. Concern for future generations and nonhuman life and inequities in current wealth distribution provide the moral hammer” [25].

### **3. Building a Sustainable Macro-Economy**

While most central banks have legal mandates to stabilize prices and sometimes maintain full employment, the textbook definition of a recession is two consecutive quarters with negative growth in GDP. This implies that the main goal of macroeconomic policy is to promote continuous economic growth. Changing goals is a powerful lever for changing complex systems [13]. Society should adopt the central economic goal of sustainable well-being for humans and other species. On a finite planet, this goal would require a steady-state economy that offers meaningful employment to all with an equitable distribution of resources among humans and between humans and other species. Rather than an obsessive focus on built capital and material consumption, this goal would require balanced investments across natural, human, social and built capitals, all of which make critical contributions to the quality of life [26]. Recession would be redefined as unacceptable or increasing rates of poverty, misery, inequality and unemployment, or unsustainable levels of throughput that must inevitably lead to such problems in the future. These new goals would lead to fundamentally different macroeconomic policies and rules, another powerful lever for changing complex systems [13].

### 3.1. Problems with the Current System

We have already explained how our current monetary system forces us to choose between ecologically unsustainable growth and human misery. There are several additional problems that make it difficult to achieve the new macroeconomic goals described above. Such problems must be avoided in any alternative system.

One of the most serious problems with our current system is its pro-cyclical nature: it exacerbates both booms and crashes. Banks loan money readily when the economy is booming, thus promoting bubbles, and call in loans faster than they make new ones during down-turns, potentially turning them into major recessions. In other words, our current system creates positive feedback loops when negative feedback loops are required.

Minsky makes a convincing case that firms decide how much to borrow and banks how much to loan based on recent economic history. A firm engaged in hedge investments will make sure that it can meet payments on both principles and interest from its expected cash. The longer a period of stable economic growth continues, the more confident banks and firms become that firms can meet obligations on debt payments from current income and the higher a ratio of debt obligations to income they are likely to tolerate. As firms become more confident in the free flow of credit, some will begin making speculative investments, for which they can repay interest on loans from current income, but count on being able to roll over the principle. Eventually, some firms may make Ponzi investments, which means they rely on new loans simply to make interest payments. At this point, even a small exogenous shock that increases firms' costs, decreases revenues or reduces bankers' willingness to lend will force the Ponzi investors to sell off assets to make payments. As investors begin to sell off assets, asset prices fall and, along with them, income flows. Banks may become unwilling to roll over the principle on loans to speculative investors, forcing them to sell off assets, as well. The resulting economic destabilization can reduce income to hedge investors, eventually causing them to default. Minsky viewed the transition from hedge to Ponzi investments and, hence, financial instability, as virtually inevitable [24].

This Minskyian cycle becomes even more serious when an economy confronts biophysical limits. Many proponents of endogenous money theory argue that money is loaned into existence for productive investments, increasing supply along with demand and, hence, that endogenous money creation is not inflationary. However, some factors of production, particularly land, have perfectly inelastic supply, so any increase in demand will lead to an increase in price. Non-renewable resources, including, most importantly, fossil fuels, have perfectly inelastic supply in the long run and relatively inelastic supply in the short run. For example, oil supply increased less than 4% in response to a 350% price increase between 2005 and July, 2008 [5]. Agricultural products also have highly inelastic supply in the short run, and renewable resources have inelastic supply in the long run, especially when exploited faster than they can reproduce. Increasing demand for such resources will lead to an increase in price, which, in turn, is likely to attract speculators. Speculative demand further increases price, attracting yet more speculators in a positive feedback loop. Higher asset prices provide more collateral for more bank loans and more speculative investment, driving up asset prices even further in an inflationary process. Such asset bubbles cannot be sustained indefinitely. Eventually, prices will cease to rise, reducing speculative demand. As falling demand causes prices to drop, speculators will sell,

causing a further decline in price. Speculators who had leveraged their investments with extensive loans will be unable to make payments and will default. Banks, in response, will dramatically restrict their lending. As old loans are repaid faster than new loans are made, the money supply contracts, making it virtually impossible to repay principle plus interest, driving further defaults, emergency asset sales, declining prices, and so on, in a deflationary positive feedback loop. Aggregate demand declines, and the resulting layoffs lead to further decline in demand. The result is a self-reinforcing downward economic spiral, leading to recession or worse. The poor usually bear the brunt of the resulting suffering.

Another problem is that the current system systematically transfers resources to the financial sector and to those wealthy enough to lend. Borrowers must always pay back more than they borrowed. At 5.5% interest, homeowners must pay back twice what they borrow on a 30-year mortgage. The \$50 trillion total debt of the US is equal to 350% of GDP, and interest payments on that debt amount to a transfer of a significant fraction of national income to the financial sector. The share of the financial sector in GDP has risen in tandem with total debt.

A final problem is that the banking system will only create money to finance market activities that can generate the revenue required to repay the loan plus interest. Public goods, by definition, generate benefits for society as a whole, not just the individual investor. Since the banking system currently creates far more money than the government, horizontal money prioritizes investments in market goods over public goods, regardless of the relative rates of return to human well-being. Studies find that government investments in public goods regularly generate 25%–60% non-diminishing annual rates of return, in monetary measures [27]. While our goal is not to stimulate economic growth, public good investments in alternative energy, new forms of agriculture and other green technologies will likely play a critical role in reducing throughput. When the private sector invests in green technologies, it patents them, then charges monopoly prices, which ration access to those who can pay, which reduces the potential benefits offered by the technologies. In an apparent paradox, the value of the information underlying green technologies is maximized at a price of zero, which requires public provision and open access [28,29].

### *3.2. Solutions 1: Monetary Policy*

A new monetary system cannot force us to choose between economic misery and ecological collapse; rather, it must advance the macroeconomic goal of shared prosperity and the prevention of misery, poverty, unemployment, inequity and unsustainable throughput. Money creation, therefore, cannot be debt-based and interest-bearing. Modern money supply is ultimately backed by the taxation power of government and the productive capacity of a nation's citizens. The benefits of money creation should therefore be shared by the nation as a whole and not captured by a private financial sector. Money creation must be counter-cyclical, leading to economic stability in a no-growth economy. Money creation should also emphasize investments in public goods over private goods, since the most serious threats to human well-being, these days, revolve around the former.

Controversial as the proposal may be, we believe that to achieve all these goals, the public sector must reclaim the power to issue money, a constitutional right in the US, and take away this right from banks by gradually moving towards 100% fractional reserve requirements [21,23]. In essence, horizontal money must be eliminated and replaced with tightly regulated vertical money. The public

sector would create and destroy money through a variety of different mechanisms compatible with the goals described above. Banks would only be able to loan money in time deposits, in which case, the owner of the money forgoes the right to use it while it is loaned to someone else. Banks would be restricted to the role that most people believe they play anyway—serving as an intermediary between those who want to save their money and those who want to borrow it. The following sub-sections describe (1) how banks would function with 100% fractional reserves, (2) how governments would create and destroy money and (3) how society can transition to our proposed system.

### 3.2.1. Banks with 100% Fractional Reserves

A sustainable monetary system would eliminate the right of banks to create money. Instead, it would return banks to the simple business of protecting people's deposits and matching lenders with borrowers. In a steady-state economy, bank loans would be constrained by actual savings. Money saved in time deposit accounts could be lent out until maturity.

Dyson *et al.* [30] have proposed that each bank hold three electronic accounts at the central bank. The first holds all demand deposits in the form of digital money. Demand deposits could not be lent and would never be at risk, regardless of what banks do with their remaining money. In exchange, depositors would receive no interest on them, but rather would pay fees to the bank for the service of protecting them. The second centrally held account would be an investment pool, which that bank uses to make loans. This would correspond to time deposits or savings accounts that could not be withdrawn on demand—they would either be deposited for a fixed period of time, with penalties for early withdrawal, or would require a notification period before they could be withdrawn. Changing their name to 'investment deposits' would make it clear that banks would loan this money to investors and the money would therefore be at risk. Interest would be the reward for risk and for foregoing the use of the money being loaned. Different pools or banks could offer interest rates that vary with the risk of the loan. Interest rates would be determined by the supply and demand for money. If investments go bad and the money cannot be paid back, there would be no risk of systemic failure or bank runs and no risk to those taxpayers that did not choose to invest their money. The third account is the 'bank funds' account, which is used to pay salaries, keep profits, and so on. This would be the banks' own money, and they would also be free to invest it. Since banks would not be able to loan more money than they actually have, there would be no risk of bank runs, no need for a federal deposit insurance program and no risk to taxpayers.

The implementation of a 100% fractional reserve banking system will drastically change the structure of a bank's balance sheet by increasing the importance of time deposits, which will serve as the primary funds supporting loans. Individuals will have an incentive to invest in time deposits rather than liquid checking accounts. This, in turn, will affect the savings pattern of individuals. Many post-Keynesians argue that low savings rates are recessionary. Our goal, however, is to contract the physical size of the economy to a sustainable size. We will explain below how to achieve this without causing "recession," in our newly defined meaning of the word. Recall that our new definition focuses on sustainable well-being for humans and the ecosystem.

Banks would continue to specialize in acquiring information about borrowers and evaluating risk, reducing the problem of asymmetric information. Local banks run by local community members who

know prospective borrowers personally or know the people who vouch for them would of course be far better at reducing asymmetric information and, therefore, more efficient than large banks.

However, none of this explains where money would come from in this new system. The vast majority of money currently in circulation is created through fractional reserve banking. 100% fractional reserves would largely eliminate the existing money supply. Horizontal money would need to be replaced with vertical money.

### 3.2.2. Public Creation and Destruction of Money

The government could create vertical money in several different ways that would contribute to sustainable well-being. Various options are described below, and a steady-state economy would probably use a mixture of most or even all of them, learning by trial and error which approaches are most suitable. However, once vertical money has replaced horizontal money, a steady-state economy would require that the effective money supply fluctuate at approximately the same rate as economic activity fluctuates. As we will explain below, contraction of economic activity does not inevitably accompany a contraction of throughput. Regardless of the total money supply required, the creation of money would need to be balanced with the destruction of money in a manner that minimizes economic booms and busts. Each of the following options, therefore, describes both processes together for maintaining a stable money supply in a steady-state economy. The decision to increase or reduce the money supply must be based on transparent policy goals, considered below in Section 3.4.

#### 3.2.2.1. Lending and Repayment

In the same fashion that private banks create horizontal money, central banks could create vertical money by loaning it into existence. However, the goal of the central bank would be to regulate the money supply and advance the new macroeconomic goals, not to earn profit. Such a process could take several forms.

Perhaps the least disruptive process would be for central banks to make large time deposits in existing banks. These could initially be large enough to back all currently outstanding bank loans, so the shift to 100% reserves would scarcely be noticeable. There would, however, be at least four distinct differences from the current system. First, the central bank would have sole control over the money supply. Failure to renew deposits when they matured would contract the money supply. The central bank could use this power to regulate the size of banks, preventing market concentration. Many small local banks would likely be preferable to fewer, larger banks, not the least of which is because of their greater knowledge of risk in local communities. Second, the central bank could make deposits contingent upon banks serving the public interest by loaning to job-creating businesses that protect and provide jobs and public goods and not renewing deposits in banks that loan to speculators. Third, interest payments on these deposits would actually destroy money, gradually contracting the money supply. Fourth, businesses would know in advance that they could not rely on an ever-expanding money supply to repay loans plus interest and, therefore, would know that in the aggregate, they could not expect to increase revenue enough to repay principle plus interest with money left over for profit. This would deter speculative and Ponzi investors. However, it would be possible to cover principle, interests and profits by reducing costs through efficiency improvements. For example, both firms and

households could invest in energy retrofits, where cost savings would cover loan repayments, create jobs (specifically targeting the skills of construction workers who lost their jobs in the housing bust) and reduce throughput.

Another approach would be to transform banking into a public utility, perhaps gradually. In this case, all banks would be subsidiaries of the central bank and together would enjoy a monopoly on the money supply, just as existing water and sewage utilities typically have a monopoly on the services they provide. Rather than charging interest and earning profits, such banks could charge loan processing fees that would cover costs. Processing fees and repayment periods could depend on the nature of the loan. Businesses that would create jobs, protect or restore public goods, promote worker or community ownership or otherwise promote the common good could have very long repayment periods. For example, on money lent for energy efficiency retrofits, payments could be made entirely from savings on energy costs. Businesses focused entirely on private benefits would have shorter repayment periods and higher fees.

Initial loans would create new money to replace horizontal money. Once an adequate monetary base had been created, collecting outstanding loans faster than new ones were created would decrease the money supply, while the opposite would increase the money supply, if necessary, to reduce poverty, unemployment or misery.

#### 3.2.2.2. Spending and Taxing

Governments could also simply spend money into existence to provide public goods, invest in social and human capital, ensure full employment, rebuild decaying infrastructure, restore the natural systems that sustain us all and otherwise promote the common good. Many heterodox economists talk about job guarantee programs that would offer jobs to anyone who wished, but at low enough wages and benefits that it would not compete with the private sector for employment [31]. Our view is that public good investments are so important that it may be necessary to compete with the private sector for labor. We also believe that many labor saving technologies substitute fossil fuels for labor. As we reduce fossil fuel use, the demand for labor will rise. In a steady-state economy, we are more likely to suffer from labor shortages than labor surpluses.

Public goods, by definition, are not bought and sold on the market. Expenditures on public goods would therefore increase the demand for market goods without increasing their supply. Minsky argued that under the current system, there is not enough money available for principle, interest, profits and savings, unless the government engages in continuous deficit spending [24]. However, he assumed that the vast majority of money was loaned into existence to create market goods and, hence, that an increase in the money supply was the result of investments that would also increase the supply of market goods needing to be sold, leading to conditions of surplus production. The only way to sell this excess production was for government deficit spending that increased the money supply. Salaries for workers creating public goods, in contrast, would return to private sector firms, allowing them to repay outstanding loans, even without other firms taking out new loans to further increase output. A steady-state economy could therefore be compatible with interest-bearing loans, as long as such loans were sufficiently smaller than the total money supply. Total interest-bearing lending would need

to be limited, so as to avoid outpacing workers' expected surplus earnings, thereby requiring a future increase in money supply.

Grants to state and local governments would decentralize decisions about the type of public good investments that should be made. Some grants should be made for investments in public goods that will flow beyond the boundaries of state and local governments (SLGs), already a common practice. Many such grants, of course, are highly politicized (e.g., pork barrel spending), but there is no reason to believe that the level of politicization would increase.

Again, once the government had created enough vertical money to replace the existing horizontal money, any new money creation would have to be balanced by money destruction. This should be done through taxes or resource auctions, as describe in detail in Section 3.3. Any public sector decision to spend money into existence would have to be matched by a simultaneous increase in taxes or other form of revenue collection that would destroy that money. When the benefits from public investments are spread out over time, so too should be the resulting destruction of the money supply. This would be equivalent to the current use of government bonds to pay for capital investments, but with no interest payments.

Ironically, many economists argue that the public sector cannot be trusted to print and spend money, that it will create too much, causing inflation, and spend it irresponsibly. However, at least the public sector has a mandate to take care of the economy on behalf of all citizens, whereas private banks have no such mandate. Moreover, our view is that this outcome is much less likely when the goal is to gradually reduce the size of the economy. Furthermore, the US government printed \$1.6 trillion in government bonds to finance its deficit in 2010 alone, which must be paid back with interest. At the same time, the government actually reduced taxes. Issuing interest-free currency is much less risky, especially when accompanied by tax increases implemented at the time. In any case, it would be difficult for the government to underperform the private financial sector when measured by the new goals for macroeconomic policy. At the very least, voters have some control over governments and none over the banking sector.

### 3.2.2.3. Purchasing Bonds from State and Local Governments

While the constitution explicitly forbids money creation by states, the federal government could purchase interest-free bonds from state and local governments (SLGs), which would devolve monetary policy to the local level. There are clearly many advantages to decentralized decision-making. The maturation date for the bonds could depend on their use. For example, bonds used to finance infrastructure could have several different maturation dates, so that payments would be made by all the generations that benefited from the infrastructure. To prevent politicization of the loan purchases, for example, an administration refusing to purchase bonds from a state that voted against that administration, the federal government could be compelled to purchase bonds if the SLGs met certain pre-determined conditions. One condition would be that the SLG would have to implement future taxes that pay for the bonds at the same time that the bonds were issued, so that destruction of the money would be built into its creation.

### 3.3. Solutions 2: Fiscal Policy

Fiscal reform is also required to meet the goals of the macroeconomic policy described above. As described above, a steady-state economy would require that the effective money supply contract at approximately the same rate as economic activity contracts. The implication for a steady-state fiscal policy is that any lending or spending requires a careful balance of recovery of money, not as a means of revenue, but as a means to meet monetary policy goals. In a steady-state economy, the political process must ensure democracy, transparency, accountability and public participation. Because monetary policy is limited to determining the supply of money, the specific allocation of public sector funds will be determined through this political process, but here, we may expand on the above discussion to recommend priority public investments for fiscal policy in a steady-state economy (SSE).

#### 3.3.1. Public Expenditures in a SSE

Careful resource allocation is critical for the effectiveness of public investment in a steady-state economy. Public sector allocations would support explicit public goals, such as full employment, human well-being, social justice and equity and a sustainable rate of throughput, as measured by alternative indicators.

Misch and Wolff indicate a lack of theoretical and empirical research to provide insights for optimal public resource allocation across different sectors and different public investment projects [32]. This is complicated further by the fact that a SSE replaces GDP with alternative measures of social progress, which are typically excluded from the analyses of the returns on public investment. As stated above, however, the spending and lending priorities would target expenditures that generally support the common good and provide broadly shared benefits.

Essential public goods and services for a SSE include health and family services, food security, public utilities and banking systems, education, media, arts and ecosystem conservation and restoration. Public infrastructure investment would prioritize maintenance and restoration of existing infrastructure, in most cases, with additional targeted investment in new ecological infrastructure for key public sectors, including housing, energy (including conservation and efficiency), water systems, wastewater and sewage, solid waste and materials recovery, transportation and public space (including local markets and public meeting space). Public investment would also support private sector cooperatives, trusts and community financial institutions, as well as green job training and public research and development for sustainable agriculture, pollution control, green industry, renewable energy, *etc.* A full employment program is a fundamental policy priority in the SSE, providing public sector jobs, as well as facilitating private job creation in desirable sectors [33].

Any spending would necessarily be linked to a plan for recovery of funds. Conventional economists generally look at taxes as a drag on the economy, albeit necessary to finance government expenditures. The reasoning is that taxes increase costs, leading to a reduction in output and disequilibrium between marginal costs and marginal benefits, resulting in a deadweight loss of economic surplus. They are seen as a significant drag on economic growth. From a more holistic perspective, taxes are an effective policy tool for internalizing negative externalities into market prices, therefore reducing deadweight

loss and for improving income distribution. Reduced economic growth from taxation would be an additional point in their favor from the perspective of a steady-state economy.

### 3.3.2. Tax Bads, Not Goods

A shift in the burden of taxation from value added or economic goods (e.g., income earned by labor and capital) to throughput flow or ecological “bads” (e.g., resource extraction and pollution) is a powerful tool for achieving a steady-state economy. Such taxes would reduce resource extraction and waste emissions, which we want less of, and could replace taxes on labor and productive activities, which should be encouraged. In economic terms, these taxes would internalize external costs and increase efficiency [34]. It is true that throughput taxes in most countries are regressive, capturing a greater share of income from the poor than from the rich. Rather than using this as an argument against throughput taxes, it would call for spending the proceeds progressively and using other policies to promote equality.

It is possible to impose throughput taxes and increased user fees on resource depletion or on waste emissions. Taxing the origin and narrowest point in the throughput flow induces more efficient resource use in production, as well as consumption, and facilitates monitoring and collection. For example, there are far fewer oil wells than there are sources of CO<sub>2</sub> emissions. However, it may be politically easier to impose emissions taxes rather than extraction taxes. In either case, taxes will increase prices and induce efficiency in resource use. One disadvantage of green taxes is that the level of pollution is determined by price, rather than the ecosystem’s capacity to absorb waste. Prices can adjust to ecological constraints more rapidly than ecosystems can respond to the price signals [23]. We discuss the quantitative limits as an alternative below.

### 3.3.3. Tax What We Take, Not What We Make

Taxes should also be used to capture unearned income or rent, in economic parlance. Green taxes are a form of rent capture, since they charge for the private use of resources created by nature. However, there are many other sources of unearned income in society.

Most obviously, the word ‘rent’ is associated with land. Land is available in a fixed supply, which cannot respond to market signals and is an essential input into all economic activities—even the least tangible economic activities must take place on some physical substrate. The value of land is created by nature and society as a whole, not by individual effort. For example, if a government builds a light rail or subway system as a more sustainable alternative to private cars, adjacent land values typically skyrocket, providing a windfall profit for landowners. New technologies also increase the value of land, due to its role as an essential input into all production [35]. The supply of land is fixed, so any increase in demand results in an increase in price. Landowners, therefore, automatically grow wealthier independent from any investments in the land. Furthermore, speculative demand creates a positive feedback loop, in which rising prices increase demand, leading to bubbles and busts in land markets, which can trigger national and even global recessions. High taxes on land values (but not on improvements to land, such as buildings) allow local governments to capture this unearned income to repay municipal bonds sold to the federal government. This removes any reward from land speculation, thus stabilizing the economy. It also drives down land prices. Mortgage payments will be

replaced by tax payments, so there will be no negative impact on new landowners. If land values fall, so do payments, dramatically decreasing the likelihood of default and foreclosure. The stock of land is fixed, which means that it exhibits a perfectly inelastic supply, so landowners cannot pass tax increases on to renters.

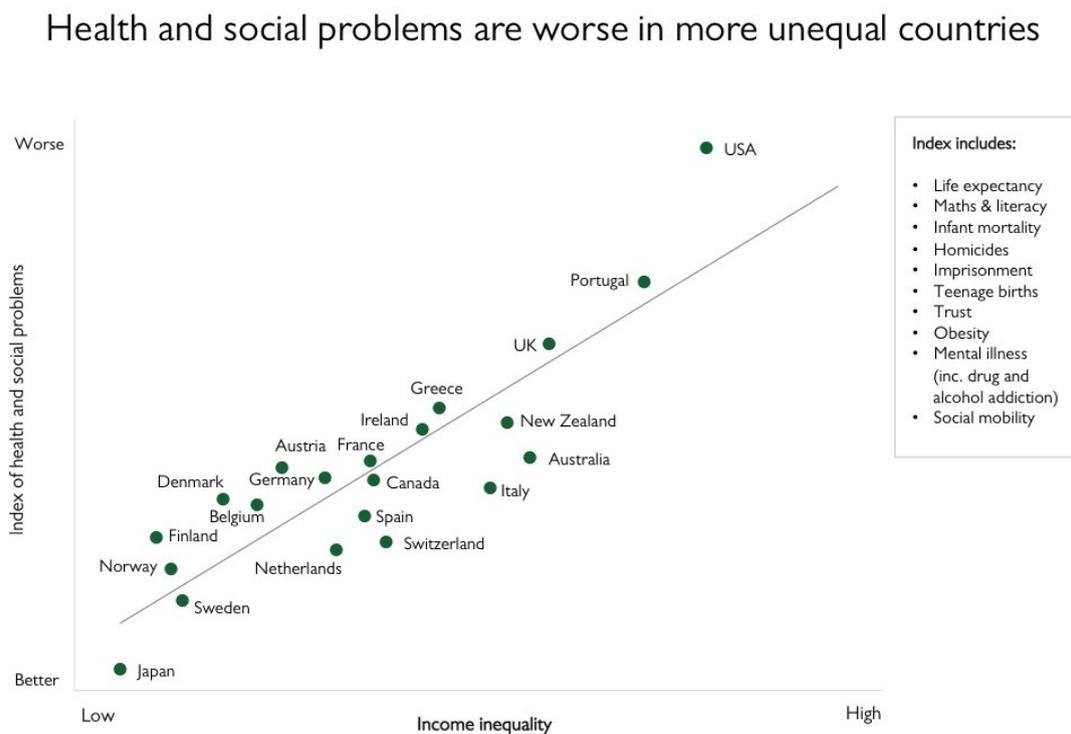
Growing demand and increasing scarcity of natural resources also drives up their price, generating windfall profits for resource owners. The depletion taxes discussed above should increase in tandem with price increases, capturing the rent for the public sector.

### 3.3.4. Taxation to Reduce Inequality

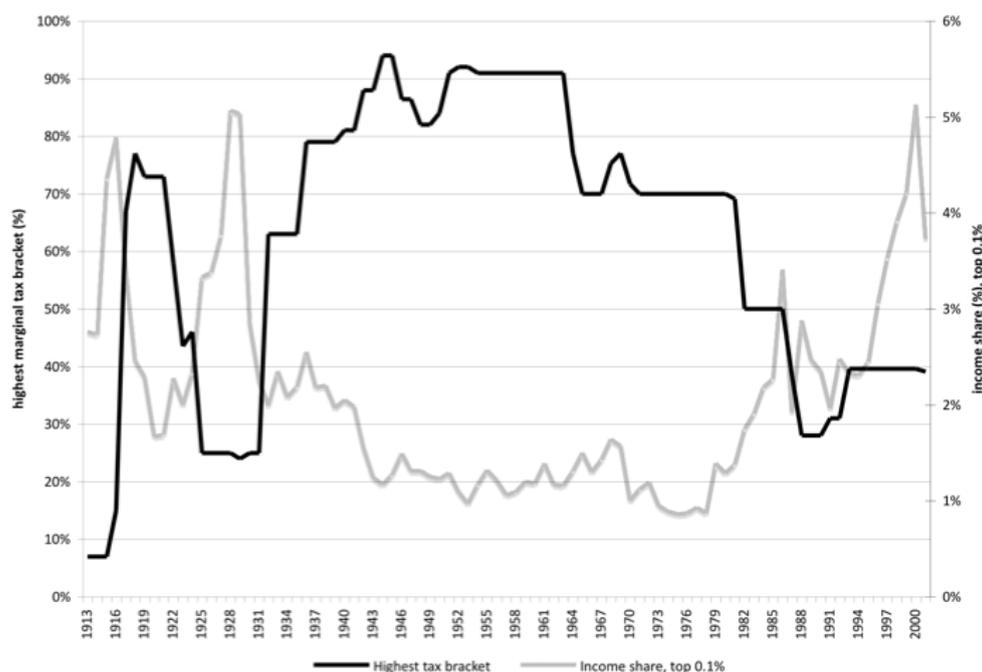
Income inequality can have very pernicious effects on human well-being. Figure 4 below shows the relationship between inequality and an index of health and social problems across OECD countries.

Inequality is also closely related to taxation policies. Figure 5 shows the highest marginal income tax bracket in the US, along with the share of income captured by the wealthiest 0.1%, clearly illustrating the strong correlation between tax rates and social justice. Note that taxes on capital gains, which account for a significant share of the income of the top 0.1%, are not included in this figure. The capital gains tax dropped from 28% to 20% in 1997, which accounts for the dramatic increase in income inequality beginning that year.

**Figure 4.** Relationship between income inequality and an index of health and social problems in the wealthiest nations [36].



**Figure 5.** The income share of the top 0.1% of US society (left axis) and the highest marginal US tax bracket (right bracket) between 1913 and 2002 [16].



This evidence suggests that tax rates should be highly progressive, perhaps asymptotically approaching 100% on marginal income. The measure of tax justice should not be how much is taxed away, but rather how much income remains after taxes. For example, hedge fund manager John Paulson earned \$4.9 billion in 2010. If Paulson had paid a flat tax of 99%, he would still have retained nearly \$1 million per week in take home income. Presumably, most of his income was taxed at the 2010 capital gains tax rate of 15%, which also applies to a large share of hedge fund manager income. Increasing his tax rate to 99% (which might entail a marginal tax rate of 99.99%, depending on the tax schedule) would have allowed the government to hire 84,000 additional teachers at \$49,000 per year. Though the reforms to monetary and fiscal policy described above would likely make it impossible to earn such bloated salaries, extremely progressive taxation should remain an option.

### 3.3.5. Cap and Auction and a Commons Asset Trust

An alternative (or complement) to taxes is a cap and auction scheme on throughput and certain other assets created by nature or society as a whole, such as airwaves. In such a system, the government caps throughput at sustainable levels, then auctions off access to the private sector. Private access to airwaves could be auctioned off to the private sector, with some set aside for public use. To prevent speculation and gaming of the market, auctions should take place at relatively frequent intervals, with no subsequent trading. Revenue paid to the government would reduce the money supply.

The creation of caps on waste emissions requires new property rights that should rightfully belong to all citizens. The creation of caps on privately held natural assets would require a change in existing property rights, prioritizing common property rights to the ecosystem services these assets create over the privately held rights to the assets themselves. If governments actually served the interest of the people as a whole without prioritizing the interests of the economically powerful, then the public

sector could own these resources as a representative of all citizens. Many people believe, however, that most governments are systematically transferring wealth created by nature and society as a whole to the economically powerful individuals and corporations that fund elections. When this is the case, it may be necessary to create a third sector, the commons sector, which owns and controls the common wealth. The commons would be managed by a board of trustees for the benefit of all citizens, present and future, bound by a legal mandate [37]. This mandate could have the force of the Constitution, but would protect rights to our shared inheritance of wealth rather than political rights. State legislators in Vermont proposed a Vermont Common Assets Trust [38].

### 3.4. Solutions 3: Monetary Trust

As discussed above, while a sovereign government may issue and spend money into existence, it is nonetheless important to regulate the quantity of money in circulation. Dyson, *et al.* [30] suggest the creation of a Monetary Trust, which is part of the government, but with a mandate to regulate money supply according to strict and transparent criteria, such as price stabilization, as determined by a consumer price index (CPI). Loans and grants to state and local governments could be contingent upon similar criteria. This would ideally prevent politicians from manipulating the system.

Specific criteria for determining the appropriate supply of money for a steady-state economy would require fine-tuning. For example, Dyson *et al.* [30] suggest that inflation should be a criterion. However, limiting throughput will decrease the supply and likely increase the price of many currently marketed resources, including fossil fuels, which is a key input into almost all economic products. This will quite likely push resource prices upwards, making the Consumer Price Index for All Urban Consumers (CPI-U) a problematic indicator during a de-growth transition, due to price volatility, in addition to the issues concerning inflation described above. Furthermore, use of many currently un-owned resources, such as waste absorption capacity, will be strictly curtailed. Firms and households will be forced to pay for assets that were previously treated as free. It is quite possible that this will drive up not only prices, but also the number of market transactions. While a CPI may be an effective indicator for a steady-state economy, there is no guarantee that physical contraction of the economy will lead to a lower demand for money or a lower level of GDP. We also believe, however, that GDP is useless as a measure of welfare; if it measures anything effectively, it is costs, not benefits [28,39].

In the case of the US, the Federal Reserve would be reformed as a public monetary trust, with the authority to perform a limited, but essential public service of regulating the total supply of federal dollars on behalf of current and future generations, without influence of the private financial sector. The money system would be accountable, democratic, transparent and debt-free. In effect, this monetary trust would serve as a “fourth branch” of government, distinct from the existing three branches, but with various “checks and balances” in place. The monetary trust would credit interest-free money to the US Treasury, under Executive administration, or credit vertical money directly to existing banks or public banks, as described above. The US Treasury would retain the sole authority to print and allocate US Treasury Notes, which would fully replace Federal Reserve Notes.

As described above, the specific public allocations are a matter of fiscal policy to be determined by Congressional budgeting, but the total money supply would be set independently of political influence, through the monetary authority. Elected politicians could choose, for example, whether to raise taxes

or reduce spending, with decisions based primarily on the goals of achieving steady-state throughput and shared prosperity. The recovery of notes would first occur through fiscal channels of payments to the federal government, as described above. The Internal Revenue Service could continue to perform this function, but would perhaps be better understood as the “Internal Recovery Service”, as the public service performed concerns the recovery of money allocated, rather than perpetuating the belief that payments to government are a source of revenue to allow future spending. The monetary trust would then remove and destroy federal dollars from mandated accounts within the IRS, as required to balance money supply. In a SSE, credits and recovery generally would be stable and roughly equal and at a scale appropriate to a sustainable level of resource throughput.

One of the biggest concerns with the government spending money into existence is that issuing more money than is required by market transactions or issuing money for speculative purposes that do not increase the supply of real goods and services will cause inflation. To address the crisis that began in 2007, the US government has issued trillions of dollars in new money, much of it used to buy government bonds. This has not resulted in inflation for at least two reasons. First, banks were actively destroying horizontal money by issuing new loans slower than old ones were repaid; much of this new vertical money was simply replacing the horizontal money destroyed. Second, the effective amount of money in an economy depends on both the nominal supply and the velocity at which it circulates. When the Fed purchased bonds from banks, many just added the new money to their reserves instead of spending it. The velocity of circulation for much of the money supply has essentially been zero.

The monetary trust may also issue negative-interest, or demurrage, currency. A negative-interest currency would offer several advantages to support a steady-state economy. First, a negative interest allows a built-in mechanism for the reduction of money supply over time. This feature would eliminate the possibility that fiscal policy might restrict taxation to an undesirable amount and, therefore, lead to an increasing money supply. Second, negative-interest currency allows for the exchange function of money, which encourages increased circulation velocity and distribution of money throughout society. Third, negative-interest currency eliminates the monetary function of storing wealth. Money as a store of wealth tends to support the commodification of money, which, in turn, leads to hoarding and consolidation of wealth. A negative-interest currency is primarily an agreement of exchange among members of a society, rather than a means to consolidate private wealth [18].

Dyson *et al.* argue that their monetary system would separate monetary and fiscal policy [30]. We believe that our proposal of replacing horizontal money with vertical money through a variety of different mechanisms would integrate monetary and fiscal policy toward a steady-state economy, while maintaining distinct monetary and fiscal authorities, responsible for decisions over total money supply and specific allocation and taxation, respectively.

#### **4. Transition**

We have tried to lay out a path to a new monetary system that minimizes economic disruption. However, we have neglected two important issues. First, how do we manage the overwhelming levels of existing debt? Second, how do we initiate such a radical transition, especially at a time when politicians pursue goals and policies virtually the opposite of what we propose?

#### 4.1. *Paying off Existing Debt*

As discussed above, total public and private debt in the US is approximately 350% of GDP. Governments take on debt with the assumption that continuous economic growth will allow it to be paid back; that option is unavailable on a finite planet. Furthermore, debt is currently growing faster than the GDP. Default on such exaggerated levels of debt would appear inevitable.

Default, however, can be explicit or implicit. One way to trigger an implicit default is through inflation, which devalues the money supply. For anyone owing debt at fixed interest levels, inflation reduces their real debt. This benefits debtors at the expense of creditors. As the latter are typically wealthier than the former, this improves the distribution of wealth. Currently, less than 10% of new mortgages have adjustable rates, so inflation (defined as a general increase in prices and wages) would benefit over 90% of homeowners [40]. Inflation harms those on fixed incomes, but this problem would be addressed by fiscal policies that prioritize the elimination of poverty and misery. To create inflation, the government could simply print up money to pay off government bonds without seeking to tax back the money created. This level of money creation would likely generate enough inflation to devalue private debts, as well. If, instead, the government seeks to avoid inflation, it would need to tax back the money used to pay off its securities. Highly progressive taxes would capture back much of the money from bondholders. However, this would not lower the approximately \$35 trillion in debt held by the private sector, which would remain unpayable.

There are, however, serious ethical implications involved in intentionally defaulting on our debts through inflation. China, for example, owns over \$1 trillion in US treasury securities, and rich countries defaulting on debt to poorer countries seems particularly unethical. There may be no simple, ethical solution.

#### 4.2. *Taking Advantage of Crisis*

We believe it highly unlikely that our proposed system will be adopted before the current system suffers another profound crisis, for several reasons.

First, new currency systems frequently spring up in response to economic crisis. Many local communities developed their own complementary currencies in response to the great depression [17]. During the 1999–2002 crisis in Argentina, literally thousands of communities developed their own complementary currencies. Some were so successful, they even spurred counterfeiting.

Second, banks frequently hold much higher reserves than they are required to in the aftermath of a financial crisis. US banks are currently holding nearly \$1.8 trillion in excess reserves at the Fed [41]. In such circumstances, there would be no noticeable impact of raising reserve requirements. We believe, in fact, that reserve requirements should be raised gradually in a process of adaptive management.

Third, though we are not proponents of his economic policies in general, we agree with one important insight from Milton Friedman: “Only a crisis—actual or perceived—produces real change. When that crisis occurs, the actions that are taken depend on the ideas lying around. That I believe is our basic function: to develop alternatives to existing policies, to keep them alive and available until the politically impossible becomes the politically inevitable” [42].

We do believe, however, that adopting our proposals prior to another crisis would spare us from considerable suffering.

## 5. Conclusions

This paper has addressed monetary and fiscal policies for a steady-state economy. The discussion implicitly recognizes the need for a redirection of society's goals away from economic growth towards improved quality of life compatible with a sustainable flow of throughput within the carrying capacity of the biosphere. The factors we have addressed are by no means the only ones necessary to create a steady-state economy based on happiness and well-being. Many non-economic factors must also be addressed, as well as the development of alternative indicators to measure progress towards these goals, both of which lie outside the scope of this paper.

In the area of monetary policy, we prescribe public credit money issued interest-free by the government, with the total amount of money determined by a monetary trust and the specific mechanisms for adjusting the money supply left to elected government officials. This requires the elimination of horizontal money through 100% reserve requirements. These policies would limit the growth imperative created by an interest-based credit creation system and return the process of money creation to the public sector. Public credit money could provide a counter-cyclical feedback loop to economic cycles, in addition to supporting adequate investment in critical public goods, without increasing debt levels. Much as Keynesians advocate government spending (borrowed with interest) during a recession, the new monetary trust can issue more credit (interest-free) to address misery, poverty or unemployment, through public spending.

In the area of fiscal policy, we recommend a change from taxing value added to taxing throughput, including depletion, land use and pollution. Unearned income in both the natural resource and financial sectors should be recovered through the capture of economic rent. Progressive income taxation could also be used to further reduce inequality. The creation of a commons sector will help ensure that collectively created and/or inherited value can be owned collectively. Reclaiming common assets would allow businesses to profit from their efforts, while society retains the wealth of the social and natural commons.

In addition, several areas of further investigation have been identified, particularly surrounding inflation, full employment, debt repudiation and transition. How will we handle the large private sector debt levels? While this paper has primarily focused on a national level, additional research is needed at multiple scales. What is the impact of national policy shifts at the international level? What policy instruments are available in light of transnational monetary agreements, such as the European Economic and Monetary Union? How does the USD's status as the international reserve currency affect this analysis? The literature would benefit from further explorations of these topics.

## Acknowledgments

The authors would like to acknowledge the financial support of the USDA Hatch Grant program, and intellectual input and support of all members of the Spring 2010 Monetary and Fiscal Policy class at the University of Vermont, including: Emily Cseh, Roman Fricker, Loren Scott, Julie

Williams and Stephen Marshall. The authors appreciate the thoughtful comments and insights of our anonymous reviewers.

### Conflict of Interest

The authors declare no conflict of interest.

### References

1. Harris, J.M.; Codur, A.-M. *Macroeconomics and the Environment*; Tufts University: Global Development and Environment Institute: Boston, MA, USA, 2004.
2. Daly, H.E. Economics in a full world. *Sci. Am.* **2005**, *293*, 100–107.
3. Daly, H.E. *Steady-State Economics: The Political Economy of Bio-Physical Equilibrium and Moral Growth*; W. H. Freeman and Co.: San Francisco, CA, USA, 1977.
4. Georgescu-Roegen, N. Energy and economic myths. *South. Econ. J.* **1975**, *41*, 347–381.
5. British Petroleum, Statistical review of world energy, full report 2012. Available online: <http://www.bp.com> (accessed on 13 June 2013).
6. Georgescu-Roegen, N. *The Entropy Law and the Economic Process*; Harvard University Press: Cambridge, MA, USA, 1971.
7. Hall, C.A.S.; Cleveland, C.J.; Kaufmann, R. *Energy and Resource Quality*; Wiley Interscience: New York, NY, USA, 1986.
8. Wackernagel, M.; Schulz, N.B.; Deumling, D.; Linares, A.C.; Jenkins, M.; Kapos, V.; Monfreda, C.; Loh, J.; Myers, N.; Norgaard, R.; *et al.* Tracking the ecological overshoot of the human economy. *Proc. Natl. Acad. Sci. USA* **2002**, *99*, 9266–9271.
9. Rockstrom, J.; Steffen, W.; Noone, K.; Persson, A.; Chapin, F.S.; Lambin, E.F.; Lenton, T.M.; Scheffer, M.; Folke, C.; Schellnhuber, H.J.; *et al.* A safe operating space for humanity. *Nature* **2009**, *461*, 472–475.
10. Malghan, D. A dimensionally consistent aggregation framework for biophysical metrics. *Ecol. Econ.* **2011**, *70*, 900–909.
11. Ekins, P. Identifying critical natural capital: Conclusions about critical natural capital. *Ecol. Econ.* **2003**, *44*, 277–292.
12. Farley, J. The role of prices in conserving critical natural capital. *Conserv. Biol.* **2008**, *22*, 1399–1408.
13. Meadows, D. Leverage points: Places to intervene in a system. *Solutions* **2009**, *1*, 41–49.
14. Millennium Ecosystem Assessment. *Ecosystems and Human Well-Being: Synthesis*; Island Press: Washington, DC, USA, 2005.
15. Daly, H.E.; Farley, J. *Ecological Economics: Principles and Applications*, 2nd ed.; Island Press: Washington, DC, USA, 2010; p. 537.
16. Greco, T. *Money: Understanding and Creating Alternatives to Legal Tender*; Chelsea Green Publishing: White River Junction, VT, USA, 2001.
17. Note that the US Federal Reserve Bank is actually a quasi-public central bank designed to be largely independent from the government. Also, in the EU zone, it is the European Central Bank that has a monopoly on money supply, not the national governments. National governments in the

EU zone function much like states in the US: they must tax or borrow before they can spend. This paper will nonetheless discuss the situation in which the central bank and treasury are controlled by national government.

18. Federal Reserve Economic Data, U.S. Available online: <http://research.stlouisfed.org/fred2/series/TREAST> (accessed on 13 June 2013).
19. Egnal, M. *Clash of Extremes: The Economic Origins of the Civil War*; Hill and Wang: New York, NY, USA, 2009.
20. Components of total united states debt. Wikimedia Commons: 2010. Available online: <http://commons.wikimedia.org/wiki/File:Components-of-total-US-debt.jpg> (accessed on 5 May 2012).
21. Soddy, F. *The Role of Money: What it Should Be, Contrasted with What It Has Become*; Harcourt, Brace and Co.: New York, NY, USA, 1935.
22. Daly, H.E. The economic thought of frederick soddy. *Hist. Polit. Econ.* **1980**, *12*, 469–488.
23. Daly, H.E.; Cobb, J.B., Jr. *For the Common Good: Redirecting the Economy toward Community, the Environment, and a Sustainable Future*, 2nd ed.; Beacon Press: Boston, MA, USA, 1994.
24. Minsky, H.P. *Stabilizing an Unstable Economy*; Yale University Press: New Haven, CT, USA, 1986.
25. Daly, H.E.; Townsend, K. *Valuing the Earth: Economics, Ecology, Ethics*; MIT Press: Cambridge, MA, USA, 1993; pp. 22–23.
26. Costanza, R.; Fisher, B.; Ali, S.; Beer, C.; Bond, L.; Boumans, R.; Danigelis, N.L.; Dickinson, J.; Elliott, C.; Farley, J.; *et al.* An integrative approach to quality of life measurement, research, and policy. *Surv. Perspect. Integr. Environ. Soc.* **2008**, *1*, 11–15.
27. López, R.; Galinato, G.I. Should governments stop subsidies to private goods? Evidence from rural latin america. *J. Public Econ.* **2007**, *91*, 1071–1094.
28. Farley, J. Rethinking gnp: From welfare to cost. *Al Jazeera*, 24 October 2011.
29. Farley, J.; Perkins, S. Economics of Information in a Green Economy. In *Building a Green Economy*; Robertson, R., Ed.; Michigan State University Press: East Lansing, MI, USA, 2013.
30. Dyson, B.G.T.; Ryan-Collins, J.; Werner, R. *Towards a 21st Century Banking and Monetary System: Submission to the Independent Commission on Banking*; New Economics Foundation: London, UK, 2011; pp. 1–39.
31. Lawn, P. Facilitating the transition to a steady-state economy: Some macroeconomic fundamentals. *Ecol. Econ.* **2010**, *69*, 931–936.
32. Misch, F.; Wolff, P. The returns on public investment: Concepts, evidence and policy challenges. Available online: [http://edoc.vifapol.de/opus/volltexte/2011/3272/pdf/DP\\_25.2008.pdf](http://edoc.vifapol.de/opus/volltexte/2011/3272/pdf/DP_25.2008.pdf) (accessed on 14 June 2013).
33. The authors agree with the comments of one anonymous reviewer that the policies recommended here will require revisiting the traditional conception of full employment. Although there is insufficient space to explore this topic here, additional scholarship is encouraged into such topics as: What is the meaning of work? How are jobs defined as a subset of work? How is useful work rewarded? What is classified as work?
34. Durning, A.T.; Bauman, Y. *Tax Shift: How to Help the Economy, Improve the Environment, and Get the Tax Man off Our Backs*; Northwest Environment Watch: Seattle, WA, USA, 1998.

35. Gaffney, M. The hidden taxable capacity of land: Enough and to spare. *Int. J. Soc. Econ.* **2008**, *36*, 328–411.
36. Wilkinson, R.; Pickett, K. *The Spirit Level: Why More Equal Societies Almost Always Do Better*; Allan Lane/Penguin Press: London, UK, 2009.
37. Barnes, P. *Capitalism 3.0. A Guide to Reclaiming the Commons*; Berrett-Koehler Publishers: San Francisco, CA, USA, 2006.
38. Vermont Senate Bill 44. *Vermont Common Assets Trust*. Available online: [www.leg.state.vt.us/DOCS/2008/BILLS/INTRO/S-044.DOC](http://www.leg.state.vt.us/DOCS/2008/BILLS/INTRO/S-044.DOC) (accessed on 13 June 2013).
39. Boulding, K.E. The Economics of the Coming Spaceship Earth. In *Environmental Quality in a Growing Economy*; Jarrett, H., Ed.; Resources for the Future/Johns Hopkins University Press: Baltimore, MD, USA, 1966; pp. 3–14.
40. Moench, E.; Vickery, J.; Aragon, D. Why is the Market share of adjustable rate mortgages so low? Available online: [http://www.newyorkfed.org/research/current\\_issues/ci16-8.html](http://www.newyorkfed.org/research/current_issues/ci16-8.html) (accessed on 13 June 2013).
41. Federal Reserve Economic Data, Excess Reserves of Depository Institutions (EXCRESNS). Federal Reserve Bank of St. Louis: St. Louis, MO, USA, 2013. Available online: <http://research.stlouisfed.org/fred2/series/EXCRESNS> (accessed on 13 June 2013).
42. Friedman, M. *Capitalism and Freedom*; University of Chicago Press: Chicago, IL, 1982; p. ix.

© 2013 by the authors; licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/3.0/>).