A Treatise on the Ecological Economics of Money

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Abstract

Monetary theory and policy are neglected areas within ecological economics. Post Keynesian monetary theory is a good starting point to understand the relationships between money and economic activity. Ecological economics is a good starting point to understand the relationships between economic activity and the environment. Insights from Post Keynesian economics and ecological economics complement each another to understand the roles of money in an ecologically sustainable economy and the policies necessary to support these roles. An ecologically sustainable economy (ESE) is one whose material and energy throughputs are within critical natural capital thresholds at appropriate scales while also being great enough to meet human needs. A fiat money system is compatible with an ESE since it takes little material and energy throughput to create and sustain fiat money, in contrast to commodity or managed money systems. Proposals to control the money supply, in the hopes of targeting economic activity within some sustainable threshold, are problematic. The source, sink, and life-support functions of critical natural capital should be sustained using policy tools other than the money supply, which should remain broadly accommodative to demand. Involuntary unemployment results within fiat money-using economies. Fiscal and monetary policies can help reduce unemployment, but these policies should be compatible with an ESE. This requires direct employment creation rather than general economic expansion to raise the demand for labour. A stable but positive rate of consumer price inflation must be directly targeted by means other than maintaining excess industrial capacity and unemployment. The overnight interest rate should be used to equalize the effective cost of credit over time, rather than being used to target capacity utilization. Currency areas could be adjusted to help manage human ecological impacts, by adjusting areas to cover significant bioregional scales or significant economic regions with shared dynamics and a sufficient internal market. A global ESE requires a global reserve currency to be used in a new financial architecture that generates stable but adjustable exchange rates between currency areas. Some principles of modelling monetary and fiscal policy in an ESE are proposed in contrast to unsuitable conventional models like the IS-LM family of models. Finally, the implications of this paper's findings are contrasted to alternative reform proposals such as 100% (or less) reserves, negative interest rates (scrip), and community

currencies like LETS. Overall, this paper suggests that radical reform of the nature of money is not needed to support an ESE. The existing fiat nature of money should be sustained but in a context of new fiscal and monetary policies that are more compatible with an ESE.

Contents

1. Introduction

We live in a monetary economy. A monetary economy is one where money plays a crucial role in production, consumption, trade, savings and investment, all of which in turn relate to growth, income and wealth and their distribution, and price levels. As Keynes argued in his day, and as contemporary ("Post") Keynesians[1] continue to emphasize today, to understand the dynamics of our economy one must understand the role that money plays in it. Classical and new classical monetary theory, built upon the work of early 19th century scholars James Mill (1965) and Jean-Baptist Say (1964), fails in this regard since its theoretical framework applies mostly to exchange economies, where supply creates its own demand thereby ensuring that full employment prevails since all savings generate investment so all income is spent. Money exists in classical theory mostly to reduce transaction costs through its use as a medium of exchange. Keynesian and Post Keynesian economists emphasize money's role in production and investment in a fundamentally uncertain world of fallible expectations and imperfect markets. The axioms underlying Keynesian economics are less restrictive than classical ones and correspond more to the actual world in which we live. Keynesian economics is therefore more of a general theory of how economies work, similar to how Einstein's *General Theory of Relativity* is broader that Newtonian theories based on more restrictive axioms (Galbraith, 1994).

Keynesian theory is certainly more general than classical theory but in light of modern insights from ecological economics, one could argue that Keynesian theory is no longer general enough. Economic-ecosystem interactions can be assumed away more justifiably when the biophysical scale of the economy is small in relation to the biosphere. But in a world where humans, through their social systems of markets and institutions, are the world's most dominant species (O'Neill and Kahn, 2000), economic-ecosystem interactions ought to be considered an important element in economic analysis, especially Post Keynesian analysis.

[1] For a brief outline of Post Keynesian assumptions some key authors cited in this paper, see Appendix 1.

Post Keynesian insights on money-economy relationships can be integrated with ecological economics insights on economy-ecosystems interactions. Since money in a Post Keynesian economy is not neutral with respect to economic activity in the short- and long-run, and since economic activity is not neutral with respect to economic-ecosystem interactions, then it follows that money is not neutral with respect to economic-ecosystem interactions. Aside from a few unconventional publications and web-published musings, there is a remarkable scarcity of thought on how money and monetary policy relates to ecological sustainability. This scarcity might be explained by the implied dichotomy in ecological economics between the "real" biophysical processes of transformation and the "paper" financial processes that can seemingly operate independently of the former. Since much of ecological macroeconomics starts from material and energy flows, it is not surprising that money is neglected, minus the odd brave but problematic attempt to link energy flows to money (e.g. Odum and Odum, 1976). However, ecological economists need not abandon a material and energy basis of analysing economic-ecosystem interactions to appreciate the importance of understanding money's relationship in these interactions.

This paper attempts to sketch out what could become a research agenda on *ecological Post Keynesian monetary economics*, to integrate Post Keynesian and ecological approaches based on the view (e.g. Gowdy, 1991: ; Mathieu, 1993: ; Khalil, 1996: ; Forstater, 2003) that both are not as distant as one might suspect and could be complementary. This integration could generate a program of ecological monetary reform as a complement to ecological fiscal reform. Existing ecological monetary reform proposals by Frederick Soddy (1934), Richard Douthwaite (1999), and Bernard Lietaer (2001) will be contrasted to the ecological Post Keynesian monetary theory and policy proposals in the present paper. To date, no broad ecological monetary treatise exists that could be used to evaluate these reform proposals or suggest an alternative route of ecological monetary reform. The present paper is a first attempt at drafting such an ecological monetary treatise, which could be used to advance further research.

This paper begins by scoping two very important if not fundamental aspects of any sort of ecological monetary analysis: 1) the ecological economic objective that should be fulfilled or at least not sacrificed by the economy's monetary system and policies; 2) the definition and nature of money. The Post Keynesian paradigm upon which this paper is built will be described as it relates to the definition of money. The core aspect of this paper follows the scoping exercise by proposing roles for money proper, sovereign (national) monetary policy, and international reserve money and the global payments system. Alternative ways of modelling money will be proposed. Finally, some comments will be offered on how the present analysis bears upon other ideas of reforming its reserve base, the interest paid on positive balances, and the scope for community currencies. Since the area of monetary economics within ecological economics is not well developed—and hardly even scoped—this paper errs on the side of breadth instead of depth in any one particular area. It is a particular application of "ecological macroeconomics," as sketched out by the author through his previous work in the MES program and plan of study.

2. Ecologically Sustainable Objective

An ecological economic investigation into money and finance requires a benchmark against which to assess its sustainability. Benchmarks abound in the literature on sustainability and sustainable development. One benchmark that is explicitly ecological and economic is Herman Daly's *steady state economy* (Daly, 1992). This chapter will begin by assessing the idea of a steady state economy and then proposing an alternative.

2.1 Ruling out a Steady-State Economy

Herman Daly advocates a *Steady-State Economy* (SSE) which he defines as follows.

> [A steady-state economy is] an economy with constant stocks of people and artefacts, maintained at some desired, sufficient levels by low rates of maintenance "throughput," that is, the lowest feasible flows of matter and energy from the first stage of production (depletion of low-entropy materials from the environment) to the last stage of consumption (pollution of the environment with high-entropy wastes and exotic materials) (Daly, 1992: 17).

An attractive feature of this definition is that sustainability is a biophysical concept, related to the thermodynamics of throughput. A more controversial feature is that a constant stock of people is necessary. Concerning oneself with the size of the human population as separate from its size *and per-capita claims on the environment* is questionable. A constant or even declining population could still be ecologically unsustainable if its throughput requirements are growing. Conversely, if the per-capita throughput requirements of today's most affluent populations were to decline, perhaps more humans could sustainably be supported on the planet assuming that humanity is within its sustainable global limit today. Either way the critical issue is the size of the human population *as a function of its per-capita throughput*. The ecological footprint concept (Wackernagel and Rees, 1996) has successfully captured this idea, and further research has shown how variable per-capita ecological impacts are (Wackernagel, Larry et al., 1999).

Another SSE shortcoming is that it is mute on the spatial and temporal scales in which throughput is to be minimized. Without a clear temporal scale to the SSE notion of sustainability, it is impossible to operationalize sustainability on even a theoretical level. Excessive throughput today could perhaps be justified as an investment to reduce the throughput requirements of future generations, if the time span of several human generations is considered the temporal scale of an SSE. Without a clear spatial scale, an SSE remains open to interpretation whether there is a global limit or smaller scale limits to the amount of throughput. Could a city or country that is unsustainable within its borders compensate through trade by importing throughput-intensive requirements from a region that is sustainable? These scale issues of space and time are front and centre in the literature on hierarchy theory (e.g. Giampietro, 1994) and its application through panarchy (Gunderson and Holling, 2002) though they remains elusive in an SSE context.

Another SSE shortcoming is that it does not provide a social context to the "desired, sufficient levels" of people and artefacts and their throughput requirements. The amount of desired and sufficient levels of artefacts is not a strict function of the amount of people. Conspicuous consumption may be highly throughput intensive and yet it cannot make everyone in society better off. On the other hand, the throughput requirements of a society being fulfilled with the spiritual followings of Zen Buddhism may be low and yet achieve the same level of psychosocial happiness as North Americans finding bargains on Boxing Day. An ecologically sustainable economy must be one that reassuringly provides humans with a high quality of life. Perhaps the way to do this is to distinguish between needs and wants, in which the former are satiable whereas the latter are not. Stocks of artefacts in a SSE ought to be distinguished among needs-based and wants-based ones to discern whether a given stock of them is sustainable or not.

2.2 Choosing an Ecologically Sustainable Economy

A better benchmark of sustainability than a steady state economy would be one that ties throughput to ecological thresholds in a scale context, while avoiding the issue of human

population size in exchange for specifying some social basis for sustainability. To respond to the SSE shortcomings raised earlier, an alternative benchmark for ecological economic sustainability could be envisioned as follows.

An ecologically sustainable economy (ESE) is an economy whose rates of material and energy throughputs are, at a minimum, great enough to meet human needs while being within the critical natural capital thresholds at appropriate scales necessary to sustain source, sink, and life-support functions of ecosystems that provide those needs.

This definition incorporates several concepts that require elaboration, including "critical natural capital" and "appropriate scales." Natural capital is the stock of biological and geological resources that (individually or collectively) provides source, sink, and life-support functions necessary for humans, among other living beings. Humans can live off the "income" from renewable (non-depletable) natural capital if the stock persists, which requires at a minimum that humans not reduce the stock below some minimum viable threshold. A minimum viable threshold is meant to be a probabilistic rather than discrete concept contingent upon the time scale used, drawing on the concept of a minimum viable population size (Shaffer, 1981) but applied loosely on a metapopulation or landscape basis. Renewable natural capital has its own natural dynamics in the absence of human intervention, hence why it is a necessary but not sufficient condition that humans not deplete the stock below some minimum viable threshold. Over sufficiently large temporal scales that include, say, cataclysmic global extinctions following asteroid showers, it is possible that no minimum viable stock exists. Hence, a short time scale of several human generations might be an appropriate basis to the idea that humans can live off "income" from non-depletable capital. Humans also liquidate non-renewable (depletable) stocks of natural capital, though of course this is a one-time event. However, the liquidation of depletable stocks often generates pollutants that deplete the source, sink, and life-support functions of renewable natural capital.

Many classification schemes have been proposed for natural capital and the income that flows from it (e.g. De Groot, Wilson et al., 2002: ; Chiesura and De Groot, 2003). That

these natural resources and ecosystem services are classified as capital is not without its own debate (Victor, 1991: ; Hinterberger, Luks et al., 1997). Much of the economic discussion about natural capital relates to whether it is a necessary input to other human-produced forms of capital, like manufactured, organization, and social capital (Costanza and Daly, 1992). The present paper assumes that natural capital is a necessary input to other human-produced forms of capital. Living natural capital, like fish populations, are dynamic stocks that grow and shrink in the absence of human intervention. Multiple equilibria, non-linear dynamics, and thresholds characterize these dynamics (Rosser, 2001). These characteristics have led to qualifying as *critical* the portion of natural capital that provides itself with resilient properties—a form of insurance that hedges against disturbances that are natural to complex systems like ecosystems (Deutsch, Folke et al., 2003).[2] Avoiding the drawdown of critical natural capital therefore amounts to avoiding the drawdown of its resilience; therefore, to the extent that the capital is necessary for human needs, avoiding the drawdown of critical natural capital is in part a necessary condition to resiliently meeting human needs. This suggests a somewhat anthropocentric objective to an ESE, though the concept of an economy is entirely anthropocentric since it is a human creation. The present paper takes for granted that humans are the world's most dominant global species (O'Neill and Kahn, 2000); the substantive issue is ensuring this human dominance is ecologically sustainable, even if it is for the selfless sake of human survival. This anthropocentrism is perhaps more explicit in the definition of an ESE rather than in Daly's SSE, though the "desired" and "sufficient" stocks of humans and artefacts in an SSE could by all indications be determined equally anthropocentrically.

"Appropriate scales" are those relevant to the natural capital in question, which would be global in the case of the climate and at the watershed scale for a given aquifer. This

[2] For there to be such thing as *critical* natural capital implies some sort of measurement to distinguish between critical and non-critical, as when scholars of the Critical Natural Capital Project distinguish it as performing "important and irreplaceable functions" like resilience (Ekins, Folke et al, 2003). Further ordering could likely be done within the realm of critical natural capital, say to determine the critical capital that has the most dependencies of other capital for some function like energy transfer. Ecological network analysis seems promising, with its ability to select the most important links in a complex system of interdependencies, generating an "importance index" that relates the impact of disturbances to ecosystems as a whole (Krivov, Ulanowicz et al, 2003).

scaling attribute of an ESE is inspired by insights from hierarchy theory, namely that ecological processes operate on many scales that relate to one another and that have specific temporal and spatial dimensions (e.g. Giampietro, 1994: ; Gordon, Provencher et al., 1997: ; Holling, 2001). At a minimum, "appropriate scales" implies that *place and time matter* in an ecologically sustainable economy, whereas this is not obvious from Daly's vision of a steady-state economy. Examples abound at attempts to deduce the spatial and temporal scales over which certain ecological processes operate, and the connections between these processes and others operating at higher and lower scales (Gunderson and Holling, 2002).

The operationalization of identifying critical natural capital and the appropriate scales over which to conserve it remain ambitious projects. This paper cannot consider all the challenges. Nevertheless, the literature on critical natural capital suggests that the source, sink, and life-support functions of critical natural capital could be protected through biophysical standards that limit capital liquidation (Ekins, Simon et al., 2003). In practical terms, this could be met by depletion permits to guard against depletion of source functions and emission permits to cover sink functions. Life-support functions relate largely to the habitat of minimal viable populations, which could perhaps be protected through similar permit schemes. Nutrient cycling and atmospheric processes are among other life-support functions that would likely be protected as a consequence of dealing with the source and sink functions since, for example, human-induced climate change results from improper use of the atmosphere as a sink of waste greenhouse gasses.

The definition of an ESE puts aside the issue of the total human population size since, by this definition, the human population can reach any size, provided its needs can be met within the critical natural capital thresholds at appropriate scales. The challenge remains that some people's needs may be unmet while other people's needs are far surpassed in the pursuit of wants. The biophysical requirements for meeting needs vary according to different climatic and technological endowments that vary across time and space. Across generations, needs change following changes in culture, longevity, etc. For example, the need for retirement savings is relatively new when compared to several generations past

when life spans were shorter and when care was provided within the family (outside of the monetary economy). An ESE calls for meeting needs but in a way that critical natural capital is not sacrificed.

3. The Nature of Money

This short chapter aims to frame the subsequent propositions of the nature of money in an ESE, including the roles of national and international policy. The nature of money is contingent upon the paradigm used to investigate it. Post Keynesian monetary economics can complement ecological economics to develop an understanding of the nature of money in an ESE. This chapter frames money in a Post Keynesian way, through its definition and its two basic roles that give rise to its uses. Involuntary unemployment is introduced as a consequence of using money with a low elasticity of substitution and production. This issue carries forward in subsequent sections so it is necessary that the reader be introduced to it here. Finally, money will be contextualized in an ESE by proposing how money and monetary policy could help or at least not hurt an ESE.

3.1 Defining money

Post Keynesian theory is based on the finding that money is largely endogenous to the demand for credit, which is generated to enable production among other economic demands for credit (Lavoie, 1984). Interest rates exist as a spread of rates related to the overnight rate set by the central bank, thus interest rates can be considered more of an exogenous rather than endogenous policy variable. The money supply curve is therefore horizontal at every short-term interest rate and not vertical (Moore, 1983). Credit is distinguished from money on the basis that credit is an asset to banks that grant it while bank deposits are the corresponding liability that is created when credit is spent (Rochon, 1999). The liability, or debt, created by the advancement of credit is a contract for deferred payment.

A stylized monetary life cycle (or "circuit" as it is known in the Post Keynesian community) involves credit being created by the banking system in response to creditworthy demand (Rochon, 1999). A new deposit is created when credit is spent. The newly created deposit can be used to acquire the goods or services produced by the initial borrower, who can use the income to retire the interest-bearing debt. What is

commonly referred to as *the* stock of money, being mostly bank deposits, is therefore the amount of credit that has not been repaid (Lavoie, 1984). If all credit were repaid, the supply of bank deposits would be no greater than the amount of state-supplied money like currency and central bank overdrafts (which are themselves credit advanced by the state, but based on criteria other than creditworthiness). Money therefore can be considered a stock, but it is a highly dynamic stock like most stocks of living natural capital. As will be discussed often in this paper, the amount of money is indicative of uncertainty, since uncertainty creates a demand for liquidity that is satisfied by holding money in the form of currency, government-secured bank deposits, or some other government-secured asset that can be converted on demand to deposits or currency.

Two "peculiar" properties of money are that it has a zero or negligible elasticity of production and substitution (Keynes, 1935: ch. 17). Money has a zero or negligible elasticity of substitution since there is no tendency to substitute money with some other asset as the exchange value of money rises. For example, when liquidity is in high demand during recessions, one does not observe people shunning money in favour of, say, diamonds. On the contrary, people tend to sell diamonds to obtain money when the value of liquidity is high. Selling diamonds merely depresses their price in the hopes that someone would sacrifice some of his or her liquidity in exchange for a cheaper diamond, leaving the total amount of liquidity unchanged. This arises since the utility of money is limited only to its exchange value, so its utility increases with its value (Keynes, 1935: 231). Money has a negligible elasticity of production in the sense that the private sector cannot produce liquidity; only government can provide liquidity (through policies discussed in detail in Section 5).[3] If money could be grown and harvested like crops, it would be produced more easily by the private sector when its value increases since it would be cheaper to hire labour to produce it. If this were the case, then depressions could be mitigated by transferring production out of other industries and into the money-producing one (Keynes, 1935: 230-231). If readily available (non-monopolized)

[3] Government policy of supplying liquidity is sometimes frustrated by the inertia of depressed expectations that fail to temper growing liquidity preference as in Japan in the late 90s to early 2000s. As in the case of Japan, sometimes inertia results from delayed fiscal loosening. See Kregel, J. A. (2000). "Krugman on the liquidity trap: Why inflation won't bring recovery in Japan." Levy Institute Working Paper No. 298. [online] <http://www.levy.org/2/bin/datastore/pubs/files/wp/298.pdf>

commodities were used as money, this might solve part of the problem of unemployment but at the expense of requiring resources and toil to produce and maintain money and not other (likely more useful) artefacts like physical infrastructure, knowledge, etc.

3.2 Roles of Money

Post Keynesian economics distinguishes itself in several ways, but most importantly based on the understanding of the roles of money. Money is commonly said to fulfil four roles: 1) to serve as a medium of exchange; 2) to act as a store of value; 3) to act as a unit of account; and 4) to serve as a means of deferred payment. Post Keynesians like Paul Davidson (e.g. Davidson, 1982: ch. 3) emphasize two chief functions of money that are at the root of the four roles listed previously.

1) *Money legally settles contractual obligations.*

   A market-oriented entrepreneurial economy is characterized by a plethora of forward contracts layered upon each other to bring about some expected stability in cash flows to allow payments to be made on time. That there is one thing (money) that can be used to settle obligations helps market participants meet these contracts, since payments can be quickly circulated between participants. Many Post Keynesian economists emphasize the importance of taxes as one of the many obligations settled by money. As easily as governments could declare something "legal tender" by printing these words on its bills, the best way of ensuring that something is used as legal tender is for the government to accept it to discharge tax commitments. Keynes drew on the work of Knapp to consider money as "anything which the State undertakes to accept at its pay-offices, whether or not it is declared legal-tender between citizens" (Keynes, 1930: 7). Contemporary Post Keynesians (e.g. Wray, 1998) have used this reasoning to suggest that, in addition to whatever other motives there are for using money, taxes create a minimum demand for money.

2) *Money is perfect store of liquidity, transferring purchasing power into the future.*

Liquidity is the ability to meet obligations as they come due. With money as the means of settling obligations, money is perfectly liquid. Other goods may hold some degree of liquidity if they can be converted into money quickly and at a rate not subject to wide fluctuations, but none is as liquid as money. Money in this case includes not only currency but also bank deposits since these deposits are accepted as a means of settling obligations. Note that government accepts cheques drawn on bank deposits as a means of tax payments, thereby confirming in a Keynesian way that bank deposits qualify as money. On the other hand, corporate shares are not money since the government does not accept them to cover taxes, nor does the public consider them as a means of settling contractual obligations. This liquidity aspect of money is closely related to what is sometimes called *Knightian* or *fundamental* uncertainty or non-ergodicity as Paul Davidson uses it to counter the rational expectations hypothesis (Davidson, 1983). Ergodicity is the property of a system "tending in probability to a limiting form that is independent of the initial conditions" (Wordnet, 2004). In an economic systems sense, it is that "the future cannot be reliably predicted from past and present price signals" (Davidson, 2000). In such a world, the demand for liquidity is greater when people's uncertainty about the future is greater since, in the absence of liquidity, people might not be able to meet their contractual obligations as they come due.

The dual role of money as a means of settling contractual obligations and as a store of liquidity give rise to the four commonly held roles of money introduced earlier. That money is liquid and is used to settle contractual obligations gives rise to it being a unit of account, a medium of exchange, a means of deferred payment, and a store of value. Consequently, there are several motives for holding money, beyond a transactions (medium of exchange) motive to include a precautionary motive (since the future is uncertain), a speculative motive and a finance motive.

Post Keynesian economics and ecological economics share the assumption that the future is uncertain in an ergodic sense, even if the source and implications of this uncertainty are talked about in different ways between the two schools of thought. Although one does not read about financial speculation and the non-neutral role of money in ecological economics, there is no reason at the outset to believe that these are incompatible with it. Post Keynesian economics and ecological economics could complement each other well on the issue of the relationship between the economy and the environment, in a real-world context of uncertainty as with their shared interest on production (and not only exchange), and the somewhat interventionist-oriented role of government in the economy (Gowdy, 1991). There are some frictions between the two approaches, notably on the issues of economic growth and the nature of scarcity, but these ought not to stand in the way of an ecological Post Keynesian monetary synthesis on the relationships between money, the economy, and the environment.

Money and monetary policy in an ESE must be compatible the biophysical requirements for an ESE. Tradable permits and quotas could be used to set biophysical limits on humanity's appropriation of source and sink functions, but money matters since it will finance the trade of these permits and finance investment that affects the future demand for such permits. *At best, the monetary system should help minimize the rates of material and energy throughputs while optimizing their use in meeting human needs*. *At worst, the financial system should be benign with respect to affecting rates of material and energy throughput*. The chapters that follow will consider the extent to which the monetary system could fulfil these ESE objectives concerning the nature of money, national money and policy, and international money and policy.

4. Why Money in an ESE Must be Fiat

Canada and all OECD countries use fiat money, meaning that their national currencies are not redeemable in commodities at guaranteed rates of exchange, so the monetary face value of bills, coins, and deposits are unrelated to their intrinsic value. Fiat money is usually contrasted with commodity money, which amounts to some asset that is non-monopolised and somewhat readily obtainable (Keynes, 1930: ch. 1). Keynes (ibid) notes that the supply of commodity money is therefore governed by its scarcity and the cost of producing or harvesting it. Keynes' nomenclature of money includes managed money, a sort of hybrid of fiat and commodity money where its supply is managed by the state through promises to convert it to one or more commodities, but otherwise its intrinsic value differs from its monetary face value.

Monetary reformers claiming some degree of ecological basis to their proposals include Richard Douthwaite (1999) and Bernard Lietaer (2001). These reformers advocate (according to Keynes' nomenclature) for a managed money system for the aim of "firmly anchoring that currency to the material/physical world" (Lietaer, 2001). Douthwaite (1999) proposes to link global and national money to the availability of energy through a system of *Energy-Backed Currency Units*, while Lietaer (2001) wants to create a "global reference currency" linked to a basket of commodities including energy sources like oil and other products. This section will assess the relative merits of a fiat money system in relation to a managed money alternative along the lines being proposed by Douthwaite and Lietaer, concluding that money must be fiat in an ESE.

4.1 Maintenance costs

Fiat money is biophysically cheaper to produce and maintain than its alternative of managed money. The physical infrastructure associated with maintaining fiat money is mostly a vast network of electronic storage and computational devices that keep track of the electronic bits that record balances and transactions, plus the minimal resources necessary to produce paper currency and coins. Cash and personal cheques are

decreasing in use relative to electronic transactions, though it is difficult to assess the throughput implications of this change. On the one hand, paper receipts are generated for almost every electronic point-of-sale and automated teller machine transaction; on the other hand, the warehouses that store the bank computers are likely much smaller than would be necessary to store stocks of currency (to satisfy non-electronic transactions). Regardless of the balance, the important point to keep in mind is that the throughput requirements of fiat money are related to its accounting and not its value since (by definition) fiat money's face value differs from its intrinsic value.

In contrast, a managed money system requires significant biophysical cost to store the commodity (or commodities) that is (are) held on reserve. The carrying cost of commodity reserves involves not only storing them securely but also offsetting their inevitable entropic decay. Durable metals and stones would be preferred commodities over things that decay more quickly, but their slower decay is offset by their greater mass that makes transporting them costly. As the story goes, bankers of the past discovered that it was more practical to transport the claims to these commodities rather than the commodities themselves. Once this succeeded, it became obvious that fractional reserves of commodities suffice since people rarely requested their share of the commodity reserve. The ecological merit of fiat money in it having comparatively little biophysical cost is perhaps implicit in the evolution of money from being a commodity, to having a fractional reserve commodity base, to having none at all. Just as Nicholas Georgescu-Roegen (1973) attempted to frame the history of societies by their ongoing search of scarce low-entropy matter/energy, he could also have framed the history of money as a process also driven by thermodynamics, but towards the benefit of systems that are comparatively less dependent on abundant low-entropy matter. While the economy is a thermodynamically dissipative system, at least its dissipative activities today in Canada and throughout the OECD are accounted for by a system that dissipates less material/energy than it would have to as a managed money system.

According to Keynes, the low carrying cost of money relative to its liquidity premium distinguishes money from other assets. The carrying cost of a fiat money *system* was

introduced earlier as the infrastructure that keeps track of deposits, transactions, etc. To individuals using a fiat money system, their carrying cost of money is likely falling as electronic transactions outpace the growth of cash and currency, which means that the foregone interest of holding cash is (possibly) reduced by interest it earns as a bank deposit instead. The risk that cash could disappear through theft or be destroyed or lost is reduced by electronic transactions of bank deposits. The risk of banks failing is mostly dissipated with deposit insurance and central banks willing to act as a lender of last resort, hence keeping low the risk of holding deposits and transferring them through electronic means. The carrying cost of deposit money to individuals is thus increasingly the service fees charged by financial institutions, which presumably are still less than the lost interest and security costs of holding cash (or else people would only hold cash).

If fiat money were transformed into managed money, its relative advantage over other assets could diminish as the carrying cost of the system would increase. To the extent that system costs are transferred onto users of the system, transforming fiat money systems into managed money systems would increase the carrying costs of individuals holding money. Lietaer (2001) cites David Korten (1999: 8) to assume that an international commodity currency with a representative basked of commodities as its reserve would cost about 3-3.5% to maintain and store it. Note that this cost would be *in addition* to the costs of a fiat system, since Lietaer's system would still require an infrastructure to keep track of the claims on the basket of commodities acting as reserves. This cost could be paid by consumers directly in the form of fees, or by a greater margin between the rates of interest paid on deposits relative to those demanded on credit. To the extent that money's liquidity premium, to certain people at certain levels of liquidity, exceeds the carrying costs of today's fiat money by a margin of less than 3-3.5% over other assets, then Lietaer's proposal could induce people to abandon money as a store of liquidity. This development could work against an ESE by generating additional demand for physical durables like diamonds to act in place of money as a store of liquidity. Furthermore, Lietaer's proposal could generate unwanted variability in the value of money, as the reserve base could be vulnerable to supply shocks that might be difficult to anticipate and regulate. Since money serves as a hedge against uncertainty, one should

realize the near futility of grounding money to commodities whose supply and value are uncertain.

Douthwaite and Lietaer overlook the precautionary motive for holding money. Money is used as a store of value as a precaution against uncertainty that can exist for the public *as a whole* since one person's uncertainty is not equally offset by another person's "dis-uncertainty" the way inter-personal risks are sometimes symmetrical. Money need not ever be realized into goods or services, but can be rolled over somewhat indefinitely as a hedge against an uncertain future, until the last remaining human on earth is stuck with—*what would then be*—a lemon. Even though money is fiat in a physical sense, it a psychological sense it can have intrinsic value as a form of security, assuming confidence in the store of value aspect. Since fiat money does not have to contend with entropic depreciation, it can be maintained to store value at little cost compared with storing commodities. Since the demand for money includes a precautionary motive, which is biophysically benign, there is no reason why money should be made more costly to maintain, as it would be if fiat money were transformed into managed money along the lines proposed by either Douthwaite or Lietaer's.

4.2 Production costs

Consider the first steps in the monetary circuit summarized earlier; when a bank sees a creditworthy opportunity to advance credit, and when that credit is granted and spent, a deposit is created. The role of financial institutions advancing credit is to succeed at correctly assessing the creditworthiness of person or organization asking for credit (Rochon, 1999). Many factors are considered by financial institutions. In a fiat money system with little or (as in Canada) no statutory reserve requirements, the availability of reserves is not an issue. To create new credit within a managed money system, banks would need to obtain more reserve commodity. Minus the possibility of a bank borrowing excess commodity reserves from another bank, the process of obtaining new reserves would be time and energy intensive. Effort is required to grow or mine the

commodity, which comes at a social opportunity cost of whatever other task could have been performed with the same amount of effort. Keynes' quip about "the form of digging holes in the ground known as gold-mining, which not only adds nothing whatever to the real wealth of the world but involves the disutility of labour" (1935: 129) is apt.

Richard Douthwaite (1999) favours a managed money system while being critical of the historical preference of using gold and other precious metals as the base. Consequently, he proposes energy-backed currency units (EBCUs) to serve as the reserve "commodity" for his proposed national and global managed money system. These units would be used to purchase a proposed IMF-managed Special (greenhouse gas) Emissions Rights, so in effect the right to emit greenhouse gases would serve as the money's reserve commodity. A government or firm that reduces emissions would find itself with excess emissions rights that could be sold for EBCUs. He likens this proposal to an international reinstatement of the gold standard but where "the right to burn fossil energy has replaced the yellow metal, and where EBCUs play the role of the US dollar (Ibid)." He alleges that this would generate ecological sustainability.

> Under this system, countries would control their economies by adjusting the energy supply rather than the credit supply as they do today.... [As a result,] national economies could only expand at the rate they became more fossil-energy efficient, which is just what we want. And, for the first time since the gold exchange standard was abandoned, both the international and the national currency would represent something real, although the latter's value in terms of the former would not, as we have seen, be fixed (Douthwaite, 1999: ch. 4).

His proposal does not consider how adjustments to the energy system could be financed if these adjustments are a necessary condition for the availability of new finance. If the objective is to reduce energy use, then this can be accomplished by a cap and trade system for energy use or some similar scheme. There is no need, nor much utility, to requiring energy savings *ex ante* to the advance of new credit, especially since investments in energy efficiency could require *ex ante* credit creation. Douthwaite's erroneous implicit assumption is that demand for money is proportional to the demand to finance activities that generate a uniform amount of greenhouse gasses (or more broadly, that have a uniform ecological impact). The biophysical dimension of market activities

has relatively little bearing on their market price and hence on the finance motive for holding money. Money can purchase somewhat immaterial services, like fortune telling sessions and the care of children and elders, which used to be provided outside of the monetary economy but have since been enclosed. So long as these service providers in turn recycle their income into purchases of similarly immaterial services, then the ecological impact of a given circulation of money is relatively benign. For example, fortune-tellers could purchase economic forecast advice by economists, who in turn use their income to purchase massage sessions to sooth their classical suffering of rigormortise. There is no obvious reason why these benign activities should be made more difficult, minus perhaps the hope of pushing them out of the market into the informal economy where cooperative modes of exchange might be more common. Reformers who want to reform money for the sake of constraining ecological impact are on the wrong track because not only can money be used to finance ecologically benign activities, but it can also finance activities like brownfield remediation that aim to reduce the ecological liabilities of contaminated sites.

Harvesting reserve commodities for the sake of expanding credit imposes several biophysical costs, including: 1) the foregone benefits of leaving the depleted natural capital intact; 2) the foregone benefits of using the natural capital to create renewable substitutes for depletable sources (e.g. manufacturing wind turbines as a renewable substitute to non-renewable fossil-fuel energy); 3) the environmental impacts of harvesting, transporting, and storing reserve commodities. One might note that in a fiat non-reserve money system, creditworthiness is based on existing assets or income collateral. With existing assets being a physical good, one might be tempted to say that fiat money is therefore still grounded in commodities, but of a more diverse variety including property, machines, rare art, etc. First, expected future income flows and the present value of financial wealth can be used as collateral anyway. Secondly, when physical goods are used as collateral, it is important to note that these goods were not created to act as collateral, but simply end up serving that role. If physical goods were produced for the sake of becoming collateral, then there would be no point in obtaining a loan in the first place since, presumably, some other means was found to finance the

acquisition of the collateral and that same means could finance whatever the credit was meant to acquire.

5. Fiscal and Monetary Policy

Conventional economic wisdom holds that fiscal policy is the mix of government spending, taxation, and borrowing, which involve reallocating a given stock of money whose supply is controlled by monetary policy. Fiscal and monetary policy are conventionally understood to affect each other, but remain independent from each other, with the central bank taking charge of monetary policy and the government taking charge of fiscal policy. High government deficits are alleged to raise interest rates and crowd out private sector investment, unless governments attempt to "monetize" deficits by forcing their central bank to buy them. Monetary policy could affect fiscal policy to the extent that changes in interest rates affect the costs of rolling over government debt. Nevertheless, conventional wisdom suggests that monetary policy should be conducted independently of the government, which reinforces the view that monetary policy is distinct from fiscal policy. This paper subscribes to the view that fiscal policy is monetary in nature and monetary policy would better be termed *financial* policy (e.g. Boulding, 1967: 282-283). The reasoning behind this view should become apparent by the end of this section; in short, fiscal policy affects the supply of settlement balances in the banking system while monetary policy affects the resilience of the financial system. "Fiscal" policy is therefore an appropriate topic in this paper about monetary issues.

This section begins by introducing the relationship between fiscal and monetary policy in a country like Canada that has a sovereign currency, a public central bank, and a fiat money system. This relationship must be understood to appreciate the realm of possibilities and constraints of the role of fiscal and monetary policy in an ESE. Subsequently the main (macroeconomic) role of fiscal and monetary policy in an ESE is proposed. Recall the ESE aim of ensuring that human needs are met and that the economy's throughput does not undermine the source, sink, and life-support functions of critical natural capital. As alluded to in Section 2.2, human needs vary as a function of culture, geography, etc. This paper will only consider the macroeconomic need of income. In a capitalist economy, employment is a major means of income provision for most people. As explained in Section 3.1, involuntary unemployment develops in an

economy that uses as money something that has a negligible elasticity of production and substitution. Consequently, an ESE must, at a minimum, grapple with the problem of involuntary unemployment as a potential impediment to the provision of human needs.

5.1 The interdependence of fiscal and monetary policy

Consider the following description of the process as it operates in Canada, drawing upon Montador (1995) from the Bank of Canada's securities department and Wray's (1998) more general linking of the process to government spending. Settlement balances are the means by which banks and other private members of the payments system settle their claims against each other and against the central bank. Settlement balances are government-created money, not bank-created deposits. Government spending increases the amount of settlement balances in the banking system when one of its cheques, drawn on the government's account at the central bank, is deposited by a member of the banking public. Government taxation decreases the amount of settlement balances as deposits are moved out of the banking system to the government's account with the central bank. A surplus of settlement balances occurs on days when the public draws more in funds from the government's central bank account than vice versa—in other words, expenditures were greater than taxation on that day. This surplus would tend to bid down the overnight interest rate as the banks with surplus balances compete against one another to loan out their surplus to deficient members of the payments system. After all, a positive balance earns its holder no interest, so it is worth loaning it at some positive interest rate. Alternatively, if there were a shortfall of settlement balances resulting from more taxes been collected than money spent, this would tend to bid up the overnight interest rate.

The overnight interest rate is a policy variable set by the central bank. To ensure the rate is attained on the overnight market, the Bank of Canada neutralizes the monetary impact of government fiscal policy by offsetting drains with additions and vice versa (Montador, 1995). The bank achieves this by some combination of three means. First, it can shift the government's deposits from (or into) the government's account at the central bank to (from) accounts at the chartered banks, since the Bank of Canada is the fiscal agent for

the Government. Secondly, the bank can offer overdraft loans or repurchase agreements in the overnight market, so deficient members of the payment system can borrow needed settlement balances from the central bank or loan excess ones to it. Thirdly, the bank can buy or sell treasury bills in open market operations (outside of the overnight market). The details of the Bank of Canada's operations ought not to blur its important implications.

1. *Deficits do not crowd out private investment; deficits create liquid financial assets.*

   The Federal government's fiscal operations of taxing and spending affect the money market, but these effects are mitigated by the issue or redemption of bonds and bills by the central bank and federal government. Over the course of a year, if expenditures match revenues then fiscal policy was monetarily neutral on balance. Otherwise, fiscal policy is not monetarily neutral so it cannot be modelled against an unchanged money market (as is done in the infamous IS-LM model; more on this in Section 7). The central bank's intervention to neutralize the potential monetary effect of fiscal policy guarantees that interest rates do not automatically rise in response to federal deficits (nor fall with surpluses). Private sector investment therefore cannot be financially "crowded out" by public borrowing. A net increase in government debt absorbs net increases in deposits generated by government spending, keeping bank deposits at their previous level but providing the banking public with an increase in their liquid financial assets.

2. *Federal spending is not constrained by the availability of money to tax or borrow.*

   The spending powers of the government are not constrained by its cash flow position vis-à-vis the private sector. Rather, settlement balances are created or destroyed as needed to accommodate the balance of government spending over the taxes collected. While government spending might rhetorically and politically be considered constrained by the amount of taxes it can levy or bonds that it can sell, these are not necessary *ex ante* but are created *ex post* if needed to neutralize the spending. Thus conservative rhetoric of federal governments ever having being "cash strapped" is

heretical. Provincial and municipal governments could theoretically reach limits to their borrowing, but the federal government cannot. Note this applies for domestic money only. The federal government could be facing *foreign currency* flow constraints, say if the foreign exchange reserves were wiped out to support an overvalued exchange rate. So long as a federal government has sovereign control over its monetary policy, foreign currency can only be used to purchase foreign goods, services, or assets; in other words, foreign currency is necessary to finance a current account deficit but not a budget deficit.

Another common but faulty assertion is that the federal government could find its bonds without buyers, which would trigger default on interest payments or debt that came due, or would require sharp spending cuts. Recall from the process described earlier that the first round of "borrowing" in response to federal spending involves the central bank removing the surplus of settlement balances through shifting deposits out of banks or by borrowing the excess. The only way this could fail would be if the private banks (through an amazing act of charity) preferred to hold non-interest bearing settlement balances as opposed to interest-bearing assets offered by the central bank. Following the first round of borrowing, other debt instruments are issued to replace the ones used in the overnight or open markets by the central bank. For example, the Canadian public can purchase "Canada Savings Bonds" from the government. This effectively reallocates ownership of the government's debt from the financial sector to the banking public, but is not a requisite act to fund a government deficit. The purchase of a federal bond is an opportunity made possible by the initial government spending.

3. *Debt monetization or default is not a risk.*

The outstanding stock of federal government bonds and bills represents the amount of settlement balances that would have been created by government spending if the central bank were not committed to meeting its target overnight interest rate. Wray (1998: 87) suggests that government bond sales be viewed as an "interest rate

maintenance operation" and thus an aspect of monetary policy not the financing of fiscal policy. So long as the central bank does not want to give up its target interest rate, then it is impossible for the bank to monetize (purchase with cash) the debt.[4] Monetizing the federal debt would generate a surplus of settlement balances in the banking system, pushing the overnight rate to zero, unless some other neutralization mechanism were implemented like restoring and increasing statutory non-interest bearing reserves. Remarkably, conventional wisdom as professed through economics texts (e.g. Dornbusch, 1999: 436-437) still cite debt monetization as an inflationary means of financing federal spending. In fact, the first consequence of monetization would be the central bank loosing control of its overnight interest rate target well in advance of the banking system being compelled to expand credit sufficient to generate inflation. So long as the central bank is committed to achieving a target overnight interest rate over the value of 0%, there cannot be a risk of monetization. More significantly, federal debt denominated in sovereign fiat currency is nominally risk-free, as classified by the Bank for International Settlements in its Basal capital risk standards (Bank for International Settlements, 1998: par. 36).

These important implications would not exist if the money system (in this case the Canadian dollar) were not fiat. If a newfound supply of reserve commodity were necessary in advance of expanding private and public credit, federal deficit spending could undoubtedly face constraints. The federal government would have to compete against the private sector to finance its deficit and therefore risk "crowding out." Another consequence of a non-fiat money system would be that debt monetization could be possible to the extent that the government devalue the reserve base of money. Fortunately, fiat money provides the government with greater potential of financing its needs, even if conservative orthodoxy preaches the opposite. One of these needs is to insure against the paradox of thrift, as will be discussed next.

[4] Monetization would involve the central bank swapping federal bonds for cash, thereby creating central bank liabilities to retire the government's debt liability. In cases like Canada, where the central bank is owned by the government, monetization would not reduce liabilities but just change the way in which they are recorded on the public accounts.

5.2 Insuring against the paradox of thrift

Along with the many advantages of using money to settle contracts and serve as liquidity comes a disadvantage introduced earlier whereby attempts to save money by not spending it can be self-negating as more people try to do this concurrently. Because money has a zero elasticity of substation and production, no market mechanism exists to ensure that everyone can concurrently increase his/her liquidity by hoarding bank deposits or currency. Central bank intervention as a lender of last resort is necessary to stave off bank defaults arising from a sudden increase in demand for liquid currency. Fiscal intervention in the form of increasing indebtedness is required to enable the public to increase its store of liquid deposits. Both central bank and fiscal interventions of these sorts are necessary in an ESE.

Attempts by the public at large to increase their net store of bank deposits reduces demand relative to where it would be if that increase in attempted savings were instead spent or invested. In an economy with uninsured currency and commodity-reserve constrained credit, people could "save" by reducing their consumption spending and instead lending their newly idle cash to banks. This would provide the banking system with an increase in loanable funds, thereby lowering interest rates and thereby inducing greater investment, which acts to counter the reduced demand brought about by initial reduced consumption spending. As argued earlier in Section 4, commodity reserve-constrained credit is counterproductive in an ESE since they would require greater throughputs to sustain the system and could constrain the financing of ecologically beneficial activity. Uninsured deposits are equally counterproductive since it opposes the basis of money as a means of dealing with uncertainty.

In an economy where the public's fiat money is held in the form of bank deposits and the lending rates by banks is linked to the overnight rate set by the central bank, attempts by many people to concurrently save by hoarding deposits is futile. One person's attempt to increase saved deposits through reduced spending reduces someone else's income. There are no more or no less total deposits in the banking system, so there is no autonomous response on the part of banks to change the interest rate they offer on deposits or charge

on loans. The people whose incomes are reduced by other people's reduced spending will downgrade their expectations of the future, thereby reducing their propensity to spend or demand credit. In this case, reduced growth in the demand for credit reduces the growth in deposits, reaffirming that the public's attempt to increase its store of bank deposits through reduced spending is self-defeating. The biophysical consequence of this process is that reduced demand resulting from attempts to save deposits correlates to reduced throughput, especially if demand for durable goods fall. Some ecological monetary reformers might see this as a positive step towards reducing the economy's demand on the environment, but these reformers should realize that this is a haphazard way of reducing ecological footprints. As discussed earlier in Section 4.2, the demand for credit is not a fair proxy for the demand for financing environmentally degrading activity, nor is the precautionary demand for money biophysically costly. Since fiat money is close to being biophysically neutral, there is little utility in an ESE to economizing it, especially since this could switch people's preference towards throughput-intensive assets as a store of value.

Government debt can help avoid this futile paradox of thrift by offering liquid, secure bonds and other government paper. The paradox of thrift happens because the private sector cannot create net liquidity—the apparent "liquidity" of, say equity markets, is a *gross* and not *net* property since the liquidity of one person's holdings is a function of someone else demanding them, while no possibility exists for the market *as a whole* to be liquid (Toporowski, 2000). Federal governments with sovereign fiat monetary policy are not constrained in their ability to supply liquidity since the government is in the fortunate position of defining it and creating it without limit (since it is not tied to a reserve commodity). The "ecology" of this process takes place somewhat independently of the real world. That government debt can grow with little biophysical cost is, in this case, a huge *asset* for an ESE. The macroeconomic challenge, in the context of an ESE as in a contemporary context, is to ensure that the level of government debt is sufficient to insure against the paradox of thrift. The next section proposes a way of ensuring this.

5.3 Achieving full and liveable employment

In Keynes' words, "unemployment develops, that is to say, because people want the moon; [people] cannot be employed when the object of desire (i.e. money) is something which cannot be produced and the demand for which cannot be readily choked off" (Keynes, 1935: 235). As discussed earlier in Section 3.1, Keynes refers to liquidity having the unique concurrent properties of a low or zero elasticity of substitution and production. Money is not produced more easily by the private sector when its value increases nor do other assets become more attractive substitutes when the value of liquidity increases. There is no market mechanism that produces more liquidity when its demand is the greatest (nor less when its demand falls). A Post Keynesian conclusion of this fact is that involuntary unemployment is a possible and particular consequence of an economy that uses money with these properties. Since this paper advocates the maintenance of a fiat money system in an ESE, it is necessary to deal with its social consequence of involuntary unemployment, which works against the need for income in a monetary economy.

Involuntary unemployment and underemployment can be considered as an indicator of an unfulfilled demand for liquidity—in other words, the workings of a paradox of thrift.[5] In simple terms, once people's liquidity demands are met, excess money holdings are directed towards increased consumption or investment spending, which generates greater demand and likely lower unemployment or underemployment. The level of unemployment can be considered an indicator of the degree to which liquidity demands are not met. Since the private sector cannot create net liquidity, it is up to the public sector through growing debts to close the gap and thus reduce unemployment. The mechanism of this argument is best understood by William Vickrey's asset-based approach to macroeconomics (1997) and subsequent work by Forstater (2000), which is appropriate to the discussion of fiscal and monetary policy in an ESE.

[5] An alternative way of stating this is that unemployment is an indicator of lack of sufficient aggregate demand, which would be necessary to increase the demand for labour to its full-employment level. Insufficient demand is as much a consequence of a paradox of thrift as it can help cause or maintain the paradox by increasing people's precautionary savings.

5.3.1 Connections between unemployment, liquidity, and public debt

For Vickrey (e.g. 1997), the difference balance between desired and actual holdings of net assets is brought into equilibrium through changes in income, which relates to changes in (un)employment. People's attempts to reduce their spending to increase their savings (say because the value of their assets is less than the desired level or because they have lost income through being newly unemployed or underemployed) generates reductions in other people's incomes. With savings being income that is not consumed, the level of savings is always equal to investment—but not because savings are necessary for investment, but rather the reverse causation. Vickrey's approach is novel because of the demographic and institutional factors he argues have contributed to an extraordinary imbalance between desired and actual holdings of assets, namely increased longevity contributing to increased retirement spans that are being funded by the accumulation of financial assets. The implication of his analysis is that substantially increased government debt is necessary to close the gap of unfulfilled desired holdings of net assets. Vickrey cautions that this gap has not, and will likely not, be closed by market processes other than reduced income leading to unemployment or underemployment.

Immediate needs are met by liquidity. People will tend to hold a positive balance of bank deposits and currency to pay bills as they come due, to enable cash purchases, and for a variety of other reasons. If they are astute financiers, they may trade their bank deposits for secure but higher-interest liquid government bonds, GICs, or special higher-interest savings accounts, all of which can be liquidated to deposits in a relatively quick period like a few days. Future needs can be met by acquiring less liquid financial assets and physical ones that can be liquidated. These assets of lower liquidity include residential property, RRSPs, pension assets, equity and holdings of corporate bonds. People will build up their future financial needs after more immediate liquidity needs are satisfied, minus the extent to which people cannot opt out of forced contributions to future financial needs as through mandatory pension contributions.

Over the last few decades in Canada, job security and remuneration have fallen, as unionization rates have slipped, corporations have moved towards hiring people on short-term contracts and through "temp agencies" and the social safety net of unemployment insurance and welfare has been eroded (Jackson, Baldwin et al., 2000). These developments logically tend to increase the demand for liquidity following a precautionary motive. Recall from earlier that the private sector cannot create liquidity on a net basis; liquid assets are created by the government or their liquidity is guaranteed by the government through lender-of-last-resort policies and deposit insurance (as with bank deposits). Attempts by many economic actors (people and firms) to concurrently increase their liquidity falls victim to the paradox of thrift unless the government accommodates it (as discussed earlier). Government accommodates the liquidity demands of the public through increased production of bills and bonds. Unfortunately, there is no automatic process that increases the supply of liquidity if its demand increases (or conversely to decrease liquidity as its demand falls). Under current macroeconomic stabilization policies, liquidity is produced when governments generate deficits. If deficits are not great enough to match liquidity demands, or if government spending is not well targeted towards the unemployed, then unemployment persists. The apparent magnitude of unemployment could be tempered by underemployment, lower wages and benefits, increased incarceration rates, a decrease in participation rates, and so on—though these alternatives do not necessarily ensure that sufficient income prevails to meet needs. Granted, deficits can equally be too large to the extent that the public's attempt to shed its excess liquidity can put upward pressure on prices. An ESE attempt to deal with this latter possibility is covered in Section 5.5.

Vickrey (1994: ch. 22) notes a realization over the last few decades that increased longevity necessitates an enormous financial portfolio upon retirement to be able to finance 25-30 years worth of independent living in the face of increasing medical costs and so on. This has helped to contribute to soaring equity prices as the demand for them has outstripped their supply, as corporations have not expanded their investment enough to absorb the demand for their equities. Vickrey proposed several reasons why this has been the case, including that corporate expansion has been less capital-expansive than in

the past, as it moves towards just-in-time production, capital-saving innovations like fibre optics, and a slew of other technological developments. Since the demand for liquidity has remained high and somewhat unsatisfied over the last few decades, demand for the products of industry has not risen in step with the demands for equities of those same industries. Consequently, industrial strategies are increasingly directed towards corporate takeovers, aggressive cost-cutting, and creative bookkeeping to boost its share price through the use of stock options in lieu of salaries, share buy-back schemes, restructuring write-offs, etc.

5.3.2 Finding the best means of reducing unemployment

The popular rhetoric of "pump priming" attributed to Keynesian economics has been criticised for a number of theoretical and practical reasons. The theoretical challenge has been that requisite government debt crowds out private sector investment at best or at worst is subject to Ricardian equivalence whereby the public's reaction to increased debt is reduced spending on expectation of greater future taxes. This challenge is faulty because it judges Keynesian theory based a classical assumption of the neutrality of money. Section 5.1 showed how crowding out is fallacious and readers of this paper could easily find more critiques of Ricardian equivalence (e.g.Vickrey, 1997). The practical challenge to Keynesian employment policy is often that since deficits often persist along with unemployment, and since deficits are supposed to cure unemployment, then surely deficits do not cure unemployment. As alluded to earlier, deficits may persist with unemployment if deficits are not big enough or if government spending is not well targeted towards the unemployed. Some might try to argue that unemployment is natural or is desirable because of some non-inflationary rate of unemployment (NAIRU) constraint. This paper does not assume the existence of a NAIRU but rather proposes why it is neither needed nor desirable. A significant theoretical and practical challenge to Keynesian employment policy is from ecological economists who caution against the ecological impact of the demand-increasing macro policies (e.g. Daly, 1996: 48).

Employment policy in an ESE should minimize unemployment and underemployment as a means of ensuring that the need for income is met in a way that minimizes the amount of additional biophysical throughput that would be generated (ultimately limited, of course, by the ESE constraint of critical capital thresholds not being overcome). General increases in aggregate demand are not appropriate in an ESE context to reducing unemployment. The higher the capital (narrowly defined as manufactured capital) to labour ratio of an economy, the greater the requisite increase in demand per net new job created. As this ratio has increased over time in Canada as in other OECD countries (Gera, Gu et al., 1998), it suggests that demand-induced employment creation is increasingly costly in a biophysical sense, as it will induce growth in manufactured capital. Since manufactured capital is "produced" by human-transformed natural capital, greater manufactured capital implies a depletion of natural capital. With a limit on the amount of natural capital that can be depleted in an ESE, the employment-generating capacity of conventional expansionary demand policy could become limited before full employment is attained.

Several alternative unemployment-reduction policies resonate within the ecological economics community, including work sharing, a guaranteed annual income that is akin to paid employment for work in the non-market sector, and more laissez-faire solutions like ecological tax reform that aims to generate greater demand for labour at the expense of labour-saving but resource-intensive production techniques. To date these employment policies have yet to be articulated in terms of their relationship to a monetary economy, in which an unmet demand for liquidity is a cause of unemployment *requiring monetary intervention* and not simply the redistribution of work and the adoption of more labour-intensive production techniques. Work sharing might initially change the official statistic of unemployment, but unless somehow it were joined by policies that reduce the (unmet) demand for liquidity (which caused the unemployment), then further unemployment or underemployment could result. Work sharing policies could work if they are accompanied by the reduction in wants in a sort of campaign of *in*voluntary simplicity where the returns from productivity gains (if they occur) would be converted to reduced working hours without increased work income or increased

profitability for corporations. Still this would amount to changing the structural nature of employment and not the cyclical problem of bouts of increased unemployment resulting from changes in the demand for liquidity. A guaranteed annual income might be a socially just means of compensating for non-market labour, but it is not clear how it could serve as a monetary intervention to the monetary cause of unemployment.

A hopeful (thought controversial) solution is the proposal of "Employer of Last Resort" (Forstater, 2003) or a "Job Guarantee" (Mitchell and Watts, 2002). The program proposed by these authors involves the federal government setting a wage rate at which it would commit to funding the employment of everyone who voluntarily chooses to accept an ELR job. The government would therefore create a buffer stock of jobs. The ELR wage in an ESE context would have to be set high enough to ensure at least a liveable wage, which constitute an effective minimum wage rate (against which low-paying private sector jobs must compete). The authors propose that participation in an ELR job would not be means-tested, but available to anyone willing and able to work. The nature of the jobs is an important issue, specifically to make sure that the jobs are compatible with an ESE and that they are not a substitute for existing or potential secure (salaried) public service jobs. This is an ambitious challenge, but that could be met after some trial and error.

To provide the unemployed with some choice of ELR work, there would likely have to be more offers in the jobs bank than there are applicants. Job offers could be included from all levels of government, public educational and social intuitions, and perhaps non-profit community organizations and religious institutions. Several administrative rules would need to be stipulated, drawing on the work of Forstater (2000) and Mitchell and Watts (2002). The ELR job offer should not replace an existing job. The ELR applicant would not be committed to staying on the job. The nature of the work is socially useful but not essential. The agency offering the job would evaluate the ELR applicant's performance so the applicant can use the evaluation (and reference) when applying for a non-ELR job. The agency offering the job would have to understand that their offer is not guaranteed to be filled by an ELR applicant, assuming there are more ELR job offers than there are

ELR job seekers (which should be the case to allow job seekers sufficient choice of jobs). The private and permanent public sector can search the databank of ELR workers for hires. One would need to ensure that ELR job seekers be presented with significant choice; hopefully the preceding requirements would not be too restrictive. (Again, this is a proposal that would need to be experimented on a trial and error basis.) The offering agency would need to see an ELR program not as a way of building its core human resources but rather supplementing it with what would be equivalent to "temporary workers" but where the workers have more bargaining power than do present temporary workers employed through "temporary agencies." Suitable jobs might include street musicians and artists, conversation partners for new immigrants and bedridden people, park stewards, repair clinics for consumer durables, surveyors for roof garden potential, heritage interpreters, etc. Further details about the environmental potential of this program can be found in Forstater (2003) and in Mitchell and Watts (2002), who argue that one requirement could be that all ELR jobs must increase the Genuine Progress Indicator.

To a macroeconomist, this ELR proposal could be envisioned as a replica of the central bank's lender-of-last-resort policy but transformed to finance employment-of-last-resort in the public sector. For this to achieve full employment, it is necessary that all ELR employment be deficit financed, though the remaining fiscal budget could (and likely would) be in a surplus position. The macroeconomic ingenuity of this policy is that it provides a useful anchor to the amount of debt needed to reduce unemployment, since the needed debt is generated in response to actual unemployment. Undoubtedly, the pool of ELR workers would shrink and grow over the business cycle. Instead of having a "reserve army of the unemployed" as inferred by the theory of the NAIRU, this would provide the economy with an organized "army of the publicly employed" from which the private sector and public (non-ELR) sector could hire. The deficits generated automatically by ELR hiring would *directly* finance reduced unemployment, thereby avoiding the problem of conventional policy being less targeted and therefore less successful on a per dollar basis. Granted the new income from ELR workers could spill over into sectors with conventionally large ecological footprints, even if the ELR work is

relatively benign. This suggests that a program of fiscal reform should be undertaken simultaneously so that the composition of aggregate demand changes beyond the change induced by the benefits of ELR activities (Forstater, 2003). This would help to ensure that ELR achieves unemployment reduction without necessarily increasing the biophysical scale of the economy, since employment policy would no longer be equivalent to growth policy.

A consequence of an ELR policy is that government debt should be allowed to rise. Economic growth is conventionally relied upon to lower the alleged "burden" of rising public debt on governments and the taxpaying public. Growth of biophysically benign market activities may increase in an ESE but it is likely that the macroeconomic goal of endless growth would be replaced with one of endless (sustainable) renewal. One wonders then if growing government debt would not be more burdensome in an ESE than in a conventional growth-oriented economy. This issue will be examined next.

5.4 Sustaining public indebtedness

What would be a sustainable level of public debt in an ESE (and how do we measure this)? A growing government debt is often said to be fiscally unsustainable in the long-term, though potentially beneficial in the short-term as a stimulus to reduce unemployment. Government debt is alleged to impose a fiscal burden on future governments to the extent that interest payments and debt reduction divert money away from alternative spending opportunities or tax reductions. This fiscal burden is often framed as an intra- and sometimes inter-generational tax burden, though this can be disputed by recognizing that tax-supported interest payments on the debt simply redistribute net worth in a given period and not across it. In Kenneth Boulding's terms, tax-supported interest payments are part of the grants economy (Boulding, 1992: 131). Often the debt burden is measured relative to GDP, on the assumption that growth makes a given level of debt more sustainable. Ecological economists are typically critical of pro-growth policies and thus might instinctively object to government debt if it requires growth to reduce its burden. One would be hard-pressed to find an assessment of the

sustainability of public debt in an ecological economics context, besides an attempt to completely restate it along biophysical terms (Azar and Holmberg, 1995); if there were one, what indicator would be used to measure it?

The debt-to-GDP ratio is used to assess the *relative* magnitude of public debt in relation to an economy, which is hypothetically the debt's ultimate guarantor. It is a ratio of stock to flow that might best be thought of as the macroeconomic equivalent of a family's measure of their debts relative to income. A deficit-to-GDP ratio is sometimes used to show the relative growth of government debt in relation to the economy (a negative deficit or surplus of course would indicate shrinking debt). This ratio of a flow to flow might be thought of as the macroeconomic equivalent of the growth of a family's indebtedness relative to its income. No theoretical maximum or optimal ratio has been identified for either the debt- or deficit-to-GDP ratios, though this has not prevented policymakers from generating their own targets. The Maastricht Treaty (1992) stipulates that European Union member countries' debt should be no greater than 60% of its GDP and deficits no greater than 3%. Regardless of whether an optimal ratio could be identified, it should be clear that in an ESE context, debt- or deficit- to-GDP indicators should be replaced with better means of assessing the financial flow and stock dimensions of sustaining government indebtedness.

5.4.1 Financial flow indicator

One wonders how either ratio of deficit-to-GDP or debt-to-GDP became widely used, though it might relate to the assumption that growing national income generates greater tax revenues, which makes it easier for governments to sustaining a given level of debt. Alternatively since GDP is such a paramount indicator (much to the chagrin of ecological economists), then perhaps it was only a matter of time that economists decided to measure public debt relative to it. Regardless, is it a useful indicator?

For debt- or deficit-to-GDP ratios to be meaningful relative or absolute indicators of fiscal sustainability, GDP would have to be a good indicator of national income. In fact,

net domestic product (NDP) would be preferable since GDP counts as income the depletion of capital assets, which is unsustainable unless compensated by new investment. However, even a debt-to-NDP ratio is less than ideal since the amount of net domestic production is only remotely relevant to determining how easy it is for government to sustain its level of debt or take on more of it. What matters most is how easy it is for government to appropriate net domestic production—that is, how easy it is to tax in excess of rates needed to sustain direct spending and transfers besides income to bondholders. Government debt itself is somewhat irrelevant; the amount of *interest payments* on the debt is the chief concern. After all, currency issued by the central bank is a debt, though it carries no interest so one would be hard-pressed to consider it as a liability worth extinguishing. It seems more appropriate therefore to measure the share of interest payments relative to government revenue.

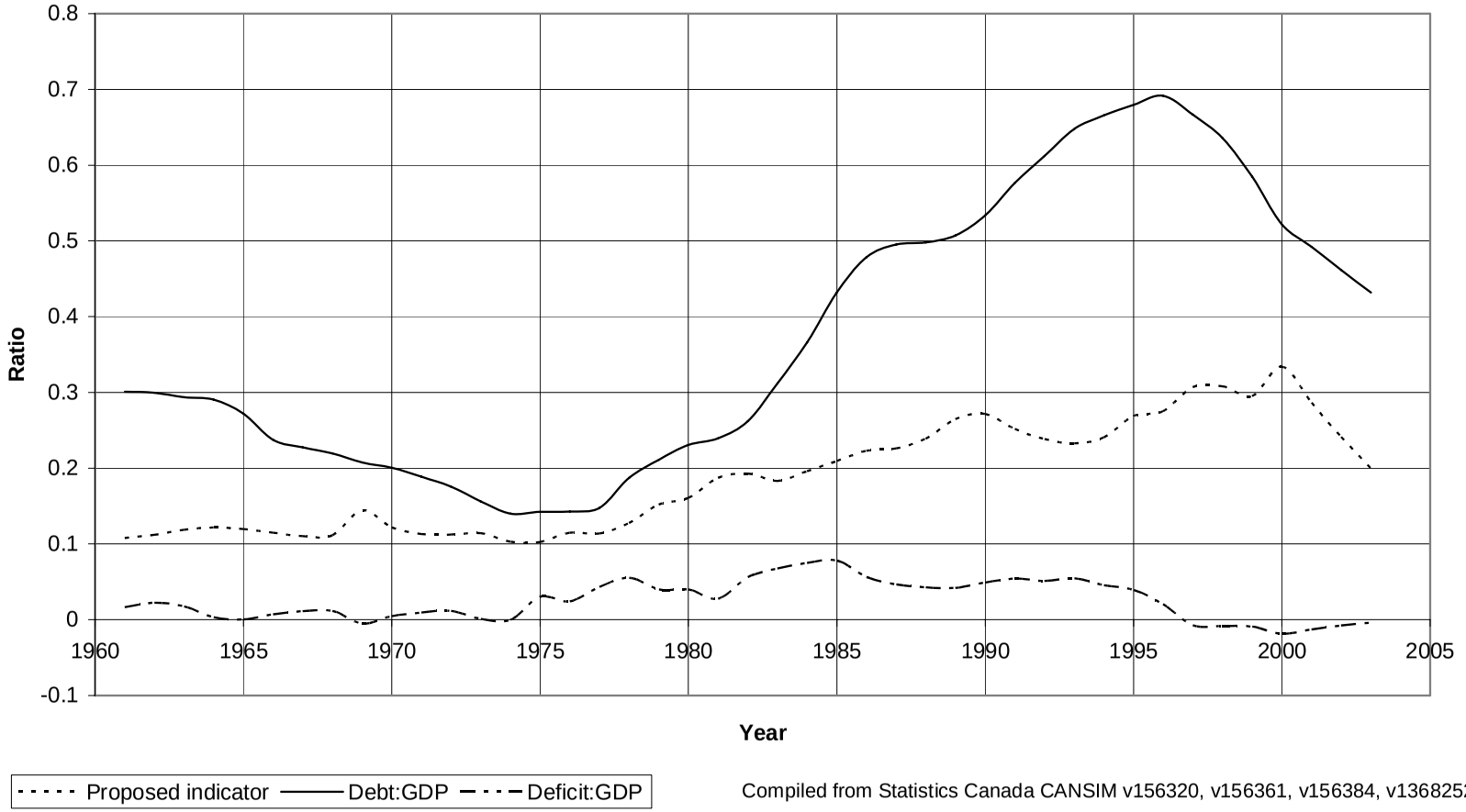
One issue with a measure of the (interest payments: government revenue) ratio is that some of the government's revenue could come from taxing the liquidation of capital. Ideally, the revenue term would be equal to sustainable income in a Fisherian or Hicksian sense or as proposed by El Serafy (1989). Included in this tabulation of income should be government's proceeds from selling bonds and other debt instruments. There is no reason why a federal government cannot generate part of its income through new debt issues. At first glance this might appear as Minsky's "Ponzi finance" in which revenue from selling new liabilities are issued to finance existing liabilities (Minsky, 1986). But it is worth noting that the un-sustainable nature of Ponzi financial structures comes about when new liabilities cannot be issued. This does not apply to federal governments with sovereign control over its monetary policy. These governments are not limited by the amount of domestic sovereign debt they can issue, assuming the overnight money markets work as described earlier (Section 5.1) and that the public demands the currency (recall from Section 3.2 that taxes create a minimum demand for the currency, so an assumption for demanding currency might be that the government can impose taxes). Ponzi Finance would only apply in the case of issuing debt in foreign currency markets to cover interest payments due in foreign currency, since government cannot create foreign currency.

Another issue with this measure is whether the financial burden associated with the debt is only the interest and not the interest plus repayment. Interest payments on public debt are a burden when viewed in light of their opportunity-cost of foregone spending on other programs, services, and transfers or reduced taxes. However, the same opportunity cost applies to funds allocated to debt redemption. After all, attempting to repay debt (run a surplus) when government income is low, like during a recession, generates a larger fiscal burden than not repaying it. The proposed indicator of financial sustainability should therefore be modified to be the ratio of

$$\frac{\textit{Interest payments plus debt redemption}}{\textit{Government revenue including debt issue}}$$

This ratio is equivalent to the amount of debt commitments relative to available finance. This indicator would serve as a proportion of the government's cash flow directed towards dealing with its debt, whether it is just paying the interest on it or also redeeming it. Over time, the change in this ratio would better reflect the change of a debt's "burden" to the government than does comparing debt-to-GDP ratios or assuming a given deficit-to-GDP ratio will persist. The proposed ratio would measure the size of the debt-related flow relative to the flow of revenue. When the budget is balanced, the new ratio would simply be the ratio of interest payments on the debt relative to government income. The ratio would reach its maximum value of one when a government only spends money on servicing its debt and (if applicable) retiring debt. The ratio would reach its minimum value of zero if government does not have any debt. Hence the absolute level of the ratio is greater given greater interest payments on the debt, which is determined by the interest rate and the absolute size of the interest-bearing debt. Figure 1 compares this ratio in a historical Canadian context relative to measures of debt-to-GDP and deficit-to-GDP, assuming that government revenue is from sustainable income even though this is likely not the case (no means was found to infer sustainable income from the national accounts on a historic basis).

Figure 1. Comparison of conventional indicators of debt-to-GDP and deficit-to-GDP versus the proposed indicator of the share of government revenue devoted to sustaining debt commitments



Compiled from Statistics Canada CANSIM v156320, v156361, v156384, v13682524

5.4.2 Sustainable stock indicator

Another indicator is called for to measure the contribution of government debt to the stock of public assets or liabilities. The commitment flow indicator generated previously says nothing about whether the government activities enabled by a given debt flow commitment is good or bad. Three sustainable stock indicators would suffice to present a realistic picture of the ecological fiscal orientation of a government in an ESE:

1) An accumulated operating deficit (a consumption account);
2) An accumulated contribution to net assets (a capital account);
3) Accumulated contributions to reducing unemployment (an ELR account).

The consumption account would reflect the balance of consumption spending over revenues, which measures the extent to which current expenses (as separate from capital formation expenditures) were financed in the same period in which their benefits were received. The measure of net debt in the public accounts typically assumes that all or most of government spending falls into the category of consumption. By providing two alternative stocks, for contribution to net assets and an ELR account, this should help to provide a clearer picture of the asset/liability stock effects of debt.

The ELR account would be take stock of the "financing" of the employer of last resort policy. Recall from the earlier discussion about ELR that it would have to be financed by deficit expenditures, thus the ELR account deficit would vary in response to involuntary unemployment. The rhetoric that government budgets must be balanced as if it were a household budget can be politically difficult to diffuse, even if it is economically questionable. The ELR account could be called "accumulated contributions" so that it would be in surplus whenever there were any ELR participants. The problem remains that ultimately the "contributions" must be placed under assets or liabilities, unless one could revolutionize accounting to create a new accounting column of "ambivalence." One option would be for the government to include "reduced unemployment" as an asset to match (on a dollar-by-dollar basis) the liabilities incurred under the ELR account to finance the program. The difference between these two items is that the liability would be interest bearing while the asset would not. One option would be to transfer surpluses

from the consumption account to the ELR account, which suggests that the consumption account should have a surplus equal to the interest on the outstanding debt incurred for ELR.

The second stock indicator of the accumulated contribution to net assets holds special ecological significance. Not only does government transfer income to people, bondholders, and businesses, but governments also invest in capital formation. Conventional macroeconomic models typically assume government spending is for consumption and not for investment. Not surprisingly, the public accounts typically account for government spending in its current year, as follows. The government surplus or debt position is mostly a measure of its cash-flow position and not a statement on its contributions to assets or liabilities. Only recently in 2003 has the Government of Canada[6] changed its federal public accounts on an "accrual basis" to count revenues and expenditures in the year in which they accrue:

> Accrual accounting recognizes transactions and other events when they occur and not when cash is received or paid. Expenses are recorded in the period when the goods and services are consumed (used). This implies that multi-year benefits associated with capital assets are matched to the time that they are expected to be used. Revenues are recorded in the period to which they pertain rather than when they are received (Department of Finance, 2002).

Government investment is thus amortized over its useful life, and not in the year of acquisition as was previously done. Previously investment that came with a high upfront cost (as does most long-term investment) would have contributed to a large deficit unless taxes were concurrently increased or spending was cut elsewhere. At the same time, the value of the newly acquired investment good was listed as a nominal $1 under the assets column of the accounts (Statistics Canada, 1990: 22) and not appraised for its full worth. No wonder public investment was politically charged as an extravagant activity. That a public asset was not valued as such provided privatization with an immense appeal whereby its entire sale price (minus $1) was booked as a capital gain, even if the sale

[6] Apparently the Government of Ontario might also adopt full accrual accounting in the near future (Peter Victor, personal communication, August 9, 2004).

price was below the present value of its cost to the government. Accrual accounting improves the possibilities of public investment to the extent that its political appeal was previously damaged by its unfavourable impacts on the annual budgetary balance. The federal debt under accrual accounting is therefore a more realistic measure of the extent to which a debt represents a liability rather than being an indicator of its accumulated cash-flow position. This development is a good starting point to developing a better measure of the government's contribution to public assets that would be necessary under an ESE.

An ESE would call for investment in critical natural capital as a means to enhancing the scale of throughput-intensive economic activities. Investment can rehabilitate depleted natural capital by, say, bringing back wetlands, restocking fish, decontaminating sites, reforestation, etc. Much of this sort of investment would have to take place through the public sector, either because the returns are public goods (which cannot be captured by the market) or because it relates to areas of public jurisdiction, as with decontaminating former military sites. To make public sector investment in natural capital appear financially sustainable, the necessary spending must be classified as investment within the public accounts. Unfortunately not all investment in natural capital is currently counted as investment; only the reduction of identified "environmental liabilities" counts (Department of Finance, 2003). Nor has the government included any of its education and health spending and transfers as investment in human capital.

The National Round Table on the Environment and the Economy recently released a set of environment and sustainable development indicators at the request and funding of the Department of Finance (National Round Table on the Environment and the Economy, 2003). Unfortunately, the public investments needed to improve the indicators would not appear as investment under accrual accounting since none of the indicators directly address environmental liabilities that are identified in the public accounts. A solution to this problem would be to expand the amount of environmental liabilities considered in the public accounts.

To expand the environmental liabilities considered in the public accounts, the government could establish a sustainability target for any or all of its indicators, like the amount and distribution of wetland.[7] One option based on Hueting (1991) would be for the government to estimate the amount it would cost to finance meeting that level, say the amount it would cost to rehabilitate wetlands until the wetland indicator is at its sustainable level. Alternatively, the government could provide an estimate of the cost of damages from not reaching the target, say an estimate of the cost of floods and reduced biomass sinks resulting from an insufficient (unsustainable) wetland cover. Once calculated, either measure could then be booked as an outstanding liability, which would be eliminated when its sustainable target is achieved. The latter proposal to list as a liability the damage costs is a more realist a liability measure than the financial cost of meeting the sustainable target. After all, the future liabilities generated by not meeting a sustainability target could be more costly than the present cost of meeting the sustainability target (though contingent upon the discount rate, which is considered later in Section 5.6.1), so booking the cost of meeting the sustainability target would understate the value of the actual liability. On the other hand, it may be very difficult to assess a monetary value of the liability, since its cost is contingent upon methods of valuing non-market impacts, uncertainties in who may bear the cost and how the cost will be handled, and a number of other considerations. In contrast, it is relatively easy to determine the cost of reducing the outstanding liability today so long as the technology and knowledge exists to achieve this reduction.

Given its feasibility, the proposal to list the cost of meeting the sustainability target as a liability would be a preferred means of allowing reductions in environmental liabilities. When that cost is incurred, it would reduce its outstanding liabilities dollar for dollar, which would avoid increasing the federal debt. This framework would also be compatible with Costanza's advocacy of "environmental assurance bonds" provided as collateral to the government of the maximum cost of dealing with an accident arising from some risky activity (Costanza, 1994), much like the Government of Ontario's "Land

[7] The current indicators infer changes in the degree of sustainability without specifying sustainable targets that would allow us to determine if Canada is sustainable or not.

Rehabilitation Performance Bond" used in mineral development and mine rehabilitation.[8] The bond's value would be listed as a liability on the public accounts to the extent that it recognizes the cost of a potential ecological risk, while also appearing on the assets side as the "fund" that can be drawn upon in case of an accident. In biophysical terms, financial funds are nonsensical since they do not provide the real resources that ultimately must be drawn upon to do some activity. Even if real resources are put aside as a quasi-fund, these resources would be subject to carrying costs like entropic depreciation and not positive interest that financial funds earn. Nevertheless the financial fund here is useful as an accounting item so that in cases when the government should mobilize real resources to perform some task (like remediate spills), it would not be financially "constrained" from doing so.

Table 1. Summary of proposed means of inferring sustainability from stock of debt.

Account	What it measures	Sustainable Target
Capital account	Accumulated investment in public assets and reduction in liabilities minus cost of meeting unfunded liabilities	Policy should ensure a balance of assets and liabilities so capital account is balanced on a net basis
Unemployment reduction account	Accumulated government spending on reducing involuntary unemployment through an ELR (or equivalent) program	Policy should not target a specific balance on this account, though an asset of "reduced unemployment" could be added to offset liability of the cost of financing reduced unemployment
Consumption account	Government spending on goods or services that are enjoyed in the same period in which they were financed	Policy should ensure a balance or surplus

On balance, the three (stock) accounts of consumption, capital, and ELR would each be useful ways of inferring the sustainability of a given stock of debt as a function of the account it appears under. The proposed accounting system, summarized above in Table 1, would likely result in the consumption account balance being balanced or positive and offsetting the negative ELR account balance, while the capital account balance would be

[8] The template of this bond can be found at http://www.mndm.gov.on.ca/mndm/mines/mg/finas/bond_e.asp

balanced on its own. Other accounts might be necessary to account for special sizeable programs, like a funded pension plan.

5.5 Controlling consumer price inflation

The consumer price index is used as an indicator of inflation and is targeted to fall within the range of 1 to 3 percent in Canada and about that range in other jurisdictions. The central bank typically raises interest rates pre-emptively when excess capacity is expected to fall below the point where the prices of labour, energy, or commodities begin to inflate. Simply stated, the central bank's monetary policy it to ensure sufficient excess capacity to minimize the risk of supply constraints, which would push up prices. This policy is based on the assumption that higher supply prices raise costs, which generate locked-in expectations of future inflation as labour bargains for greater wages, which generates positive feedback as greater wages increase supply prices, etc. The theoretical and practical issues involved in this conventional policy are widely challenged by Keynesian economists. More challenges arise in the context of an ESE, as follows.

A central bank might instinctively worry that an Employer of Last Resort (ELR) policy would be inflationary because it would effectively wipe out excess capacity in labour markets (i.e. involuntary unemployment). The bank need not worry. ELR would not compete against the private sector for its participants since they would voluntarily enrol in the program by virtue of not being demanded by the private sector. Their re-employment in the private sector or as salaried public employees could be fast and easy since ELR workers would not be committed to serve a fixed period of ELR employment. One could expect relatively fluid movement of people into and out of ELR employment. Economists familiar with the idea of a Non-Accelerating Inflationary Rate of Unemployment (NAIRU) might see this ELR program as a means of transforming the unpaid "reserve army of the unemployed" into a "temporarily employed reserve army" that could still fight wage inflation, only that (metaphorically speaking) life as a reservist would improve. Granted there could be a one-time price adjustment if the ELR wage is introduced at a rate greater than the existing minimum wage rate, necessitating the private

sector increasing its low-end wages to be just equal or above the ELR one. As stated earlier, the ELR wage should be a living wage, or at least its wage in combination with other universal public services should enable it to be liveable. As with any buffer-stock system, an ELR would amount to a price floor and would be an obvious anchor for most other private sector wages. If the buffer stock of ELR workers becomes too depleted to exert any influence over the structure and level of general wages, then either one can claim victory against unemployment or fiscal policies could be adjusted to dampen private demand for labour so the ELR buffer remains effective.

Excess capacity is a biophysically wasteful means of limiting price inflation. Industrial capacity, including plant equipment and the real estate that houses it and the transportation and energy infrastructure required to service it, require appropriating natural capital or income to "build" it. The throughput requirements of building industrial capacity often involve very taxing processes like converting ore to steel and aluminum. That a certain proportion of industrial capacity should be expected to serve as nothing more than a price buffer implies a direct biophysical cost associated with this means of limiting consumer price inflation. Granted a small amount of excess capacity might be expected to occur naturally, as high capacity levels generated during booms prove to be excessive during other points in the business cycle. But generating supernormal excess capacity is problematic. On one hand, the influence of excess capacity on prices could wear off over time, as entrepreneurs readjust their expectations of needed capacity downwards and therefore add less capacity when expanding or turning over the existing capital stock. Unless the monetary authority still attempts to generate excess capacity after the private sector revised its expectations, in a sort of deflationary spiral, then this policy might be naturally short-lived. On the other hand, contemporary central bankers are fortunate to be operating in an environment of ongoing removal of trade and investment barriers (i.e. globalization). Globalization in this way can be relied upon to sustain—if not increase—excess capacity in the now *de*-industrializing countries.

Not only is excess capacity a wasteful use of natural capital, in an ESE it also tends to keep prices low by making capacity cheaper than it would (or perhaps should) be. Excess

capacity in commodity markets works against recycling and recovery by reducing the slim margins that can be generated over the high collecting and sorting costs. Excess capacity of industrial and human capital keeps the price of manufactured goods low enough to promote year-round retail sales, sending consumers the message of abundance. Walking through an average dollar store or big-box retail outlet, one would be hard-pressed to convince average folk that conservation should be the order of the day.

An ESE therefore calls for a better means of directly targeting consumer price inflation than using excess resource, industrial, and human capacity. Ideas abound in the Post Keynesian literature since Keynesians also call for a better means of targeting consumer price inflation. Post Keynesians like Galbraith and Davidson see inflation as a struggle over the distribution of income since "every increase in the price of things produced is an increase in someone's income" (Davidson and Davidson, 1996: 154). Inflation is thus a competitive struggle between the shares of income going to wages, relative to profits, relative to interest, etc. This theory of inflation leads to policies like a tax-based incomes policy, in which wage increases in excess of a policy target would be penalized by some special tax built into the corporate tax system (Wallich and Weintraub, 1971). An alternative and perhaps better approach would be to design a system of tradable permits in the rights to gross price mark-ups, somewhat like a tax on inflationary value-added. To ecological economists, this sort of a system should resonate by being akin to emissions trading. The late William Vickrey was a strong advocate for the proposal, concerned not only with the theoretical virtues of this system over traditional NAIRU-style controls (Vickrey, 1997) but he also with the practical issues involved in setting up a system (for example, see Vickrey, 1986).

With a better policy tool of targeting consumer price inflation, one wonders whether stable consumer prices are called for in an ESE. Significant consumer price inflation in an ESE could undermine confidence in fiat money, potentially shifting demand to other physical assets as a store of value and thereby increasing throughput. However, the issue with consumer price inflation is not so much whether it exists but whether it deviates from expectations that find their way into contracts, like when wages are set to increase at

a set amount per year (Vickrey, 2000). Inflation at rates less than anticipated creates a windfall for creditors while adding costs to debtors as the real rate of their debt increases in excess of growth in income. A constant rate of consumer price inflation need not undermine confidence in fiat money as future consumer prices fall somewhat in line with expectations reflected in contracts. Furthermore, there may be significant costs to price stability as opposed to permitting a positive but constant rate of consumer price inflation (e.g. Fortin, 1993). A positive rate of consumer price inflation provides a monetary authority with a greater possible *real* range of interest rates, considering that the nominal overnight rate cannot generally fall below zero even if it would be warranted to deal with deflation (for a recent discussion on alternative ways of overcoming the zero bound see Goodfriend, 2000). Another positive aspect of positive nominal inflation is that it could make contract negotiations easier as nominal wages could increase even as the real wage is not, as proposed by Tobin (1972) based on the Keynesian insight that workers are more interested in their nominal rather than real wages. Granted the consumer price index is broad and does not reflect differences that may be taking place within various segments of society, like students whose spending goes towards tuition and rental housing versus non-students who spend less of their income on these items. The index also typically overstates inflation (Crawford, 1998) and one could argue that it cannot distinguish ongoing structural price changes taking place in response, say, to increasing the degree to which externalities have been internalized into private costs. A more appropriate consumer price index might be necessary in an ESE. When and if that new price index were created, the arguments presented in this paragraph suggest that policy should aim for a constant low but positive rate of increase in the index.

5.6 What should determine the overnight interest rate?

Keynes (e.g. 1935: 375) argued that that interest rates should be low enough to promote sufficient investment to generate full employment. Keynes concluded that effective savings are determined by the scale of investment, which is promoted by lower rather than higher interest rates. Present-day pro-investment policies such as accelerated capital cost allowances may increase investment but they usually encourage manufactured

capital-intensive rather than labour-intensive investment. To the extent that ever-greater levels of investment might be called for to generate full employment through this policy, and the extent to which manufactured physical capital is transformed natural capital, then this strategy could work against sustainability. In an ESE where resource and energy usage is subject to depletion permits, investment could end up being constrained before full employment is reached. A policy of Employer of Last Resort (ELR) was proposed as one means of generating full employment at a likely lower biophysical cost. This proposal provides the policy-determined (overnight) interest rate with an extra degree of freedom from having to influence employment. Alternative policies were proposed earlier that might help directly target consumer price changes, which would further relax the number of concurrent objectives needing to be fulfilled by the central bank's interest rate policy. What should determine the overnight rate that the central bank chooses? Two alternatives will be examined: choosing the rate to act as a macroeconomic discount rate versus a rate that equalizes the effective cost of money.

5.6.1 Discounting and the overnight interest rate

When discussing "environmental economics" Herman Daly (e.g. Daly, 1991: ; Daly, 1996: 50) draws on David Pearce's contention (Pearce, Markandya et al., 1989: 136) that environmental degradation can be both a positive and negative function of higher discount rates. On the one hand, higher rates discount the future and thereby shift burdens onto future generations, thus undermining sustainability across time. On the other hand, lower rates make investment projects more viable, which use resources and generate economic growth, thereby possibly undermining a sustainable scale of economic activity. In other words, a higher discount rate can increase capital liquidation (an allocation effect) while reducing the demand for the liquidated capital (a scale effect). The net balance between the opposing scale and allocation effects is unclear. If one effect dominated, and if interest rates were equivalent to discount rates, then the policy-determined (overnight) interest rate could be used to influence discounting on a macroeconomic scale. Unfortunately, there is no indication that one effect necessarily

dominates the other as a function of interest rates. Other factors further complicate the distinction between interest rates and discounting:

1. The proportion of economic activity based on biological resources (that can regenerate themselves) versus depletable resources (that cannot regenerate themselves within an appropriate time scale) affects the link between interest rates and discounting. Interest rates hold particular significance as discount factors in industries that harvest natural assets that can regenerate, like forests. In these industries there is some rate above which liquidation of the stock is more lucrative than regeneration (Ackerman, 1994). This rate depends on a resource's rate of regeneration, so the extent to which a given interest rate affects discounting depends on whether the interest rate is above the rate of regeneration of the biological resources under economic control.

2. Liquidity constraints affect discounting. The price of liquidated assets tend to vary with their demand, though liquidity constraints could increase the rate of liquidating natural capital assets even when their prices are not increasing. This situation could manifest itself by highly indebted poor countries depleting their wealth (mostly in the form of natural capital stocks) on an accelerated basis to earn foreign currency to finance foreign debt obligations, even when the value of the depleted exported natural capital is low or decreasing (Kahn and McDonald, 1995). Lower interest rates within highly indebted poor countries would not stem the allocation effect of discounting the future to cover an immediate shortfall of *foreign* currency. Liquidity-constrained firms that have difficulty accessing new loans or turning over existing loans could find themselves liquidating their assets even at low interest rates.

3. The way that discounting is performed in the public sector can further complicate the link between interest rates and discounting. This factor is proposed based on the way that discounting is done by the Canadian Federal Government. Governments of other countries and at other jurisdictional scales (e.g. regional,

provincial / state, municipal) likely vary in their policies on discounting. It is worth examining the Canadian Federal discounting policy in detail to show how the link between interest rates and discounting is not clear at least within this jurisdiction.

The Government of Canada's Treasury Board Secretariat sets out a *social* discount rate that should be used in all federal cost-benefit analyses. The rate is specified at 10 per cent *real* per annum, with a range from 5 to 10 per cent (again in real terms) for sensitivity analysis (Treasury Board of Canada Secretariat, 1998). The secretariat emphasises how "robust" this rate is on the basis that the government has used this since 1976. An alternative *fiscal* discount rate is discussed in the guide but is ruled out unless a project involves "few, if any social implications" (which seems doubtful). The guide from the Treasury Board suggests that the government's discount rate is independent of overnight interest rates, since these have changed dramatically over the period from 1976 whereas the discount rate has not. On the contrary, the discount rate should be somewhat interest elastic given the government's rationale for how the rate can be inferred:

> The social discount rate is roughly equal to the **opportunity cost of capital, weighted** according to the source of investment capital. For the Government of Canada, this is foreign borrowing, foregone investment in the private sector, or foregone consumption. If you know what the government's investment is displacing and what the rates of return would have been for the displaced uses, then you can calculate the opportunity cost. Essentially, the argument is that the government must achieve a return on investment at least equivalent to what the money would earn if left in the private section [sic] to justify taxing the private economy to undertake public-sector investments. If the government cannot achieve this it would be better for Canada if the money is left untaxed in the private sector (Treasury Board of Canada Secretariat, 1998).

If the source of investment capital were idle bank deposits, then the social discount rate should be the interest rate on deposits. This is the most obvious relationship between discounting and interest rates on money balances, and suggests that the social discount rate should at be somewhat interest elastic. Beyond this interpretation, the cited rationale given by the Secretariat is problematic on several counts, but especially from a perspective of how federal spending works. If investment spending were channelled

through a government's capital account (which on an accrual basis is balanced by listing the value of the created asset to offset the liability of extra debt incurred to "finance" it) then the source of (financial) investment capital is the creation of money, withdrawn from the banking system by the issue of government bonds. In this case, the (marginal) opportunity cost of capital is zero since there was no previous alternative use of the funds because they did not previously exist. If the project were financed by increasing taxes enough to offset spending (to not increase debt), then the opportunity cost of capital is at least the nominal interest rate on the taxed deposits. Yet this might still overestimate the opportunity cost. After all, government spending on a project recycles the initially taxed deposits; on a net basis, the opportunity cost is the foregone returns from the initial portfolio allocation relative to the post-project-spending one. All considered, the financial source of investment capital is a difficult if not dubious aspect used to calculate the opportunity cost of capital, even though this suggests that discounting is related to interest rates.

The biophysical source of investment capital for a project or program includes people combining their skills and energy with manufactured capital and energy, all of which are sourced from natural capital or income. The opportunity cost of employing these factor inputs depends on the value of their displaced use. The opportunity cost of employing an involuntarily unemployed person is at best zero, since there was no other opportunity. The opportunity cost of employing someone who was already working is the foregone output, which may or may not be greater than the public project or program being valued through discounting. The opportunity cost of the non-human capital is its alternative use had it not been employed. In an economy that does not value intact natural capital, the opportunity cost of depleting natural capital or income would be zero. In an ESE, the opportunity cost of depleting non-critical natural capital the foregone future stream of natural income. The opportunity cost of depleted natural income is an alternative human or non-human use.

On balance, discounting in the public sector is not as obviously related to interest rates as one might imagine. The current Canadian (Federal) discount rate policy is confusing by

being interest inelastic even though the policy's justification of discounting suggests otherwise. The extent to which a more sensible policy of discounting in the public sector would be based on interest rates depends on the source of finance and biophysical inputs employed in the project or program being discounted. The link between discounting and interest rates in the public sector is thus ambiguous, so interest rates would not be a useful tool to influence discounting in the public sector. This conclusion is supported by the opposing scale and allocation effects of interest rates in general and the specific issues of how interest rates affect industries that harvest biological resources that can regenerate and how liquidity constraints can increase discounting.

5.6.2 Equalizing the effective cost of borrowing

One novel approach to the issue of what constitutes an ideal or just interest rate was raised by Pasinetti (1981: ch. 8; 1993: ch. 6) as a "natural rate" and more recently brought to light by Marc Lavoie (1999) as a "fair rate." A fair interest rate is one that equalizes purchasing power over time in terms of wages. A fair interest rate would grow debts at the rate at which wages grow, so the effective cost of a debt is held constant in labour terms. A $100 loan taken out in 2004 would accumulate $2 in interest if wages were growing at 2%. If the wage were $10 per hour, then in 2005 it would take 10 hours to pay back the loan and accumulated interest, which was worth 10 hours in work in 2004. Lavoie notes that this would preserve the inter-temporal distribution of income between creditors and debtors. An interest rate above this fair rate therefore shifts the inter-temporal distribution of income from debtors to creditors. In practice, Lavoie argues that the fair rate would be the growth of multi-factor productivity. It would equal the growth of real wages if the rate of profit remains constant. In nominal terms, the fair rate would be the growth rate of productivity plus the rate of price inflation.

The idea of a fair rate has merit in an ESE on the basis that it would tend to preserve the inter-temporal distribution of income between creditors and debtors. This would work well in concert with other fiscal programs and transfers that aim to correct the "outstanding fault" of market economies that generate "arbitrary and inequitable

distribution of wealth and income" (Keynes, 1935: 372). One wonders if the demands for programs and transfers aimed at redistributing income would have been less if interest rates were more in line with fair rates. After all, there would be a greater need for programs and transfers to generate a more equitable distribution of income if interest rates were greater than the fair level. Setting the policy-determined (overnight) interest rate to be just below the fair rate would generate a spread of market rates that begin at around the fair rate. To the extent that long-term financing is provided at a "prime rate" that is just above the overnight rate, the market rate for long-term financing would be fair and support other policies that help generate an equitable distribution of income.

6. International Monetary Policy

6.1 Currency areas

Robert Mundell, who won the 1999 Nobel Memorial Prize in Economics for his work on currency areas, defines a currency area as a "domain within which exchange rates are fixed" (Mundell, 1961). A currency area can be the area of a single currency or a group of currencies acting as one insofar as their exchange rates are fixed and therefore their individual central banks do not have monetary independence. Mundell originally proposed regions to be optimal currency areas (Mundell, 1961) but more recently thinks the world as a whole is an optimum currency area (Mundell, 1997). Currency areas usually overlap with national boundaries of a sovereign currency though the global trajectory seems to be towards regional or continental currency areas, as with the growing Euro and calls for a North American Monetary Union (NAMU) and an East Asian Currency, among others. Mundell (1997) lists seventeen items to consider whether one currency area should or should not join another one under a unified currency area. None of the seventeen items relate to anything of direct ecological or geographic significance, though the economic implications of the terms of trade and policy independence are of course ecologically significant. Two questions are particularly relevant in the context of an ESE. What should determine the extent of currency areas and what system should govern exchange rates between them, which would be supportive of ESE objectives or at least not stand in the way of objectives being met?

6.1.1 The merits of many currency areas

The cost of exchange across currency areas, say between the USA and Canada, is mostly a taxable mark-up added by currency traders, plus the inconvenience of finding a place to exchange the currencies, plus the difference between the actual exchange rate and its purchasing power parity and the cost of this exchange rate's volatility. The cost of the exchange rate's volatility is essentially the cost of not fixing exchange rates. The other costs are the costs of not using a single currency. The difference between the actual

exchange rate and its purchasing power parity is the common misalignment of exchange rates that prevent rates from equalizing the relative cost of identical items in each country (Rogoff, 1996). This misalignment is significant throughout the world, whether measured by *The Economist* and their "Big Mac Index"[9] or by other measures. There may also be duties, taxes, or other fees like the additional cost of mailing a product across a border. These exchange rate costs are extra to the cost of transporting goods to the consumer, or the consumer travelling to consume a bundle of goods and services in the other currency area.

High exchange rate costs can limit exchange between currency areas. Geographically proximal trade that crosses currency areas may be substituted by less proximal trade occurring within the same currency area, if exchange rate costs are greater than the savings in transport costs realized by proximal trade. To minimize throughput used to transport goods for exchange (or to transport the person to the goods), geographically proximal exchange might involve exchange across currency zones, especially in areas where there are no obvious geographical limitations to trade. Much of Canada's border with the USA, especially in western Canada, is not geologically or biologically significant. While cross-border exchange in the West is significant, it would and probably should be greater if there were a common medium of exchange—if the area was under one currency area and not two.[10]

Thus far, one might be tempted to do away with national currencies or national monetary independence to reduce currency transactions costs that can inhibit geographically proximal trade. If a continent or the entire world were to become a currency area, relative prices could better reflect the cost of transporting goods and services in the absence of currency exchange costs (that some might call "distortions"), so presumably the market mechanism of prices affecting choices would generate local exchange. Under this scenario, trade could still be "distorted" by the comparative degrees of cost internalization, given different property rights regimes and the extent to which policy is

[9] See http://www.economist.com/markets/Bigmac/Index.cfm

[10] Admittedly, other factors have roles to play in determining preferences for local exchange versus within-area exchange, such as regulatory standards, nationalism, etc.

able to align social and market prices (to say nothing about different national policies towards technology, social organization and other factors that influence productivity). Nevertheless, the most significant challenge in an ESE context would be that highly aggregated currency areas (continental or a single global one) removes the possibility of *independent* monetary, fiscal, and exchange-rate policy. These policies act as broad levers on the biophysical scale of the economy and other economic policies that influence the nature of economic activities. If smaller-scale currency areas are useful, then what should determine their geography?

6.1.2 Redrawing currency maps

On a bioregional basis, currency areas in a global ESE would roughly correspond to the geographic boundaries ideal for managing human ecological impact. This is challenging since there is no obvious hierarchy of importance attached to management scales. Larger scales introduce greater heterogeneity that can be difficult to manage, even if there might be economies of scale to a single large management infrastructure. Smaller scales thus might introduce greater costs from less economies of scale but also relate to areas of greater homogeneity and therefore potential greater ease of management. The ideal management scale depends upon the issue being managed; some issues are easily dealt with on a large level like the planet or on a continental basis, while others may be suitable for sub-watersheds. The National Ecological Framework for Canada establishes a four-part classification system, from 15 broad ecozones, encompassing 53 ecoprovinces, grouping 194 ecoregions, representing 1021 ecodistricts (Marshall, Schut et al., 1999). This classification is said to come from an ecosystems approach to thinking, planning, and acting. Humans are not settled to the same degree throughout these classification areas, though human impacts of source functions (harvesting resources) and sink functions (waste assimilation) are throughout. In this case, it might be useful to select some level of aggregation, say ecozones, and manage human activity on that scale. This would link the jurisdiction of management with an ecologically meaningful scope, the essence of bioregional management (Miller and World Resources Institute, 1996).

Redrawing currency areas implies redrawing political boundaries to correspond to them, so that fiscal, monetary, and exchange rate policies are consistent and effective. Political boundaries are not easily redrawn, though they can be implicitly redrawn by entering into trade or customs agreements that coordinate policies and restrict unilateral actions. Based on administrative feasibility, it might be easier to redraw currency maps to reflect existing administrative boundaries that are more appropriate currency area delimiters, like existing provinces, states, municipalities or collections of similar counties. In a Canadian context, the significant devolution of powers to provinces from the Federal government might better be used if provinces (individually or in small groups) also had control over monetary policy, which would necessitate independent currencies. Under this scenario, the Maritimes or Atlantic Canada could have lower interest rates to, say, facilitate expanding there relative to the booming central region of Ontario and Quebec. Ontario and Quebec might then engage in a currency union with some northern US states around the Great Lakes since so much of the trade takes place within this region. Granted Ontario and Quebec are perhaps still too large an area, considering the variable bioregions and regional economies within the provinces. The provinces could be partitioned, though this would be much more difficult than simply grafting a currency on an existing well-defined administrative boundary.

An economic-dynamic basis (for lack of a better term) for redrawing currency areas would be the extent to which areas are sufficiently linked in trade or institutional relationships that their dynamics follow similar patterns. One could look at changes in employment, wages, prices or some other macroeconomic indicator and delimit areas based on shared patterns. To the extent that employment, wages, or price changes move in harmony, any of these indicators could be used. The challenge with this approach is that this regrouping could be frustrated by existing administrative or national borders where economic policies vary and hence so would dynamics of their constituent economies. Nevertheless, growth in any of these indicators tends to spill-over into neighbouring jurisdiction by virtue of greater movement of people, goods, and information (through radio, television, and the print media). With common areas having common institutions and sufficient internal trade, ESE-type policy might be easier to

implement. With sufficient internal trade, the argument that pro-ESE policies would put an area at a competitive disadvantage relative to its trading partner could be less compelling as trading relationships are not as significant. For the same reason, harmonization of employment and growth policy would be easier within these redrawn common currency areas.

Three alternative bases have just been listed for determining how currency areas might be redrawn in an ESE. The bioregional basis might be ideal if one were starting from scratch, without existing political jurisdictions and currency areas. Administrative feasibility might be greatest for realigning currency areas based on existing jurisdictions that are more appropriate than the scale of their parent(s). ESE-based policymaking would be the easiest if currency areas encompassed regions that shared a similar type of dynamic, either in terms of harmonious changes in employment, wages, prices or some other significant macroeconomic indicator. Perhaps the last option would be ideal, but with the second option to fall back on. Even if none of these options is pursued in the near future, the preceding discussion suggests that current trends towards merging currency areas might run counter to ESE objectives by depriving countries of key macroeconomic levers (Smithin and Kam, 2004). If currency areas were redrawn to help achieve ESE objectives, what system should determine their exchange rates?

6.2 A new global reserve currency and financial architecture

Currently there is no globally agreed upon reserve currency among central bankers. The US dollar acts as a de-facto reserve currency by being widely circulated internationally and comprising an important portion of foreign currency reserves of the world's central banks (Tavlas, 1998). Ecological monetary reformers Lietaer and Douthwaite are rightly united in objecting to the US dollar being a de-facto global reserve currency. The United States of America routinely runs huge trade (current account) deficits that it finances by the rest of the world exporting goods and services in exchange for accumulating US assets, namely US dollars. This allows the US to finance at minimal cost its disproportionately large ecological footprint that extends well beyond its borders

(Wackernagel, Larry et al., 1999). The foreign demand for US dollars to serve as a national currency (under a currency board arrangement) and as significant portion of foreign exchange reserves (Tavlas, 1998) is met by the rest of the world running a trade surplus with the USA. The USA is granted a "free lunch" by issuing relatively costless US dollars in exchange for useful goods and services. Another problem arises since American monetary policy aiming to affect domestic conditions spills over to other countries and the global economy at large.

A global reserve currency is necessary in an ESE as a common unit of account for all trades across currency areas. This global reserve currency must not be used as a sovereign currency in any currency area, in order to limit the problems raised earlier. This also requires that the global reserve currency not circulate freely beyond national central banks and a global inter-bank coordinating body necessary to keep track of global balances and the international payments system. To guard against global liquidity shortages, the system governing this currency must enable it to be created on demand to finance trade. The system must also have some mechanism to guard against currency hoards, that would otherwise generate a global version of the paradox of thrift discussed earlier in a national context. In other words, the system must provide an incentive to recycle earnings from current account surpluses into demand for exports of areas with currency account deficits. The exchange rates between sovereign currencies and the global reserve currency must be flexible, to enable sovereign monetary policy, but generally stable, to reduce exchange rate uncertainty that makes speculation worthwhile and consequently generates further instabilities. Any system that can meet these requirements would be appropriate.

The preceding requirements for a new financial architecture are very similar to the requirements that led Keynes to develop his Bancor plan and Paul Davidson to breathe new life into this plan under a system of an International Monetary Clearing Unit (Davidson, 1993). Davidson's proposal seems to be the most promising of global monetary reform proposals around today. A revitalized global financial infrastructure compatible with an ESE could work as follows.

A global clearing institution would be developed to coordinate payments among national central banks. Many such institutions already exist, like the Bank for International Settlements and the International Monetary Fund, though it might be best to create a new institution void of history, political baggage, and an administration that would likely resist reform. This institution would hold the accounts for each member (national) central bank to contain their reserves. Each central bank would guarantee one-way convertibility from the global reserve currency to the domestic currency under control by the central bank. Central banks would guarantee this convertibility to other central banks and to the clearing institution. Convertibility would be done on a fixed but adjustable rate known to all central banks and perhaps in line with some ecologically appropriate level[11]. Trade between currency areas transfers balances between the relevant central banks, subtracting from deposits of the seller and adding to the deposits of the buyer's central bank. It would perhaps be useful to allow the balances to operate similar to a LETS system (described later in Section 8.3) in that the sum of all balances at the clearing institution would add to zero. This would remove the challenge of ensuring that the global supply of reserves grows in proportion to demand, which seems to remain an outstanding issue with Davidson's proposal. All positive balances would be charged a negative interest rate, set by the clearing institution as needed to induce global central banks to avoid hoarding positive balances. Negative balances would not be charged interest.

Davidson argues that this alternative system would allow relatively independent economic policy within currency areas and buffer them from shocks against other members of the system. For example, domestic inflation would be buffered from

[11] An ecologically appropriate exchange rate could be one that is misaligned with its purchasing power parity in a way could temper (favour) expansion within a currency area that is broadly beyond (beneath) its ESE threshold relative to others. For example, an area that is close to its ESE threshold could reward emigrants through an appreciated exchange rate relative to another more sustainable area, which would make the emigrants' savings increase in purchasing power when transferred to that other more sustainable area. If there were indicators of the throughput intensity of imports and exports, then exchange rates could be used to influence the trade balance based on the extent to which a currency area is within its critical natural capital thresholds. The problem with this approach, notwithstanding whether it is even feasible, is its implication that current and capital balances not be allowed to fluctuate according to relative productivities with trading partners.

affecting the exchange rate of other currency areas, since it would only affect the domestic exchange rate in terms of the global reserve currency, and not the supply of global reserve currency or exchange rates of other countries. This could allow the government(s) of each currency area to focus on meeting their domestic needs with less fear (than at present) that meeting domestic needs could generate unwanted perturbations of their currency in the foreign exchange markets. When governments of many currency areas collaborate on international treaties, they can be assured that any monetary mechanism built into the treaty would better reach its intended objectives, since the global payment system would be less distorted by whether a country's currency is used more or less than others as a foreign exchange reserve.

7. Modelling the Relationship between Money and an Ecological Economy

The IS-LM model is likely the most common macroeconomic model used to infer the output and interest effects of monetary, fiscal, and exchange rate policy. The model plots interest rates on the y-axis and income or output on the x-axis. A downward sloping IS curve is the goods market equilibrium schedule, showing the negative relationship between interest rates and income. It reflects the relationship between higher interest rates and reduced investment, being shifted by changes in autonomous spending and rotated by changes in the marginal propensity to consume. An upward sloping LM curve is the money market equilibrium schedule, showing the positive relationship between interest rates and output that ensure the demand for money equals its supply. A greater responsiveness of the demand for money to income generates a steeper curve while the curve shifts in response to changes in the real money supply. The intersection of the LM and IS curves show the output and interest rate combination at which the money and goods markets are concurrently in equilibrium. A positively sloped balance of payments (BP) schedule is sometimes added to the mix. Its flatness indicates the degree of capital mobility. Depending on whether fixed or flexible exchange rates are used, the IS or LM schedules are adjusted through fiscal and monetary policy (respectively) to bring about concurrent balances in the goods, money, and balance of payments.

However popular the IS-LM(-BP) this model is, it cannot serve to model fiscal, monetary, and exchange rate policy in an ESE. Even Sir John Hicks, who created the SI-LL equilibrium model (the precursor to the IS-LM model), is dissatisfied with it (Hicks, 1980). The model's benefit is that it captures the essential Keynesian insight that money and real markets must be solved simultaneously, so there is no classical dichotomy between the two. Nevertheless, its problem is that LM schedule is a stock variable and the IS schedule is a flow variable, related to each other but not in the same period. The money market can equilibrate rapidly by changing portfolio allocations and by the creation and destruction of money. In contrast, investment spending on the IS schedule takes time. The interest rate on the y-axis is therefore a short-term rate for the LM but a long-term rate for IS. This problem could be resolved by assuming away uncertainty so

expectations are fulfilled, so both the IS and LM curves are treated in the same period. However, relying upon this heroic assumption to save the IS-LM model would undermine another aspect of it. The LM curve is derived based on demand for liquidity. Liquidity is pointless if we assume a certain world where "rational expectations" are fulfilled (Davidson, 1983). Even without this problem of time, an LM stock constraint would obviously change in response to IS-flows, so one cannot use the model to perform comparative statics of moving just the IS or LM schedule, in spite of it being used that way (e.g. Dornbusch, 1999: ch. 10). Hicks concludes that the IS-LM model is inappropriate forward-looking policy model (Hicks, 1980).

The preceding critique of the IS-LM model should be enough to make ecological economists wary of attempts to add a fourth "environmental equilibrium" schedule to it, as proposed by Anthony Heyes (2000) and picked up by Daly and Farley (2004: ch. 16) and Mohan Munasinghe (2004) in the *ISEE Internet Encyclopaedia of Ecological Economics*. The obvious question then is what should be in its place? In keeping with the ecological economics tradition of methodological pluralism, and that models should reflect the real world as opposed to making the real world conform more to its models (Norgaard, 1989), several principles could be used to guide integrated ecological monetary models. These principles would be based on general assumptions about how the economy works but would be broad enough to allow a plurality of models. Six minimum principles follow for driving the development of ecological monetary models that are consistent with a synthesis of ecological and Post Keynesian economics.

1. *The economy is a process in time.*

   As Paul Davidson says, "the economy is a process in history… which prevents everything from happening at once" (Davidson, 1982: 9). Time must be explicit in models attempting to derive useful conclusions about economic processes in general and especially in regards to their ecological context. Production takes time, as do the results from positive or negative feedbacks. The simultaneous clearing of many markets in conventional models requires that one ignore time, so that expectations

have no time to change in reaction to the events unfolding in time. History matters because stocks are inherited as are contractual commitments made in the past. The future is uncertain in a non-ergodic sense. Heterogeneous expectations of the future cannot be satisfied so the theories built on rational expectations, like a natural rate of unemployment resulting from fully anticipated inflation, are incompatible (e.g. Davidson, 1983).

One challenge that this modelling principle poses is that time in economics and ecology mean different things. The principle laid out here refers to time as calendar time, not economic time like the "long run" that is meant to be a state in which all adjustments have been made and not a specific period in time. Keynesian economics is useful since its concept of time is more relevant to calendar-time, though its span is shorter than many critical ecological processes like climate change. Keynes' heavily cited comment of "in the long run we are all dead" (Keynes, 1923: 80) would be disconcerting to ecologists whose foci are beyond the average human lifespan, though Keynes meant this more to suggest that appeal to some "long run" condition evades accountability to short-run problems.

2. *All dynamic processes occur when flows accumulate in stocks (Radzicki, 1997: ch. 1).*

Confusion between stocks and flows is common in conventional economics (Boulding, 1992: 129). This confusion is apparent in the appeal of IS-LM analysis, which mixes stocks and flows, and the mistaken but common reference to GDP as wealth or even as income (when in fact it is not net of capital depletion). Fortunately ecological economists are more familiar with the distinction between stocks and flows since it is the basis for systems dynamics, which has generated formative models like the Limits to Growth model (Meadows and Club of Rome., 1972: ; Meadows, 1974: ; Meadows, Meadows et al., 1992) and GUMBO (Boumans, Costanza et al., 2002).

Few monetary models are specified in terms of stocks and flows and completely

closed so all flows begin from some stock and end by contributing to a stock. This is changing in the Post Keynesian community as a new line of "stock-flow consistent" monetary modelling is being developed that shows transactions between sectors and across time periods (Lavoie and Godley, 2001-2002: ; dos Santos, 2004). These monetary models could be integrated with biophysical input-output models to track the physical resources being transferred by these monetary flows.

3. *Real (biophysical) and monetary processes feed back on each other.*

   This principle is obvious to Keynesians but perhaps less obvious to ecological economists who often disregard monetary processes on the classical grounds that they are merely a mirage for the real transfers of energy and matter. Real transfers of energy and matter are financed in a monetary economy by the extension of credit, the circulation of credit as money, and finally the retirement of credit, in the context of a complex system of credit/debt relations that are neutral in neither the short nor long runs. Models that incorporate feedback between real and monetary processes will be of great help to understanding how to transform our economy's relationship with the environment.

4. *Unemployment results within monetary economies.*

   As emphasized many times in this paper, unemployment results because the private sector cannot create net liquidity, since its elasticity of substitution and production is close to zero. A paradox of thrift is generated unless the government, as the sole issuer of net liquidity, is able to satisfy the private sector's liquidity needs. Ecological monetary models must not assume away the possibility of unemployment. Models may incorporate some policy that would effectively counter unemployment, say through some employer of last resort policy, but they should not assume that unemployment cannot exist. Unemployment must be generated endogenously unless the model aims to generate the conditions that would generate an exogenously given

level of unemployment (as would be the case if one were modelling the financial and ecological implications of an employer of last resort policy).

5. *Manufactured capital uses natural capital as an input.*

   This is an obvious principle to ecological economists who believe in strong sustainability, in which natural capital is an input into other forms of human-created capital. The value of manufactured capital can certainly exceed the value of its natural capital inputs to the extent that natural capital seems negligible, but this does not negate the fact that it is a necessary input. Natural capital comes in various forms, like renewable (non-depletable) or non-renewable (depletable), cultivated or indigenous, critical and non-critical, etc. A high level of abstraction away from the details of natural capital is fine, so long as natural capital in some form is present and is drawn upon to contribute to new manufactured capital.

6. *Institutions are a necessary component of any ecological monetary system.*

   It should be obvious that any ecological monetary model have at least a government or some monetary institution that enables money to play its role as a legal means of settling contractual commitments and storing purchasing power by being liquid. One might wonder if this ought to be explicitly included in monetary models. The behaviour of money or financial market in any model is, in a way, an institutional rule created by the model-builder. The setup of equations that govern how credit is created can be viewed as a model of a particular institutional policy. This principle is necessary in an ESE to ensure that the constraints of an ESE are followed. The drawdown of natural capital to create manufactured capital (principle 5) is ultimately bounded by the availability of non-critical capital. This constraint is necessarily since a market economy with either externalities (arising from public goods or because legal institutions are not strong enough to enforce property rights) or imperfect information (arising from human ignorance or uncertainty) will not naturally preserve its critical natural capital.

Hopefully these six principles are not be too restrictive. Ecological economists ought to be comfortable with all principles, though the principle that unemployment results within a monetary economy (and reasoning behind it) may be new, though not surprising. Keynesian readers might be challenged by the principle that manufactured capital uses natural capital as an input, if not by its logic than by its relevance in a monetary model (though it should be obvious as a principle in support of an ESE). The most concise way of summing these principles is that not only does "money matter" to the economic world, as the Keynesians tell the classical economists, but in an ESE so do time, dynamics, feedbacks, unemployment, natural capital, and institutions.

8. Implications for Alternative Monetary Reform Proposals

Some ecological monetary reformers might be surprised by this paper's proposition that fiat money, underwritten by the government through its fiscal and monetary actions and created by government and credit-granting private institutions, is compatible with an ESE. This paper would not be complete without directly addressing three alternative proposals for ecological monetary reform: constraining the money supply by requiring 100% (or less) reserves, making money have negative interest, and complementing national currencies with community currencies. Various people have advocated these ideas and this section is not meant to provide a survey of the ideas, but rather a comment on how they relate to this paper's analysis of money and monetary policy in an ESE.

8.1 100% reserves (or less)

Frederick Soddy's ideas on money (e.g. Soddy, 1934) are frequently cited by ecological monetary reformers for his proposal to abolish fractional reserve banking as a means of returning seigniorage and the control of the money supply exclusively to the state. The argument is usually based on the assumption that interest-bearing fractional reserve debts require growth and that since growth is infinitely impossible, then interest-bearing fractional reserve banking must be abolished. Others like Irving Fisher (1935) proposed 100% money but for non-ecological reasons. The ecological argument for 100% money is best summed by Herman Daly:

> Under our current fractional reserve banking system… the money supply is a by-product of private commercial activities of lending and borrowing, rather than a public utility for effecting exchange. Over 95% of our money supply is created by the private banking system (demand deposits) and bears interest as a condition of its existence. Unless loans are repaid at interest and renewed, the money supply will shrink and transactions will be more difficult. Fractional reserve money is therefore not neutral with respect to the scale of the physical economy—it requires growth of GDP to keep the money supply from declining. And GDP growth correlates positively with throughput growth. Furthermore the seigniorage (profit to the issuer of fiat money) now goes largely to the private sector (banks and their customers), rather than to the public sector, the government, the legitimate supplier of the public utility of money (Daly, 2003).

For government to control the money supply requires that money no longer be endogenously created in response to demand. Under this policy, the central bank would no longer directly control the overnight rate. Rather the rate would reflect the availability of loanable funds (reserves) relative to their demand, fluctuating as loans are repaid, credit is extended, taxes are paid and government cheques are cashed. To avoid instability, the government would somehow have to rapidly (and continuously) adjust its excess of spending over taxation to neutralize changes in the banks' reserves, since these reserves would otherwise no longer grow or fall to accommodate growing or declining needs by the banking system. Absent this successful intervention, allowing interest rates to float could have significant distributional consequences as fluctuating rates change the relative position of debtors over creditors (whose significance in terms of equity was considered earlier in Section 5.6.2). Besides raising interest rates, banks would likely have to engage in periodic loan calling whenever their reserve base shrinks as deposits are transferred to other banks, to the central bank, or to cash. The central bank could still act as lender of last resort, supplying the banks with needed reserves if they fell short of the 100% target. But if it did this, the money supply would become endogenous, as the banking system could create credit in excess of available reserves. If 100% reserves were kept in place, then the central bank would have to resist always acting as a lender of last resort, putting the financial health of banks in jeopardy, unless the banks tend to loan out less than 100% of their reserves to maintain a buffer against reserve drains.

Fundamental to the monetary circuit presented earlier (in Section 3.1) is that money is created when credit is spent; money disappears when credit is repaid. Money is thus the amount of credit that has not been repaid. The money supply grows when the rate of taking on new credit is greater than the rate at which it is retired. The extent to which credit is retired depends on the demand for liquidity; increased hoarding of bank deposits reduces the ability to retire credit as in a paradox of thrift, unless the government increases the supply of bonds and bills to substitute for hoards of deposits. The demand for liquidity includes precautionary, speculative, and transactions motives, whose relationships to GDP vary. The supply of new credit does not automatically increase to satisfy an increased demand for liquidity. Rather the supply of credit is a function of

expectations about the future, which influences economic expansion, which require credit. Rising expectations can generate growth but they can also respond to increased growth. The connection between money and GDP growth is therefore not as obvious as Daly assumes. Rather, Post Keynesians are adamant that money is not causal (e.g. Lavoie, 1984: ; Rochon, 1999). The growth of fractional-reserve fiat money is better understood as a response to the financing needs of economic activities, not the cause of those activities. For it to be the reverse would require the money supply to be exogenously set and not demand-determined (endogenous). Strangely, the first part of the excerpt suggests that Daly understands that money is endogenous to demand, though his conclusion does not logically follow from it.

Proponents of 100% money like Daly ought to acknowledge that government would earn zero seigniorage revenue in an economy with zero growth in GDP and the money supply. Perhaps the plea for increased government money creation as a means of generating free revenue is meant as an interim solution until monetary growth ceases. (One wonders though if increased seigniorage from a growing economy would make governments even more addicted to growth than they are currently.) Assuming that governments ought to profit from money creation and that they should have the capability of controlling it (say to reign excess or inflationary credit growth), what other means are available besides reserve ratios? One option would be to introduce a "money-creation tax," which would be a lot easier to administer and create than having to abandon control over interest rates and risk monetary instability in the bid to earn the government seigniorage revenue. The banks might counter this proposal by promising to raise fees or grow the margin between interest charged on loans and paid on deposits to recuperate their lost revenues. However, banks would equally have to raise revenues under a 100% reserve proposal to recover their lost source of revenue earned by expanding credit without reserves. A money-creation tax would be easier to provide government with greater seigniorage revenue (though under a money-creation tax it would be pseudo-seigniorage). As for proposing 100% reserves as a means of controlling the supply of credit, a better policy might be to require reserves held as a proportion of *assets* rather than reserves like deposits (e.g. see Palley, 2000: ; D'Arista, 2002).

8.2 Negative interest rates (or scrip)

Silvio Gesell is well known in monetary reform circles as the German merchant who advocated depreciating fiat money, which was no doubt as revolutionary then in an era of gold-reserve managed money as it is now under the assumption that money should earn interest. Gesell's proposal is appealing to ecological economists since his monetary analysis is based on noting its peculiar biophysical properties that sets it apart from real items that it can be used to acquire:

> Only money that goes out of date like a newspaper, rots like potatoes, rusts like iron, evaporates like ether, is capable of standing the test as an instrument for the exchange of potatoes, newspapers, iron and ether. For such money is not preferred to goods either by the purchaser or the seller. We then part with our goods for money only because we need the money as a means of exchange, not because we expect an advantage from possession of the money….So we must make money worse as a commodity if we wish to make it better as a medium of exchange (Gesell, 1906: sec. 4.1).

His proposal of a depreciating fiat currency would put it on par with other material items that have to contend with entropic decay. According to Gesell, money's problematic virtue is that it escapes the laws of thermodynamics, hence why people hoard it as a store of value instead of ensuring it is kept circulating. Under Gesell's plan, the nominal value of money would depreciate 5.2% annually unless validated by a currency stamp of the same cost. This effectively amounts to a negative interest rate along the lines proposed by Kennedy and Kennedy (1995). Gesell's monetary proposal is notable in an ESE context since he wanted money to be fiat (he wanted to deprive gold of its claim to legal tender), he advocated the stabilization of international exchange rates, and he advocated stabilization of the general purchasing power of stamped money in terms of a price index (Gesell, 1906: sec. 4.1). Interestingly Daly (1996: 184) claims that Soddy discarded Gesell's ideas as those of a "monetary crank" though one might find Gesell's proposals consistent with a physics-based conclusion that fiat money's peculiarity is that it violates the second law.

Keynes praised Gesell's ideas and suggested "the future will learn more from the spirit of Gesell than from that of Marx" (Keynes, 1935: 355). Although Keynes said the idea of stamped money was sound, Post Keynesians have not carried this idea forward. The main obstacle, as Keynes noted, is that money is not unique in having a liquidity premium. Depriving money by *too much* of its liquidity premium would shift its demand to substitutes. Exactly how much is too much is unknown. Interest in this idea has surfaced recently by Goodfriend (2000) at the Federal Reserve Bank of Richmond as a way of exceeding the (nominal) zero bound of the overnight rate to help avoid liquidity traps in deflationary periods. However worthy this idea is in a zero-inflationary setting, it would not be necessary if inflation remained steady and positive enough to enable small nominal rates to generate real negative ones (as advocated earlier in Section 5.5). Under constant but positive rates of inflation, currency (which does not bear interest) would depreciate in real terms, but without the need to administer a system of currency stamps. Bank deposits would still earn interest, but the real rate of the interest would be negative as is effectively done today through point-of-sale and cash-withdrawal service fees.

8.3 Community money like LETS

The Local Exchange Trading System (LETS; sometimes called Local *Employment* Trading Systems) is well as a form of community currency, often grouped together with "community dollars" like TorontoDollars.[12] A LETS system generally operates as follows.[13] A central database records each transaction between members of the system, transferring balances between member accounts as LETS-denominated trade takes place. Every member of a LETS system begins with a zero balance and freely engages in trade with other members, selling goods and services to accumulate points or buying them to reduce their points. Typically there is no limit to the number of positive or negative points one can accumulate. In response, some systems advocate that traders inform themselves of the other person's balance in advance of trading to determine if the other person is sufficiently reciprocating. Otherwise, people could conceivably keep

[12] For more information see http://www.torontodollar.com
[13] This description follows from http://www.gmlets.u-net.com

purchasing items and decreasing their negative balance, in a sort of free lunch financed by other selfless members accumulating positive balances. LETS balances are typically valued at parity with the local (sovereign) currency.

The appetite for community money like LETS is likely to grow as prominent ecological economists and organizations are espousing its benefits. Robert Costanza announced to his audience at the 2004 International Society for Ecological Economics (ISEE) conference of the upcoming launch of a Burlington community currency. In the fall of 2003 Costanza co-instructed a course "Topics in Ecological Economics: Local Currency Systems" at the University of Vermont.[14] At the Canadian Society for Ecological Economics (CANSEE) 2003 conference in Jasper, Herman Daly argued in his keynote address that "Ecological economists also welcome the local reclaiming of money as a public utility by the various supplementary local currency movements" (Daly, 2003). This topic has yet to find its way formally into the journal *Ecological Economics*, besides studying the motivations and attitudes of people engaged in a LETS system (Barry and Proops, 1999). But based on the interest by prominent ecological economists like Costanza and Daly, it is worth briefly addressing whether community currency is compatible with this paper's proposed roles of money in an ESE. To this end, two very Keynesian insights will be offered that seem to be missing from the proposals.

8.3.1 Ensuring that exchange is reciprocal

The motivation behind LETS is that it amounts to a system of mutual credit. Unfortunately, the determination to avoid any interest within the system works against ensuring it actually generates mutual exchange. One could hope that all LETS traders verify the points balance of the other person they are trading with to be sure the person is not excessively negative (and therefore enjoying a free lunch from others). However, this proposal is unlikely to work for a number of reasons. People are unlikely to want to engage in trading whereby they have to divulge their balance. Few people and businesses would want to have their bank balances be public knowledge. Even if people would

[14] The syllabus for this course is available at http://www.uvm.edu/giee/NR285/LETS_Syllabus.htm

share their balance, one wonders what standard would be appropriate to determine if someone is "excessively" negative (i.e. should appropriate balances be appropriate to age, income, means, history, etc.).

One obvious solution to this problem (that has yet to make it into any LETS literature) would be to charge negative interest on *positive* balances. Attempts by positive balance holders to hoard their balance should be made costly in order to help avoid the LETS exchange system from being used as a store of value, which would compromise it unless some authority would commit to preventing the paradox of thrift. One could charge negative interest on negative balances, but the only way for negative balance holders *as a group* to become positive is to convince the group of positive balance holders to buy from them. This solution is somewhat like Gesell's proposal for taxing money, which inspired Keynes' Bancor plan that would have charged countries with positive current accounts interest to get them to spend their hoards. The difference is that under the Bancor plan, central banks would have no alternative to holding negative-interest reserve currency besides spending it to get something real like traded goods or reduced external liabilities (Davidson, 1993). In a LETS system, people ultimately have a choice between using the sovereign currency or the LETS unit of account. If there were exchange parity between the two, any positive balance holder would likely trade his or her LETS balance into sovereign interest-bearing currency to avoid the negative interest rate of LETS. To relieve this potential, the exchange rate could be depreciated so that, say, positive balance holders loose 50% of their holdings when transferring it out. But if this were the case, fewer people would likely enter the LETS system, considering their potential losses when measured against their reference unit of account, the national money system. This highlights Keynes' distinction (1930: 4) between a "money of account" and "the thing that answers to [it]." LETS is unlikely to work if it overlaps with sovereign money and if it does not charge interest on those hoarding positive balances. This leads to wondering whether there are other ways to increase the potential of having LETS act more as a "money of account."

8.3.2 Creating demand for community exchange

One motivation behind LETS is that it is supposed to enable exchange that would otherwise be constrained by lack of money. This is a surprising claim since LETS communities have always been small and the examples of financed transactions seem to include ones that would ordinarily be mutually provided without a quantitative unit of account. Obviously until community exchange is widespread, the scope for it achieving its intended benefits is minimal. Unless LETS becomes the "money of account" it is not likely to become a serious competitor to sovereign money. Attempts at solving this problem relate to the issue of whether the community currency should trade at par with the sovereign one. A 1:1 exchange ratio *guaranteed by the central bank* would help reassure risk-averse community members that LETS is sound, though this could promote excessive exits of positive balance holders out of LETS to earn interest, thereby undermining its sustainability. A depreciated exchange rate might help limit exit, but it could limit entry as discussed before.

A solution to the problem of community acceptability would be for local (municipal or county) governments to accept LETS balances as a means of paying taxes. This would follow Keynes' claim from Knapp (Keynes, 1930: 6) that money is anything that the state accepts at its pay offices, hence taxes create a minimum demand for the money they are payable with. If this were implemented, local shops (for example) would widely accept LETS balances not out of generosity or charity but simply because it would enable them to discharge their municipal tax payments (or other payments if other institutions are part of it). For this to work, governments would have to pay their employees in LETS balances since their tax revenues would no longer be uniquely sovereign money. To sustain a government spending more sovereign money than it collected in taxes would require devaluing the exchange rate of LETS (measured in terms of sovereign money) since the government could not meet interest payments on sovereign loans used to fund the difference. Interestingly the conclusion here that government must become involved in community currency for it to work seems to destroy the anarchist spirit of LETS.

On balance, ecological monetary reformers ought not to let their enthusiasm for LETS or any other monetary idea that appears radical, prevent them from solving critical obstacles that must be overcome before it can be proposed as a serious supplement or alternative to sovereign money. In particular, LETS' promise of mutualism will remain elusive so long as interest is not applied to outstanding positive balances or until some other means is found to ensure that positive balances are not hoarded. The extent to which the demand for LETS will grow or at least remain sustainable is dependent on its relationship with the sovereign money it is meant to supplement. The potential for government to accept tax and fee payments in LETS could be useful at broadening LETS' acceptance, though the government would also have to convert some of its expenditures into LETS as well. Both of these solutions are contingent upon how LETS relates to sovereign money, through its exchange rate and through whether it is able to supplant sovereign money as the money of account.

9. Conclusions

Relatively little is written about money in the ecological economics literature. Considering how fundamental money and monetary analysis is in conventional macroeconomics, and considering how important macro-scale issues are in ecological economics, the paucity of work on money in an ecological economy is surprising. The few ecological economists who have written about money, like Daly(2003), Douthwaite (1999), and Lietaer (2001), shun the neoclassical notion of "neutrality," which states that money only affects prices and not output in the long run. These ecological economists tend to overemphasize the role of money in output, suggesting that the system of fiat debt-based money requires endless economic growth to sustain it. Consequently, control over the money supply or changing the nature of money is advocated by these economists in the hopes of targeting economic activity to within a sustainable threshold. The best, but very limited, criticism against this view is from Dalendina (1997) in a short review of *Interest and Inflation Free Money* (Kennedy and Kennedy, 1995). Beyond this, the paucity of monetary insights in ecological economics has meant that the few books and web sites purporting to advance an "ecological" monetary reform carry on with exceptionally scarce critical alternative insights. The current paper is a modest attempt to fill this void and help introduce Post Keynesian insights to the issue of ecological monetary reform and make the case for why Post Keynesian economics and ecological economics are appropriate bases to understand how money relates to the economy and how the economy relates to the environment.

This paper began with two important qualifications: the sustainable objective of an ecological monetary economy and the definition of money. The objective of an ecologically sustainable economy (ESE) is an economy whose material and energy throughputs are, at a minimum, great enough to meet human needs while being within the critical natural capital thresholds at appropriate scales necessary to sustain ecosystem services that are used to provide human needs. Alternative views abound of what ought to be a sustainable objective and an attempt was made to justify the chosen approach rather than relying upon the objective of a "steady state economy." Money was defined

as whatever the state will accept as a means of paying taxes, which currently includes bank deposits and the sovereign bills and coin in circulation. This idea is accepted within Post Keynesian economics but is not widely accepted by other economic genres. The conventional roles of money serving as a medium of exchange, store of value, unit of account, and a means of deferred payment arise because money legally settles contractual obligations and is a perfect store of liquidity and vehicle of transferring purchasing power into the future. These two important opening qualifications give the paper a basis in Post Keynesian and ecological economics, respectively. The analysis that followed from these qualifications can be viewed as ecological Post Keynesian monetary economics.

Several monetary issues were examined in the context of an ESE. Table 2 summarizes the issues, and the suggested ESE approach to them in contrast to the current approach as it exists. The present fiat nature of money is compatible with an ESE because it is biophysically cheaper to create and maintain when compared to money with a full or partial commodity reserve. Money's role of settling (legally) all contractual obligations and storing liquidity requires that its supply accommodate more or less to demand. This differs from proposals from Douthwaite (1999) and Lietaer (2001), among others, to abandon fiat money and to constrain the supply of money in the hopes of constraining economic activity to within some sustainable threshold. If the conclusion that fiat money is compatible with an ecologically sustainable economy is sound, then this is good news for the ecological economics community. Radical monetary reform is unnecessary, so ecological economists have one less potential hurdle to clear before an ecologically sustainable economy results. Nevertheless, fiscal and monetary policy must be reformed to be compatible with an ESE, as summarized in Table 2.

Table 2: Summary of the proposed roles of money and policy in an ESE as compared to the present system. Suggested reforms are summarized as they were discussed in the paper.

Monetary issue	Approach in an ESE context	Current approach to issue	Suggested reform(s)
Role of money	Settles contractual obligations and serves as a store of liquidity with minimal biophysical production and carrying cost (*therefore must be fiat)* Supply should accommodate to demand; exogenous control too blunt and imprecise an instrument	Same roles as in ESE though typically listed more specifically as being a medium of exchange, store of value, unit of account, means of deferred payment	No reforms necessary since fiat money meets ESE roles, whereas commodity or managed money systems would not, nor would exogenous control be a useful means of targeting growth
Optimum currency areas	Should relate more closely to appropriate scales for managing ecological impact of human activities	Areas growing towards regional scope to limit exchange rate variability and promote greater integration and policy harmonization between nations	Adjust currency zones either to correspond to ecologically significant area or area with similar economic dynamics and internal market
Macroeconomic role of fiscal policy	Should finance the provision of unmet needs, notably the protection against insufficient income caused by involuntary unemployment Should ensure equitable distribution of income and wealth	Unmet needs are increasingly met residually as financing permits, rather than as a priority that determines financing needs of government Sustain growth in market activities in hopes that this reduces inequities and increases demand for labour sufficiently to reduce unemployment	Compensate for involuntary unemployment in a targeted way, such as through an employer of last resort, rather than increasing demand for throughput-intensive activities to increase demand for labour Adjust inequitable distribution of income or wealth in concert with equitable interest rates (see below)
Public debt management	Distinguish between fiscal sustainability and biophysical sustainability, to not sacrifice the latter for the sake of reducing the former	Management of Debt:GDP or Deficit:GDP as indicator of fiscal sustainability, even if public accounts treat investment in natural capital as a current expense	Distinguish debt used to finance public consumption, investment, and unemployment reduction, while recognizing ecological investments as investments

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Monetary issue	Approach in an ESE context	Current approach to issue	Suggested reform(s)
Monetary (financial) policy	Sustain confidence in monetary system by sustaining banking system and guarding against unwarranted changes in consumer price inflation	Lender of last resort sustains banking system solvency	No reform necessary to lender of last resort policy
		Interest rate used to sustain sufficient level of excess industrial and employment capacity to hedge against inflation	Use other policies besides interest rate to target inflation and unemployment
			Set interest rate to roughly equalize effective purchasing power over time
International payments system	Should enable trade while allowing independent fiscal and monetary policy within currency areas	Flexible exchange rates determined in currency markets often generate instability	Create a unit-of-account reserve currency to be held only by central banks
		US Dollar serves as *de facto* global foreign exchange reserve currency	Adopt flexible but stable exchange rates measured in terms of the reserve currency, with interest payable on positive balances of reserves to guard against reserve hoards
Modelling fiscal and monetary policies	Should take into account several principles, including that time, dynamics, feedbacks, unemployment, natural capital, and institutions matter	IS-LM remains the hallmark of fiscal and monetary policy modelling	Develop models and modelling approaches that recognize: the economy is a process in time; all dynamic processes occur when flows accumulate into stocks; biophysical and monetary policies feed back on each other; unemployment results within monetary economies; manufactured capital uses natural capital as an input; institutions exist within ecological monetary systems

Involuntary unemployment and an arbitrary and inequitable distribution of income and wealth are as possible in an ESE as in a non-ESE. The main task of fiscal and monetary policy remains to deal with these two "outstanding faults" (Keynes, 1935: 372). Before one sets out to use these policies, their interdependence must be understood in the context of the monetary nature of fiscal policy and the financial nature of monetary policy. This paper described one way of understanding the connections between the demand for liquidity and unemployment (or underemployment) and its policy implications. Governments that can produce liquidity are the only potential insurers against the paradox of thrift that generates involuntary unemployment. While work sharing or legislated reduction in the workweek could help to redistribute unemployment more equitably, these policies are only partial solutions that cannot be relied upon to deal with the monetary nature of unemployment.

Readers familiar with the ecological economics literature might find this paper's summary of Post Keynesian theory of unemployment somewhat novel, as it differs from conventional (non-Keynesian) economics and has yet to be picked up in the ecological economics community. There should not to be any objectionable ecological aspects of this theory. The proposal for governments to act as employers of last resort is potentially more controversial. It is likely to appeal to people who believe that employment is personally rewarding and socially beneficial to the extent that the work can satisfy unmet public needs and reduce the social liabilities associated with being unemployed. The proposal would likely be challenged by people who believe that employment is drudgery, and employment of last resort would be even less appealing on an individual basis and less useful to society. The main conclusion that readers should draw from this discussion is that an ESE requires some direct means of dealing with unemployment, of which employment of last resort is but one means. Further research is warranted on how to design an effective employment of last resort policy or, if this policy is unacceptable, some other alternative needs to be proposed and detailed.

Another underdeveloped area of ecological economics besides unemployment reduction is the related issue of public debt and the way in which public spending is accounted for

by the public accounts. The public accounts must be reformed to avoid sacrificing reductions in unemployment and public investments in natural capital (or reducing human-induced ecological liabilities) in the name of "fiscal responsibility" based on questionable accounting. The proposal to distinguish between the outstanding debt used for consumption, capital, and unemployment-reducing expenditures should not be controversial, though the implications may cause consternation as it implies a likely upward trend of government debt. Since socially minded economists allay fears of rising public debt with the assumption that economies can *grow* themselves out of its burden, ecological economists might assume that growing debt requires growing GDP and therefore a low- or no-growth economy ought to have little public debt. Sceptics of debt and GDP growth should be convinced by the paper's critique of debt-to-GDP and deficit-to-GDP ratios and advocacy for an alternative indicator that measures the share of a government's revenue devoted to sustaining debt. Research is needed to incorporate the alternative indicator in models that compare how government finance could fare in a low- or no-growth economy, comparing the traditional indicators to the proposed one or other alternatives that could be developed.

The proposal to reform to the international financial system should find allies within the ecological and Post Keynesian communities, since it is clear that both these communities are critical of the existing system even if the nature of this criticism differs. More research is needed into determining if and how there could be an ecologically appropriate exchange rate between currency areas, perhaps as a means to directing expansion and immigration towards areas whose critical natural capital is under less pressure. The discussion on ecologically optimal currency areas is novel and could set the stage for a more thorough investigation into operationalizing alternative means of redrawing currency areas, such as a bioregional basis or on a scale that would incorporate areas of similar economic dynamics (or on another basis).

Several principles of modelling money in an ecological economics context are proposed. These bring together established principles from both Post Keynesian and ecological economics communities. A substantial task for further research is to generate

parameterized working models compatible with these principles. In the interim, this paper concludes that the Post Keynesian critique of conventional textbook IS-LM models of fiscal and monetary policy ought to caution ecological economists from attempting to extend these models to include some sort of environmental equilibrium. Until a simple graphical model successfully supplants the IS-LM model, one imagines that ecological economists could have as hard a time as Post Keynesians do from shunning IS-LM.

This paper is only the beginning of a much-needed thorough investigation into the nature of money and monetary policy in an ecologically sustainable economy. Ecological economics is very macro-oriented, for it starts with the macro-view that economic analysis cannot discount the source, sink, and life-support functions of nature that sustain human societies and thus sustain their economies. That the economies of OECD nations are monetary economies cannot be discounted within ecological economics since: 1) money is not neutral with respect to decisions to produce, invest, consume, or to avoid any of these activities; 2) production, investment and consumption are not neutral with respect to affecting the source, sink, and life-support functions of nature; 3) both of the previous points matter to an economics that is real-world focussed. Post Keynesian economists spend much of their time convincing their neoclassical competitors of the first point above. Ecological economists spend much of their time convincing their non-ecological competitors (Keynesians included) of the second point. There is great potential for both economic communities to expand their mastery of real-world economics by incorporating insights from each other and working together towards a more socially and ecologically rewarding economy. Several issues not covered in this paper could stand as obstacles to a successful synthesis of Post Keynesian and ecological economics, specifically different attitudes towards growth. Nevertheless, money and monetary policy could be a good place to begin an ecological-Post Keynesian synthesis along the lines proposed by this paper.

10. Appendix 1. Post Keynesian Assumptions and Key Cited Authors

Contemporary (Post) Keynesians take from John Maynard Keynes several key assumptions that distinguished Keynes' work from classical economists and add to it more recent developments and clarifications advanced by an active community calling itself Post Keynesian, defined as follows.

> [Post Keynesians]… stress the dynamic nature of an economy which uses money and which is subject to uncertainty. The nature of time is such that markets do not always clear. Individuals in those markets do not always receive the correct signals to encourage optimal behaviour. Post Keynesian economists emphasize the institutional setting of the economy and the social relationships therein (Pearce and Massachusetts Institute of Technology, 1986: 333).

The fundamental Keynesian assumptions that are retained by Post Keynesians and which are key to this paper's content, include: 1) the future is uncertain and present decisions are made on the basis of (fallible) expectations about the future; 2) money matters in the short- and long-runs; 3) public intervention is called for in the economy to correct involuntary unemployment and an arbitrary distribution of income and wealth.

Paul Davidson is a key author cited frequently in the current paper for his contemporary views on Keynes' fundamental insights. Davidson edits the *Journal of Post Keynesian Economics* and has published several important papers and books that emphasize the Keynesian ideas of uncertainty, the nature of money, and alternatives to the current international financial system. Key contemporary Canadian Post Keynesians cited in the current paper for their work on money include Marc Lavoie and Louis-Phillipe Rochon. The late William Vickrey is a key Post Keynesian for his work on public debt, unemployment, and inflation. L. Randall Wray and Mathew Forstater are key American Post Keynesians who advocate full employment through a proposal for government to act as an employer of last resort without conventional constraints of balanced budgets.

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