

# *Ecological Macro-economics*

***Under existing macro-economic arrangements, growth is the only real answer to unemployment - society is hooked on growth.***

***Douglas Booth, 2004'***

Put bluntly, the dilemma of growth has us caught between the desire to maintain economic stability and the need to remain within ecological limits. This dilemma arises because stability seems to require growth, but environmental impacts 'scale with' economic output: the more the economy grows, the greater the environmental impact - all other things being equal.

Of course, other things aren't equal. And the dominant attempt to escape the dilemma relies precisely on this fact. Things change as economics grow. One of the things that changes is technological efficiency. It's now widely accepted that technological efficiency is both an outcome from and a fundamental driver of economic growth.

Proponents use this feature of capitalism to suggest that growth is not only compatible with ecological goals but necessary to achieve them. Growth induces technological efficiency as well as increases in scale. All that's needed to remain within ecological limits is for efficiency to outrun (and continue to outrun) scale.

But historical evidence for the success of this strategy is deeply unconvincing. Global emissions and resource use are still rising.

Apparent declines in carbon emissions in advanced economies turn out on closer inspection to be due to accounting errors and cross-boundary trades. Much of the growth that is desperately needed in developing countries is inherently material in nature. And rebound effects from technological change push consumption even higher. In short, efficiency hasn't outrun scale and shows no signs of doing so.

That doesn't mean such a transition is impossible. On the contrary, we've already seen how little effort has truly been dedicated towards achieving it. But it's also abundantly clear that we won't make much progress without confronting both the economic structure and the social logic that lock us into the 'iron cage' of consumerism.

In the next chapter, we'll address the social logic. Here we focus on economic structure. In particular, we explore the need for a different kind of macroeconomics.<sup>2</sup> One in which stability no longer relies on ever-increasing consumption growth. One in which economic activity remains within ecological scale. One in which our capabilities to flourish - within ecological limits - becomes the guiding principle for design and the key criterion for success.

In a sense, it's surprising that such a macro-economics doesn't already exist. There's something distinctly odd about our persistent refusal to countenance the possibility of anything other than growth-based economics. After all, John Stuart Mill, one of the founding fathers of economics, recognized both the necessity and the desirability of moving eventually towards a 'stationary state of capital and wealth, suggesting that it 'Implies no stationary state of human improvement'.

Though John Maynard Keynes's macro-economics was largely concerned with the conditions of prudent growth, he also foresaw a time when the 'economic problem' would be solved and we would prefer to devote our further energies to non-economic purposes.<sup>3</sup>

And it's now more than three decades since Herman Daly made such a cogent case for a 'steady state economy'. He defined the ecological conditions for this economy in terms of a constant stock of physical capital, capable of being maintained by a low rate of material throughput that lies within the regenerative and assimilative capacities of the ecosystem. Anything other than this, he argued, ultimately erodes the basis for economic activity in the future.<sup>4</sup>

Admittedly, this terminology doesn't roll off the tongue easily for economists, who are schooled in a language that rarely even refers to natural resources or ecological limits. And that is clearly one of the points. Economics - and macro-economics in particular - is ecologically illiterate.

Daly's pioneering work provides a solid foundation from which to rectify this. But what we still miss is the ability to establish economic stability under these conditions. We have no model for how common macroeconomic 'aggregates' (production, consumption, investment, trade, capital stock, public spending, labour, money supply and so on) behave when capital doesn't accumulate. We have no models to account systematically for our economic dependency on ecological variables such as resource use and ecological services.

Though these are unfamiliar goals for economists, the aim of this chapter is to show that they are not only meaningful, but achievable. In fact, this call for a robust, ecologically-literate macroeconomics is probably the single most important recommendation to emerge from this book.

## Macro-economic basics

Macro-economics is scary terrain for the uninitiated. But the main parameters can be set out easily enough. The principal macroeconomic variable - the one all the fuss is about, so to speak - is the GDP. Whether it deserves pride of place in a new ecological macro-economics is an open question. But it's a key element in the macroeconomic vocabulary. So it's useful to set out some of its basic characteristics.

Broadly speaking, the GDP is a measure of the 'busy-ness' of the economy. All it does really is count up - in three different ways the economic activities going on within a particular geographical boundary, usually a nation.

The first of these three accounts is the one we identified in Chapter 1. It's the sum of all the 'final' expenditures (E) on goods and services in the economy. Formally speaking, these include consumer expenditure (C), government expenditure (G), gross investment in fixed capital (I) and net exports (X).<sup>5</sup> In mathematical terms:

$$E = C + G + I + X$$

In order to spend, we need to have generated an income. The second GDP account measures this income. It does so by adding up all the wages and dividends (including profits and rents) paid out within the economy. These incomes are secured - either directly or indirectly<sup>6</sup> - from the output generated by all the productive activities in the economy. The third GDP account measures this output as the 'value added' by productive enterprises.

So the first type of GDP account (E) tells us what people and government spend (or invest). This is sometimes referred to as aggregate demand. This second (income) tells us what people earn and the third (output) tells us how much value firms produce. The second and third are sometimes referred to as aggregate supply (Y). The economy is said to be in equilibrium when aggregate demand equals aggregate supply. That is, when expenditure equals income, or in mathematical terms when:<sup>7</sup>

$$Y = C + G + I + X \quad (2)$$

Notice straightaway that there's something very formulaic about the GDP. It is literally a measure of different kinds of activity. It makes no explicit normative judgement about the nature of those activities. On the other hand, it has implicitly already made some normative judgements. Firstly, by counting only the monetary value of things exchanged in the economy, and secondly by assuming that all of these monetary values are equivalent.

These implicit judgements give rise to some of the criticisms raised against the GDP. Lots of things happen outside of markets that result from or impact on economic activity. Some of these are positive things like the value of household work, caring and voluntary work. Others are negative things, such as the ecological or social damage from economic activities! No attention is paid by the GDP, for example, to the health or environmental costs of pollution or the depletion of natural resources.

By contrast, all kinds of things are included in the GDP - the costs of congestion, oil spills and clearing up after car accidents, for example - which don't really contribute additionally to human well-being. These 'defensive expenditures' are incurred because of economic activities that are also counted positively in the GDP. But to count both sets of activities as contributing meaningfully to economic welfare seems perverse.

A more general criticism of the GDP is its failure to account properly for changes in the asset base, even when it comes to financial assets. Gross fixed capital investment is measured. But depreciation of capital stocks goes unaccounted for and the GDP is almost completely blind to the levels of indebtedness identified in Chapter 2. Perhaps even more importantly from our perspective, the depreciation of natural capital (finite resources and ecosystem services) is missing completely from this macro-economic account.<sup>1</sup>

These perversities have generated a long-standing critique of conventional macroeconomic accounting. Numerous suggestions have been made for supplementing or adjusting the natural accounts to rectify the situation. For instance, there is a strong argument in favour of including some account of positive benefits from things like household work, adjusting for the depletion of capital (both human-made and natural), subtracting external environmental and social costs and taking account of defensive expenditures.<sup>2</sup>

We return to the policy implications of this in Chapter 11. The main aim here is to outline how the principal macro-economic variables relate to each other. A key element in that understanding is the balance between supply and demand and the importance of this balance for labour employment.

Demand depends mostly on people (and government) spending money on goods and services in the economy. How much people spend depends partly on their income. But it also depends on how much of their income they decide to spend rather than save and on how much they're prepared to borrow in order to spend. These things in their turn depend on their confidence in the economy and their expectations about the future.<sup>3</sup>

Supply is determined, in conventional macro-economics, by a production function, which tells us how much income (Y) an economy is capable of producing with any given input of the 'factors of production'. The most important factors of production (in the conventional model) are capital (K) and labour (L). Output is calculated by multiplying the factors of production by their 'productivity'. Broadly speaking, productivity captures the technological efficiency with which inputs (factors) are transformed into output.<sup>12</sup>

Again, critics argue that this form of production function is unsatisfactory because it makes no explicit reference to the material or ecological basis for the economy at all. Clearly both consumer goods and capital stocks (buildings and machinery) do embody material resources. But the flow of goods and the stock of capital are measured only in monetary terms and don't carry any explicit reference to the material flows needed to create them.

It's possible to derive production functions which do include explicit reference to material or energy resources. We might even conceive of production functions which include ecological constraints - so that, for instance, production is forced to remain within a certain carbon budget. These are some of the changes likely to be needed for a robust ecological macro-economics. They're discussed further in Appendix 2.<sup>13</sup>

But for now, this conventional form of production function is good enough to illustrate the key relationship between supply and demand. In fact, we can take an even simpler form of production function, in which income, Y, is calculated as the product of labour L, and the productivity of labour P. Explicitly we have:

$$Y = P \times L \quad (3)$$

In this production function the dependency on capital, on technological efficiency and on resources is all rolled into the labour productivity. P, can be thought of as the average amount of income generated by one hour (say) of labour input. The change in P, over time is critical in determining how much growth (increase in Y) is possible. In fact, if the labour input L remains constant, then growth is determined exactly by the increase in labour productivity.

When labour productivity increases over time, as it is generally expected to do because of technological improvement, then the only way to stabilize economic output Y is by reducing the labour input L, or in other words by accepting some under-employment.

Conversely, as we've already seen (Chapter 6), when demand falls, revenues to firms are reduced, leading to job losses and reduced investment. Reduced investment leads to a lower capital stock which, together with a lower labour input, in turn reduces the productive capability of the economy. Output falls and with less money in the economy, public revenues also fall, debt increases and the system has a tendency to become unstable.

This dynamic is basically what gives rise to the economist's insistence that continued growth is essential for long-term economic stability. But of course this assumption does nothing to alleviate the concerns about ecological impact. We're right back with the dilemma of growth.

Taking a step back for a moment, there are only two ways out of this dilemma. One is to make growth sustainable; the other is to make de-growth stable. Anything else invites either economic or ecological collapse. We'll look at the option of making de-growth stable in a moment. But first let's just revisit the possibility that a different kind of growth could deliver us from the dilemma.

## Changing the 'Engine of Growth'

Would or would not a different 'engine of growth' help us here, as Achim Steiner and others have suggested. Similar proposals have been voiced for some years by ecological economists. Pointing out that 'ever greater consumption of resources is [in itself] a driver of growth' in the current paradigm, Robert Ayres argues that 'in effect, a new growth engine is needed, based on non-polluting energy sources and selling non-material services, not polluting products'.<sup>15</sup>

Similar visions for business models based around materially-light product-service systems have been put forward by others. A recent government taskforce report highlighted the potential for such models to reduce the requirement for personal ownership, improve the utilization of capital resources and lower the material intensity of the economy.<sup>16</sup>

This idea is still essentially an appeal to decoupling. Growth continues, while resource intensity (and hopefully throughput) declines. But here at least is something in the way of a blueprint for what such an economy might look like. It gives us more of a sense of what people are buying and what businesses are selling in this new economy. Its founding concept is the production and sale of de-materialized 'services', rather than material 'products'.

It's vital to note that this cannot simply be the 'service-based economies' that have characterized development in certain advanced economies. For the most part that's been achieved, as we've seen, by reducing manufacturing, continuing to import consumption goods from abroad and expanding financial services to pay for them.<sup>17</sup>

Nor does it necessarily look anything like what passes for service sector activity in advanced economies at the present. When the impacts attributable to these are fully accounted for, many of them turn out to be at least as resource-hungry as the manufacturing sectors. Leisure is one of the fastest growing sectors in modern economies and ought to be a prime candidate for de-materialization in principle. In practice, the way we spend our leisure time can be responsible for as much as 25 per cent of our carbon 'foot-print'.<sup>19</sup>

So what exactly constitutes productive economic activity in this economy? It isn't immediately clear. Selling 'energy services', certainly, rather than energy supplies.<sup>19</sup> Selling mobility rather than cars. Recycling, re-using, leasing, maybe.<sup>20</sup> Yoga lessons, perhaps, hairdressing, gardening: so long as these aren't carried out using buildings, don't involve the latest fashion and you don't need a car to get to them. The humble broom would need to be preferred to the diabolical 'leaf-blower', for instance.

The fundamental question is this: can you really make enough money from these activities to keep an economy growing?<sup>21</sup> And the truth is we just don't know. We have never at any point in history lived in such an economy. That doesn't mean we couldn't. Again, having a convincing macro-economics for such an economy would be a good starting point. But it sounds at the moment suspiciously like something the *Independent on Sunday* would instantly dismiss as a yurt-based economy - with increasingly expensive yurts.

The dynamics described in Chapter 6 just don't seem easily amenable to moderation of the kind envisaged. Social logic, questions of scale and the laws of thermodynamics are all a significant stumbling block to the changes hoped for by those with well meaning intentions for continued growth with drastic reductions in material intensity. However much material efficiency you squeeze out of the economy, eventually you'll reach a limit, at which point continued growth will push material throughput up again.

Daly is explicit on this point. 'The idea of economic growth overcoming physical limits by angelizing GDP is equivalent to overcoming physical limits to population growth by reducing the throughput intensity or metabolism of human beings', he wrote, over 30 years ago. 'First pygmies, then Tom Thumbs, then big molecules, then pure spirits. Indeed, it would be necessary for us to become angels in order to subsist on angelized GDP.'<sup>22</sup>

But this doesn't mean we should throw away the underlying vision completely. We are almost certainly still some way from absolute thermodynamic limits. And whatever the new economy looks like, low-carbon economic activities that employ people in ways that contribute meaningfully to human flourishing have to be the basis for it. That much is clear.

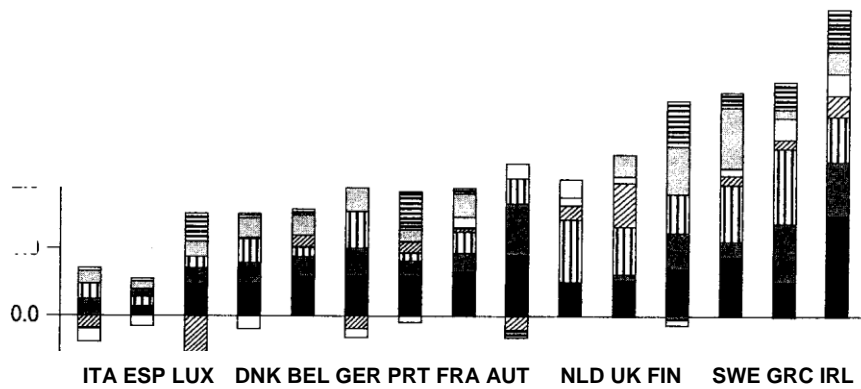
In fact, the seeds for such an economy may already exist in local or community based social enterprises: community energy projects, local farmers' markets, slow food cooperatives, sports clubs, libraries, community health and fitness centres, local repair and maintenance services, craft workshops, writing centres, water sports, community music and drama, local training and skills. And yes, maybe even yoga (or martial arts or meditation), hairdressing and gardening.

People often achieve a greater sense of well-being and fulfilment, both as producers and as consumers of these activities, than they ever do from the time poor, materialistic, supermarket economy in which most of our lives are spent.<sup>23</sup> But in formal terms these activities - let's call them ecological enterprises -barely count. They represent a kind of Cinderella economy that sits neglected at the margins of consumer society."

Some of them scarcely even register as economic activities in a formal sense at all. They often employ people on a part-time or even voluntary basis. These activities are usually labour intensive. So if they contribute anything at all to GDP, their labour productivity is of course 'dismal' - in the language of the dismal science.

To come back to macro-economics, their problematic status is confirmed by data on labour productivity in Europe. Where these activities exist in the formal economy, many of them are classified as 'personal and social services'. Figure 8.1 confirms just how fantastically unproductive this sector has been over the last decade!

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Figure 8.1 Sector contributions to EU labour productivity growth 1995-2005

Source: Timmer et al 2007, Figure 3. See note 25.

Between 1995 and 2005, labour productivity in the personal and social services sector declined by 3 per cent across the EU 15 nations; the only sector ('Pers' in Figure 8. 1) to show negative productivity growth. Only in a couple of nations was there any improvement at all in labour productivity. Across Europe, output grew much more slowly in this sector than in the economy as a whole. In fact it only grew at all because more people were employed there."

In short, this sector - the one where our hopes might lie for a 'different engine of growth' - just doesn't perform well by conventional standards. On the contrary, it's already 'dragging Europe down' in the productivity stakes. If we start shifting wholesale to patterns of de-materialized services, we wouldn't immediately bring the economy to a standstill, but we'd certainly slow down growth considerably.

We're getting perilously close here to the lunacy at the heart of the growth-obsessed, resource-intensive, consumer economy. Here is a sector which could provide meaningful work, offer people capabilities for flourishing, contribute positively to community and have a decent chance of being materially light. 27 And yet it's denigrated as worthless because it's actually employing people.

This finding is instructive in various ways. In the first place, it shows up the fetish with macro-economic labour productivity for what it is: a recipe for undermining work, community and environment.

This is categorically not to suggest that increases in labour productivity are always bad. There are clearly places where it makes sense to substitute away from human labour, especially where the working experience itself is poor. But the idea that labour input is always and necessarily something to be minimized goes against two well-supported understandings.

Firstly, there's a very good reason why de-materialized services don't lead to productivity growth. It's because, in most cases, human input is what constitutes the value in them. The pursuit of labour productivity in activities whose integrity depends on human interaction systematically undermines the quality of the output. 28

Secondly, work itself is one of the ways in which humans participate meaningfully in society. Reducing our ability to do that - or reducing the quality of our experience in doing so 29 - is a direct hit on flourishing. Relentless pursuit of labour productivity in these circumstances makes absolutely no sense.

In summary, it seems that those calling for a new engine of growth based around de-materialized services are really on to something. But they may have missed a vital point. The Cinderella economy is an incredibly useful starting point from which to build a resource-light society. But the idea that it can (or should) provide for ever-increasing economic output doesn't quite stack up.

## Sharing the work

Coming back to macro-economics, we have made some progress though. Looking again at equation (3) above, it's clear that the Cinderella economy offers us at least a way of questioning the downward pressure on employment in a non-growing economy. Specifically, the suggestion is that we don't after all necessarily have to accept a continually increasing labour productivity P.

This insight already suggests more room for re-configuring the conventional macro-economic model than is usually assumed by economists. Simply shifting the focus of economic activities from one sector to another has the potential to maintain or even increase employment, even without growth in economic output.

All the same, there are reasons nor to accept declining labour productivities across the economy as a whole. Conventionally, the reason for this is that the higher the labour content of a good or service the higher its cost. In fact, in a growing economy, as we saw in Chapter 6, average wage costs rise continually. So even maintaining stable prices relies on increasing labour productivity.

In a low or no-growth economy this pressure is reduced because average incomes no longer rise continually - or rise by less. Nonetheless, to remain competitive in international markets we would still need to ensure that labour productivity doesn't fall too far, at least in our key export (and import) sectors. In this case, we have to look at equation (3) in a different way.

If labour productivity increases overall, then the only way to stabilize output is for the total hours worked by the labour force to fall. In a recession this typically leads to unemployment. But there is another possibility here. We could also systematically set about sharing out the available work more evenly across the population. Essentially, this means reduced working hours, a shorter working week and increased leisure time.

Interestingly, some of the increased labour productivity in Europe during the period between 1980 and 1995 was taken up in exactly this way, as increased leisure. This trend was reversed during the last decade, with working hours increasing and labour productivity

growing more slowly. But as a route to prevent large-scale unemployment, sharing the available work has much to recommend it.

This is the option taken, for example, by Canadian ecological economist, Peter Victor, in a Study designed to test a low or no-growth scenario for the Canadian economy. Astonishingly, Victor's work stands out as an almost unique attempt to develop any kind of model of a non-growing economy. It is, in short, a worthy pioneer of the idea of an ecological macro-economics. 30

The model is calibrated against real historical data from Canada on the principal macro-economic variables: consumption, public spending, investment, productivity growth, savings rates and so on. Making specific assumptions about the future, the model then estimates the national income, computes the fiscal balance and tracks the national debt over a 30-year period to 2035. It also keeps an account of unemployment, greenhouse gas emissions and poverty levels. 31

Figure 8.2 illustrates one of the stabilization scenarios generated by the model. By manipulating the 'drivers' of growth in the model, income growth is gradually reduced from 1.8 per cent a year to less than 0.1 per cent a year, effectively stabilizing per capita GDP. Notably though, this is achieved without compromising economic and social stability.

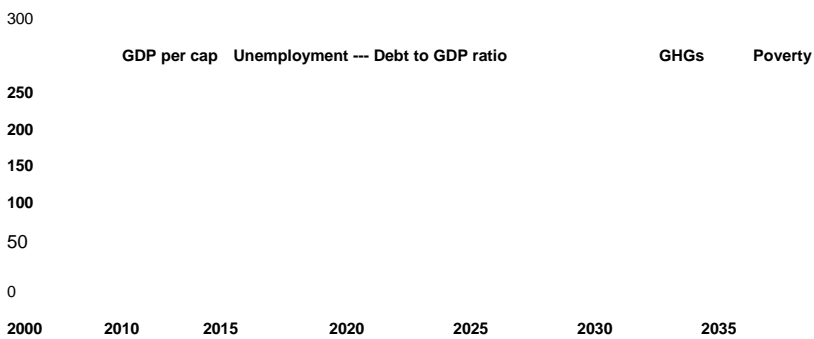


Figure 8.2 A low growth scenario for Canada

Source: Victor. 2008b.

In fact, unemployment and poverty are both halved in this scenario as a result of active social and working time policies. Even more striking is that the debt to GDP ratio has been slashed by 75 per cent. And though it falls some way short of achieving a 450 ppm stabilization target, Canada has achieved (25 years too late!) its 'Toronto target' of a 20 per cent cut in greenhouse gas emissions. 32

The key policy intervention used to prevent wide-scale unemployment is a reduction in working hours. Labour productivity is assumed to increase in the model, pretty much in line with historical increases in labour productivity in Canada. And this would normally lead through the logic discussed already to a reduction in employment. But unemployment is averted here by sharing the available work more equally across the workforce. 33

Reducing the working week is the simplest and most often cited solution to the challenge of maintaining full employment with non-increasing output. And there is clear precedent for it, for example, from labour policies in certain European nations. 34 But it's worth noting that there are some other more radical suggestions for reorganizing work to ensure equity and to encourage continuing participation in society. These include quite radical changes to the wage structure, such as the introduction of a basic (or citizen's) income. 35

This is not to suggest that any of these changes is easy to implement. Reducing working hours, for example, only tends to succeed under certain conditions. 'One of the fundamental pre-conditions for the working time policy pursued in Germany and Denmark' writes sociologist Gerhard Bosch, 'was a stable and relatively equal earning distribution.' 36 A shift to a completely different income basis would be even more complicated.

But the point here is that - even within a relatively conventional macroeconomic framework - different configurations of the key variables are possible. And these configurations deliver different outcomes. The goal of achieving economic stability while remaining within ecological limits begins to look more achievable.

## Ecological investment

We've focused so far on the question of labour (and labour productivity) in the transition to a sustainable economy. But there's another key area to address in a coherent ecological macroeconomics, namely the question of capital and capital productivity.

As we've seen already, capital investment is a vital input to production. Investment maintains and improves production facilities. It provides for radical innovation which can revolutionize the productive capacity of the economy. And in particular it stimulates continual increases in labour productivity.

The starting point in an ecological macro-economics has to be slightly different. The transition to a sustainable, low-carbon economy represents an enormous challenge. Above all, this challenge is about investment. It's about allocating sufficient resources to transform our economies fast enough that they don't completely undermine the prospects for prosperity in the future.

A study by Italian ecological economists Simone d'Alessandro, Tommaso Luzzati and Marto Morroni underlines this point. Using an experimental simulation model, they explore the challenge associated with making a successful transition from a fossil fuel economy to one based on renewable energy. 37

As we saw in Chapter 7 this is one of several key targets for substantial new investment. But there's a balance to be struck. If we invest too slowly, we run out of resources before alternatives are in place. Fuel prices soar and economies crash. If we invest too fast, there's a risk of slowing down the economy to the extent that the resources required for further investment aren't available.

The upshot, according to d'Alessandro and his colleagues, is that there is a narrow 'sustainability window' through which the economy must pass if it is to make the transition to a non-fossil world successfully. Crucially though, this 'sustainability window' is widened if

the balance between consumption and investment in the economy can be changed. Specifically, if the savings ratio is increased and more of the national income is allocated to investment, the flexibility to achieve the transition is higher, according to this analysis. 38

In other words, the balance between consumption and investment has to change in a new ecological macro-economics. From the perspective of the demand side, that needn't matter too much. A shift between **C** and **I** in equation (1) needn't necessarily lead to a reduction in aggregate demand **E**. It would simply reduce the importance of consumption as a driver of growth and replace it with an enhanced role for investment.

Clearly the target of investment would also need to change. The traditional function of investment, framed around increasing labour productivity, is likely to diminish in importance. Innovation will still be vital, but it will need to be targeted more carefully towards sustainability goals. Specifically, investments will need to focus on resource productivity, renewable energy, clean technology, green business, climate adaptation and ecosystem enhancement. These are precisely the kind of targets that emerge from the consensus around a global Green New Deal (Chapter 7).

Foregoing consumption growth seems inevitable if we are to sustain this enhanced need for ecological investment. What we don't yet know is whether ultimately the scale and nature of this kind of investment can maintain the growth potential of the economy as a whole.

The conventional Keynesian response suggests that increasing investment in the economy has a Multiplier effect and stimulates growth. But we can't use that reasoning here for a couple of reasons. In the first place, Keynes assumed that the increase in investment is funded through increased borrowing, not by substituting savings for consumption. Secondly, the Keynesian multiplier can't be trusted here is that the calculation assumes that the marginal propensity to consume remains constant. But the whole point about a shift from consumption to savings is that it alters that assumption. In fact, Keynes's paradox of thrift suggests that this shifting from consumption to savings will simply slow down recovery.

What we need in order to address this question properly is a fuller exploration not just of the targets for ecological investments but also of the nature of these investments. How productive are they in conventional terms? Do they have higher or lower rates of return than conventional investments? Do they have shorter or longer periods of return? Do they increase the productive capacity in the economy more than or less than conventional capital investments? Do they increase or decrease labour productivities?

Answering these questions fully again requires a macroeconomic model. But it's a very different kind of macro-economic model than is currently employed to understand the growth-based economy. Essentially it requires us to explore more deeply the 'ecology' of ecological investment: the set of conditions (rate of return, nature of return, period of return and so on) that determines how the investment interacts both on the supply side and the demand side of the economy. Such a task is beyond the scope of this book. But we can already hazard some guesses about the outcome of a greatly enhanced role for ecological investment.

In the first place, the answers will depend on the composition of investment needed for the transition. Specifically, this is determined by three main types of investment:

- investments that enhance resource efficiency and lead to resource cost savings (for example energy efficiency, waste reduction, recycling);
- investments that substitute conventional technologies with clean or low-carbon technologies (for example renewables);
- investments in ecosystem enhancement (climate adaptation, afforestation, wetland renewal and so on).

The impact on the productive capacity of the economy will differ markedly across these investment types. Investments in resource productivity are likely to have a positive impact on overall productivity. But they won't necessarily bring preferential returns over conventional investments unless the relative prices of labour and materials change substantially.

Some investments in renewable energy will bring competitive returns in some market conditions. Others will only bring returns over much longer timeframes than traditional financial markets expect. Investments in ecosystem enhancement and climate adaptation might not bring conventional financial returns at all, even though they are protecting vital ecosystem services for the future and may also be contributing to employment. 39

In other words, simplistic prescriptions in which investment contributes to future productivity won't work here. The ecology of investment will itself have to change. Investment in long-term infrastructures and public goods will have to be judged against different criteria. And this may mean rethinking the ownership of assets and the distribution of surpluses from them.

Specifically, there is likely to be a substantially enhanced role for public sector investment and asset ownership. The public sector is often best placed to identify and protect long-term social assets. Public sector rates of return are typically lower than commercial ones, allowing longer investment horizons and less punishing requirements in terms of productivity.

Appendix 2 sketches the outline for a new macro-economic investment framework that builds on these points. Particular attention is drawn there to the challenge of matching supply with demand under these new conditions. Investments in ecosystem maintenance (for example) contribute to aggregate demand, but make no direct contribution to aggregate supply - at least under the assumptions of a conventional production function. They may be vital in protecting environmental integrity. And this, in its turn, is vital for sustaining production at all over the long-term. But in the short-term, they appear to 'soak up' income without increasing economic output. 40

In a conventional growth-based economy this is problematic because it reduces the growth potential in the economy. In a sustainable economy this kind of investment needs to be seen as an essential component of macro-economic structure. Whether it leads to growth or not is, once again, somewhat beside the point.

## Foundations for an ecological macro-economics

In summary, the aim of this chapter has been to show that a new ecological macro-economics is not only essential, but possible. The starting point must be to relax the presumption of perpetual consumption growth as the only possible basis for stability and to identify clearly the conditions that define a sustainable economy.

These conditions will still include a strong requirement for economic stability. Or perhaps 'resilience' would be a better word for what is required here. A sustainable economy must be capable of resisting the exogenous shocks and avoiding the internal contradictions which cause chaos during periods of recession.

But the requirement for resilience will need to be augmented by conditions that provide security for people's livelihoods, ensure distributional equity, impose sustainable levels of resource throughput and protect critical natural capital.

The fundamental macro-economic variables will still pertain. People will still spend and they will still save. Enterprise will still produce goods and services. Government will still raise revenues and spend them in the public interest. Both private and public sector will invest in physical, human and social assets.

But new macro-economic variables will need to be brought explicitly into play. These will almost certainly include variables to reflect the energy and resource dependency of the economy and the limits on carbon. They may also include variables to reflect the value of ecosystem services or stocks of natural capital."

And there are likely to be key differences even in the way that conventional variables play out. The balance between consumption and investment, the balance between public and private sector, the role of different sectors, the nature of productivity improvement, the conditions of profitability: all of these are likely to be up for renegotiation.

Ecological investment must play an absolutely vital role. If debt is to be kept under control this suggests that a different savings ratio will be needed. And that a different balance between consumption and investment in the aggregate demand function is likely. In addition, the level and nature of this investment almost certainly calls for a different balance between public and private sector investment.

An ecological macro-economics will require a new ecology of investment. This will mean revisiting the concepts of profitability and productivity and putting them to better service in pursuit of long-term social goals. We will almost certainly need to abandon the mindless infatuation with labour productivity and think systematically about the conditions for high employment in low-carbon sectors.

Above all, the new macro-economics will need to be ecologically and socially literate, ending the folly of separating economy from society and environment.