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Towards an Environmental Macro-economics

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TOWARDS AN ENVIRONMENTAL MACROECONOMICS¹

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ABSTRACT: When environmental macroeconomic frameworks replace standard macroeconomic frameworks differences in policy outcomes ensue. The non-recognition of real environmental capacity constraints could explain the inability of standard frameworks to deliver on certain macroeconomic goals. Herein environmental capital depreciation is internalized into analytic frameworks of factor-utilization, aggregate demand and aggregate supply. The analyses reveal that restricted income and wage domains alongside limited environmental capacity constrain economic performance. Hence environmental capacity expansion and initiatives towards sustainability warrant specific attention. Illustrations are made with reference to the Australian economy and her response to the 2008-10 global financial crisis.

INTRODUCTION

Extensive reviews of the theory and analysis of environmental economics, (for example, Cropper and Oates 1992 and Stavins 2004), have the domain firmly fixed on microeconomics. Nevertheless, the tradition of environmental capital (*KN*) in macroeconomics dates back to Marshall (1890) who exposted *KN* as ultimate capital – since the ultimate components of all items stem from nature. Capital theory (Fisher 1904) itself owes its origins to the acknowledged premise of *KN* being a stock that generates a flow.

The main object of this paper is to demonstrate the significant differences that would emerge in policy formulation when environmental macroeconomic frameworks are employed in lieu of the standard frameworks. Towards this end, the method employed here is an ex-post analysis and involves the display of a sequence of snap-shots of the economy. Each snap-shot is a macroeconomic representation of the economy and this in turn is a manifest of the underlying framework employed. More often than not, a given snap shot is likely to reveal the presence of disequilibria owing to presence of

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gaps in employment, output and inflation. Hence a snap-shot facilitates the choice of decisions that could help close the gaps and converge towards some equilibria. The main contention herein is that the utilization of the environmental macroeconomic framework could lead to income and employment outcomes that are more sustainable than those elicited from standard frameworks.

The paper is structured as follows. The next section deals with an explanation of the analytic frameworks for both the standard and the environmental macroeconomic contexts. This is followed by an empirical illustration with reference to Australia. The Australian response to the global financial crisis (GFC) over the period 2008-2010 is employed to illustrate the variations in policy directives that would arise when the different types of frameworks are employed.

II. THE ANALYTIC FRAMEWORK

The display of snap-shots is enabled by fitting point estimate data of relevant time periods to assumed functional forms that describe the macroeconomic frameworks. That is, specific functional forms are deemed valid descriptors of the frameworks chosen. The standard representation considered here comprises the joint display of: aggregate demand (AD), aggregate supply (AS) and factor utilization. In the environmental macroeconomic representation, the above frameworks are revised for recognizing KN. The descriptions of the standard and environmental macroeconomic frameworks are next considered in turn.

The Standard Macroeconomic Framework

Some simplifying assumptions are made with reference to the description of the component frameworks in order to facilitate the use of point estimate data. The factor

utilization framework is assumed to be a Cobb-Douglas (C-D) function of constant returns to scale involving two factors, namely manufactured capital stock (KM) and labour (L):

$$(1) \quad Y_t = \alpha_t KM_t^{\theta_t} L_t^{\lambda_t}$$

Where θ_t and λ_t , represent the factor shares of national income (Y_t) in time t accruing respectively to KM and L ; and owing to the assumption of constant returns to scale, ($\theta_t + \lambda_t = 1$).

The assumption of constant returns to scale enables factors shares of income to be elicited directly from the income accounts where the following identity prevails:

$$(2) \quad Y_t = \{Compensation\ to\ Employees\ (CE_t)\} + \{Operating\ Surplus\ (OS_t)\}$$

Because CE and OS represent respectively payments accruing to L and KM ,

$$(3) \quad \lambda_t = \frac{CE_t}{Y_t}; \quad \theta_t = \frac{OS_t}{Y_t}$$

Given the point estimate data on KM_t and L_t , the estimation of the total factor productivity measure, namely α_t is feasible. This C-D function can then enable the identification of capacity (full employment) income (Y_{Ft}) and the output gap ($Y_{Ft} - Y_t$) in terms of employment (L_t) and the labor force (L_{Ft}).

The exposition of AS is simplified by differentiating capacity supply (AS_F) from a short-run response (AS_{SR}). The latter is assumed to be Keynesian. That is, producers expect prevailing prices π_t (inflation rate) to persist in the short run and hence will strive to produce as much as possible ($Y \rightarrow \infty$) at these prices:

$$(4) \quad AS_{SRt} : \{(\pi = \pi_t) | (Y \rightarrow \infty)\}$$

Given that capacity (Y_{Ft}) in a given time period (t) cannot be exceeded, AS_{Ft} is defined as:

$$(5) \quad AS_{Ft} \{ (Y = Y_{Ft}) | (\pi \rightarrow \infty) \}$$

A simple exposition of AD following Mankiw (2010) and Flath (2005) is premised on the Quantity Equation, that is:

$$(6) \quad \pi_t = \left[\frac{M_t V_t}{Y_t P_{t-1}} \right]$$

Where (P_{t-1}, M_t, V_t) represent respectively the price level of the previous period; and money stock and velocity in t .

In (6) the rate of (π) is scaled such that $(\pi = 1)$ represents stationary price level; that is

$$[P_t = \pi_t P_{t-1}].$$

The display of a given snap-shot and the elicitation of likely changes due to possible methods of intervention are further aided by the following set of simplifying assumptions:

1. Given π_t and Y_t in time t , a short-run equilibrium namely $\{AS_{SRt} = AD_t\}$ does exist for (Y_t, π_t) .
2. The definition of money stock is confined to narrow money (MI). The changes in MI in response to changes in the interest rate (Δr) are given by $\left(\frac{dM}{dr} \right)$, which as indicated below is based on time trends of M and r .
3. Expected changes in expenditure in a given time t , (GDP_t), are drawn from changes in: tax rates ($\Delta \tau$) influencing consumption (C), government spending (ΔG); and interest rates (Δr) influencing investment stock (I).
4. Velocity of money during a given time period remains fixed at \bar{V}_t

Given the above assumptions the following definitions can be made and then elicited from the point-estimate data of relevant time periods. These definitions enable the display of expected outcomes when likely interventions are made in terms of $\Delta \tau$, ΔG and Δr .

$$(7) \quad M_t = \left[M_{t-1} * \left(\left(\frac{dM}{dt} \right) + \left[\left(\frac{dM}{dr} \right) * (\Delta r_{t-1}) \right] \right) \right]$$

Where $(\Delta r_{t-1} = r_{t-1} - r_{t-2})$ is based on the appropriate point-estimates for the interest

rates and $\left(\frac{dM}{dr} \right) = \left(\frac{dM / dt}{dr / dt} \right)$

$$(8) \quad GDP_t = \Phi_t + \beta_t Y_t (1 - \Delta \tau_t) + G_t + I_t,$$

where Φ_t , and β_t are respectively a constant comprising of net exports and marginal propensity to consume.

$$(9) \quad I_t = \left[I_{t-1} * \left(\left(\frac{dI}{dt} \right) + \left[\left(\frac{dI}{dr} \right) * (\Delta r_{t-1}) \right] \right) \right]$$

The assumption of a short-run equilibrium implies that for a given π_t , ($GDP_t = Y_t$), and hence from the foregoing an expression for AD in time t could be provided as:

$$(10) \quad \pi_t = \left[\frac{M_t \bar{V}_t}{[\Phi_t + \beta_t Y_t (1 - \tau_t) + G_t + I_t] P_{t-1}} \right]$$

The depiction of the snap shot will follow the display of (1), (4), (5) and (10) from the relevant point estimate data. The expected changes in the snap-shot for the subsequent period will in part be determined by the responsiveness of AD to the intervention measures. For example the responsiveness to changes in τ could be explained as:

$$(11) \quad \frac{\partial \pi}{\partial \tau} = \left[\frac{M_t \bar{V}_t \beta_t Y_t}{[\Phi_t + \beta_t Y_t (1 - \tau_t) + G_t + I_t]^2 P_{t-1}} \right]$$

The important distinction between the standard framework and the environmental macroeconomic framework is captured in terms of at least two aspects. The first is the policy domain. That is, the income domain within which the policy maker will try

resolve for inflation and employment. As illustrated in Figure-1 below, this domain for the standard framework is defined by $(Y_t \leftrightarrow Y_{Ft})$. The second aspect is the responsiveness to intervention such as that exposted in (11).

As illustrated below, both these aspects will display variations within the environmental macroeconomic framework.

The Environmental Macroeconomic Framework

The same way as the system of national income accounting provides the basis for standard macroeconomic analysis, the analytics of environmental macroeconomics rests on the principles of environmental accounting. The definition of sustainable income (Y_S) in environmental macroeconomics can be regarded as an extension of the ‘permanent income’ concept advanced by Hotelling (1925) and Keynes (1936). As per this extension, national income can be sustainable if: (i) there is no diminution in the stock of KN ; and (ii) the depreciation of KN , namely D_{KN} , is less than the rent generated by KN ; (Thampapillai and Uhlin 1997). A steady state then is a context when the stock of KN endowment is maintained and positive rents net of depreciation are earned. Hence, Y_S can be regarded as the economic rent earned from KN . This interpretation of rent is consistent with Marshall (1920): “The labour and capital of the country acting on its *natural resources*, produce annually a certain *net aggregate of commodities...*” (Italics mine). Thus, the basic equilibrium in environmental accounting would be $(Y_S \equiv GDP - D_{KN})$

To illustrate environmental macroeconomic framework, suppose that KN and D_{KN} can be measured on the same scale as for KM in the national accounts. When KN is introduced in the description of factor utilization, (1) would be re-written as:

$$(12) \quad Y_{tS} = \bar{\alpha}_t KM^{\bar{\theta}_t} L^{\bar{\lambda}_t} KN^{\eta_t}$$

In (12), which is deemed herein as the valid descriptor for factor utilization, η_t is the share Y that accrues to KN in time t . Because D_{KN} represents the aggregate of compensatory payments to maintain the flow of services from KN , it can be regarded as a proxy for the KN -factor income, and hence:

$$(13) \quad \eta_t = \frac{D_{KNt}}{Y_t}$$

The distribution of Y between three factors, as per (12), instead of two factors as per (1), implies that $(\bar{\theta}_t < \theta_t)$ and $(\bar{\lambda}_t < \lambda_t)$. The retention of constant returns to scale in (12) further implies that $(\bar{\theta}_t + \bar{\lambda}_t + \eta_t = 1)$.

Further, if (12) is deemed the valid descriptor for the distribution of Y_t , it is plausible to conclude that θ_t and λ_t in (1) are over-estimates for the factor shares of Y_t because they also include the income share that should accrue to KN , namely D_{KNt} . To estimate the values $(\bar{\theta}_t, \bar{\lambda}_t)$ assume that the remainder of Y_t after accounting for D_{KNt} - that is, the amount $(Y_t - D_{KNt})$ is distributed between KM_t and L_t in the proportion defined by the ratio of their shadow prices (P_{KMt} and P_{Lt}). This is illustrated in (14) and (15) below. The reason for using this ratio is that the emergence of D_{KNt} as a cost could at least in part be due to the distortions in the markets for KM and L . Hence the coefficients $(\bar{\theta}_t, \bar{\lambda}_t)$ in (12) can be defined as follows:

$$(14) \quad \bar{\theta}_t = \left(\frac{OS_t - \left[\frac{P_{KMt}}{P_{KMt} + P_{Lt}} \right] * D_{KN}}{Y_t} \right)$$

$$(15) \quad \bar{\lambda}_t = \left(\frac{CE_t - \left[\frac{P_{Lt}}{P_{KMt} + P_{Lt}} \right] * D_{KN}}{Y_t} \right)$$

The recognition of the revised equilibrium ($Y_S \equiv GDP - D_{KN}$) requires that the total factor productivity coefficient of KM and L as defined in (1) be reduced by a proportion of η_t such that when comparing (12) and (1) above, $[\bar{\alpha}_t = (1 - \eta_t) \alpha_t]$. Hence (12) could be restated as:

$$(16) \quad Y_{tS} = (1 - \eta_t) \alpha_t KM_t^{\bar{\theta}_t} L_t^{\bar{\lambda}_t} KN_t^{\eta_t}$$

Since point-estimate values of all coefficients and variables of (1) and (16) are known through either estimation or reported data, the value of KN for each year can be simply estimated through dividing (1) by (16) as in Thampapillai (2007). Hence KN would be defined as:

$$(17) \quad KN_t = KM_t^{\left(\frac{\theta_t - \bar{\theta}_t}{\eta_t} \right)} L_t^{\left(\frac{\lambda_t - \bar{\lambda}_t}{\eta_t} \right)}$$

When all arguments in (16) are known, it is possible to revise the values of observed and capacity income (Y_t and Y_{Ft}) towards values that recognize the role of KN . These are identified in Figure-1 as Y_{tS} and Y_{FtS} . Hence capacity AS would be redefined as:

$$(18) \quad AS_{FtS} \left\{ (Y = Y_{FtS}) \mid (\pi \rightarrow \infty) \right\}$$

Note that AD_{tS} represents the revised description of AD in the context of recognizing KN . Following Thampapillai and Uhlin (1997), D_{KN} is internalized into AD by redefining aggregate expenditure in (8) as:

$$(19) \quad GDP_t = (1 - \eta_t) [\Phi_t + \beta_t Y_t (1 - \tau_t) + G_t + I_t]$$

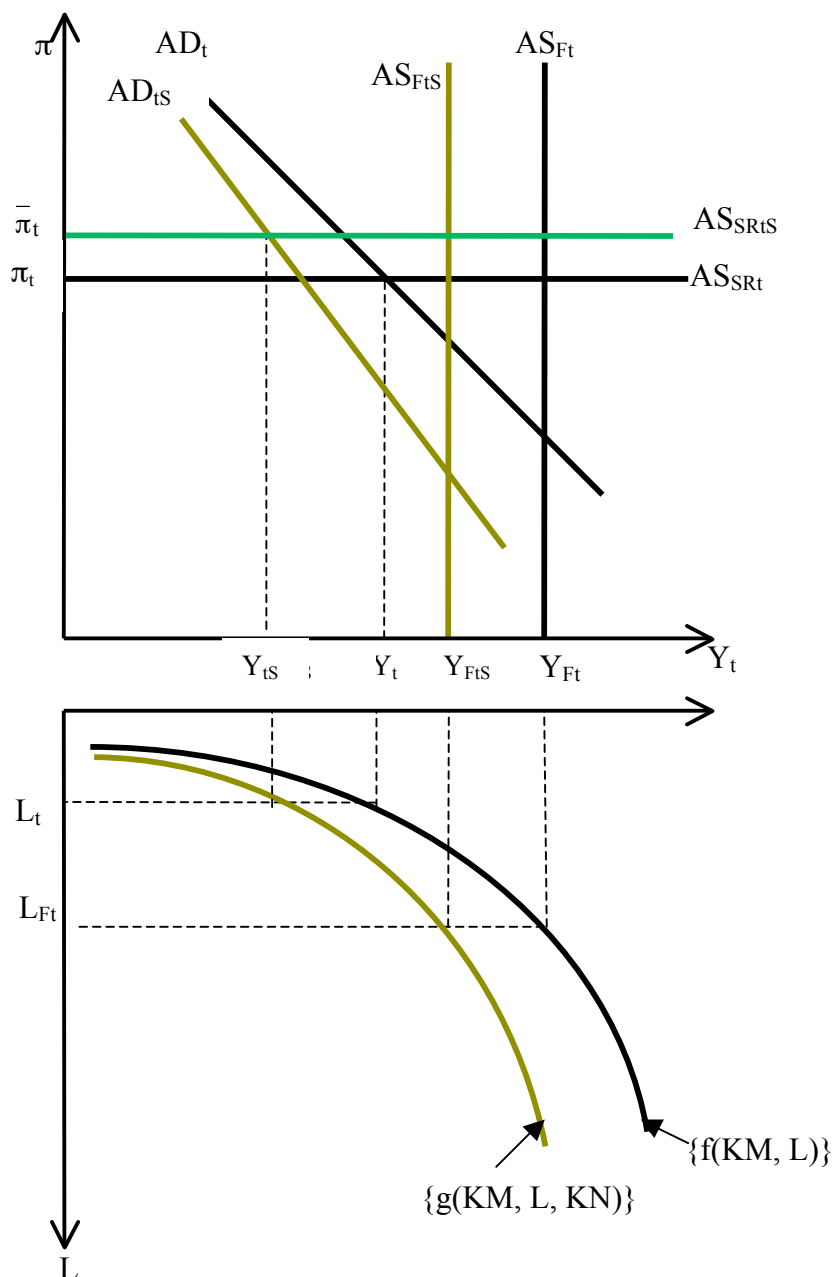


Figure-1: The Standard and Environmental Macroeconomic Frameworks – Conceptual Basis

The depiction of the snap shot will follow the display of (16), (18), (19) and (21) from the relevant point estimate data. As with the standard framework, the expected changes in the snap-shot for the subsequent period will be in part determined by the responsiveness to intervention measures. The counterpart of (11) above in the revised context would be:

$$(22) \quad \frac{\partial \pi}{\partial \tau} = \left[\frac{M_t \bar{V}_t \beta_t Y_t}{\left[\Phi_t + \beta_t Y_t (1 - \tau_t) + G_t + I_t \right]^2 (1 - \eta_t) P_{t-1}} \right]$$

A comparison of (11) and (22) reveals that the inflationary response to changes in τ would be higher in the context of the environmental macroeconomic framework than the standard framework. This is verified below. The two types of frameworks described above are illustrated in Figure-1.

III. THE ILLUSTRATION

As indicated, in this ex-post analysis two types of snap-shots, namely *expected* and *actual* snap-shots are generated following the initial snap-shot for each type of framework. Policy intervention is confined to monetary and fiscal measures. As indicated below these interventions can be ascertained from the national accounts and the minutes of the Reserve Bank of Australia (RBA) that are accessible on the public domain. The display of snap-shots commences with the last quarter of 2007 because vastly different types of intervention measures were adopted subsequent to this period due to the GFC. The final period for the display is 2010-Q2.

It is assumed that the development of the expected snap-shot for a subsequent time period, say (t+1), would follow a sequence of steps as outlined below:

1. Identification of the state of the economy in terms of output, employment and inflation gaps
2. Estimation of output response (Y_{t+1}) to fiscal and monetary intervention measures by recourse to application of definitions of *GDP* – (8) and (19) above
3. Estimation of employment (L_{t+1}) that corresponds to (Y_{t+1}) by recourse to the application of the factor utilization functions – (1) and (16)
4. The estimation of the full employment level (L_{Ft+1}) by recourse to the trend in labour force growth and the value of capacity income (Y_{Ft+1}) by recourse to factor utilization functions – (1) and (16). This would enable the display of capacity AS_{Ft+1} .

5. Estimation of (π_{t+1}) and (π_{Ft+1}) that correspond to (Y_{t+1}) and (Y_{Ft+1}) by recourse to the application of AD functions – (10) and (21)
6. Display of output, employment and inflation gaps for (t+1)

Within the above sequence, in the absence of any policy intervention, the exposition of the expected snap-shot is guided by the estimation of (d/dt) for pertinent variables and coefficients. For example, consider (7) above. In the absence of any monetary policy intervention the change in M_t is assumed to be guided solely by (dM/dt) . The (d/dt) values estimated for the analysis are summarized in Table A-1 in the appendix. Pertinent quarterly data for the period 2001-Q1 to 2010 Q-2 were drawn from the OECD e-library. Figure A-2 in the appendix presents an over-view of the basis for generating expected values.

For the illustration of the environmental macroeconomic framework, D_{KN} is confined to the cost of CO2 pollution abatement. CO2 emission data was drawn from the World Development Indicators for Australia and an emission expenditure of USD 100/tonne was used as per the Stern (2007). Further, the estimation of $(\bar{\theta}_t, \bar{\lambda}_t)$ in the environmental macroeconomic framework requires the estimation of shadow prices for KM and L . Following the standard traditions of cost-benefit analysis, P_{KM_t} is approximated to the long-term government bond rate. P_{L_t} is estimated as a capital equivalent price of L . For this purpose, CE is adjusted downwards to reflect the prevailing rate of unemployment. To obtain this adjusted value, CE_{S_t} , first an average wage rate that would support full employment in period t , W_{S_t} , is estimated – for example through dividing CE by the labour force. CE_{S_t} is then defined as $(W_{S_t} * L_t)$, where L_t is the actual workforce. P_{L_t} as a capital equivalent price would then equal (CE_{S_t}/KM_t) . Since intervention is limited to monetary and fiscal measures, the anticipated changes are captured by recourse to changes in (10), (11), (20) and (22).

The intervention measures in terms of interest rates (r), taxation rate (τ) and government spending (G) are summarized in Table-1

Table-1: Monetary and Fiscal Intervention Q4-2007 to Q2-2010

| | Δr | G | τ |
|---------|------------|-------|--------|
| Q4-2007 | 0.25 | 39.02 | 0.12 |
| Q1-2008 | 0.47 | 39.49 | 0.12 |
| Q2-2008 | 0.03 | 40.44 | 0.11 |
| Q3-2008 | -0.23 | 40.83 | 0.11 |
| Q4-2008 | -2.67 | 41.53 | 0.11 |
| Q1-2009 | -1.10 | 41.76 | 0.11 |
| Q2-2009 | -0.25 | 42.05 | 0.11 |
| Q3-2009 | 0.00 | 42.92 | 0.11 |
| Q4-2009 | 0.74 | 43.67 | 0.11 |
| Q1-2010 | 0.24 | 44.37 | 0.11 |
| Q2-2010 | 0.52 | 45.17 | 0.11 |

The observed and expected values with reference inflation, output and employment are summarized in Table-2 below. These three categories are considered in turn below.

Table-2A: Observed and Expected Outcomes - Inflation

| PERIOD | π_t (percentage) | | | | π_{Ft} (percentage) | | | |
|---------|----------------------|----------|----------|----------|-------------------------|----------|----------|----------|
| | SFW | | EMFW | | SFW | | EMFW | |
| | Observed | Expected | Observed | Expected | Observed | Expected | Observed | Expected |
| Q4-2007 | 1.007 | 1.007 | 1.175 | 1.175 | 0.908 | 0.904 | 1.071 | 1.071 |
| Q1-2008 | 1.010 | 1.011 | 1.174 | 1.178 | 0.912 | 0.904 | 1.074 | 0.919 |
| Q2-2008 | 1.002 | 1.014 | 1.155 | 1.181 | 0.911 | 0.903 | 1.055 | 0.922 |
| Q3-2008 | 1.004 | 0.999 | 1.149 | 1.162 | 0.913 | 0.904 | 1.052 | 0.909 |
| Q4-2008 | 0.993 | 0.993 | 1.140 | 1.153 | 0.910 | 0.901 | 1.042 | 0.904 |
| Q1-2009 | 1.007 | 0.961 | 1.163 | 1.112 | 0.905 | 0.895 | 1.058 | 0.876 |
| Q2-2009 | 1.005 | 0.927 | 1.176 | 1.069 | 0.903 | 0.866 | 1.066 | 0.845 |
| Q3-2009 | 1.003 | 0.914 | 1.172 | 1.053 | 0.903 | 0.852 | 1.062 | 0.834 |
| Q4-2009 | 1.010 | 0.911 | 1.180 | 1.049 | 0.905 | 0.846 | 1.071 | 0.832 |
| Q1-2010 | 1.007 | 0.916 | 1.170 | 1.054 | 0.908 | 0.843 | 1.066 | 0.837 |
| Q2-2010 | 1.012 | 0.922 | 1.167 | 1.060 | 0.908 | 0.846 | 1.063 | 0.843 |

Legend: SFW = Standard Framework; EMFW = Environmental Macroeconomic Framework

Table-2B: Observed and Expected Outcomes - Income

| PERIOD | Y_t (Year 2000 \$ Billion) | | | | Y_{Ft} (Year 2000 \$ Billion) | | | |
|---------|---|----------|-------------|----------|--|----------|-------------|----------|
| | SFW | | EMFW | | SFW | | EMFW | |
| | Observed | Expected | Observed | Expected | Observed | Expected | Observed | Expected |
| Q4-2007 | 204.09 | 204.09 | 174.87 | 174.87 | 224.66 | 224.66 | 191.86 | 191.86 |
| Q1-2008 | 207.21 | 205.63 | 178.25 | 176.36 | 227.14 | 227.25 | 194.77 | 226.21 |
| Q2-2008 | 213.34 | 207.19 | 185.14 | 177.82 | 234.20 | 229.88 | 202.61 | 227.78 |
| Q3-2008 | 219.47 | 212.86 | 191.76 | 182.93 | 240.44 | 232.56 | 209.41 | 233.87 |
| Q4-2008 | 220.00 | 216.00 | 191.53 | 185.92 | 241.71 | 235.29 | 209.64 | 237.16 |
| Q1-2009 | 217.32 | 224.33 | 188.12 | 194.02 | 240.09 | 238.07 | 206.95 | 246.14 |
| Q2-2009 | 212.17 | 227.67 | 181.40 | 197.42 | 234.97 | 240.89 | 200.11 | 249.64 |
| Q3-2009 | 214.13 | 229.91 | 183.25 | 199.65 | 237.21 | 243.77 | 202.24 | 251.95 |
| Q4-2009 | 215.91 | 231.89 | 184.95 | 201.59 | 238.69 | 246.70 | 203.72 | 253.95 |
| Q1-2010 | 219.97 | 232.60 | 189.31 | 202.25 | 242.14 | 249.69 | 207.67 | 254.56 |
| Q2-2010 | 226.07 | 234.69 | 196.02 | 204.23 | 249.01 | 252.72 | 215.17 | 256.68 |

Legend: SFW = Standard Framework; EMFW = Environmental Macroeconomic Framework

Table-2C: Observed and Expected Outcomes – Employment and Labour Force

| | L_t (Million Persons) | | | | L_{Ft} (Million Persons) | | | |
|---------|--|----------|-------------|----------|---|----------|-------------|----------|
| | SFW | | EMFW | | SFW | | EMFW | |
| | Observed | Expected | Observed | Expected | Observed | Expected | Observed | Expected |
| Q4-2007 | 9.43 | 9.43 | 9.43 | 9.43 | 11.25 | 11.25 | 11.25 | 11.25 |
| Q1-2008 | 9.55 | 9.49 | 9.55 | 9.49 | 11.31 | 11.31 | 11.31 | 11.31 |
| Q2-2008 | 9.58 | 9.55 | 9.58 | 9.55 | 11.39 | 11.37 | 11.39 | 11.37 |
| Q3-2008 | 9.65 | 9.61 | 9.65 | 9.61 | 11.45 | 11.43 | 11.45 | 11.43 |
| Q4-2008 | 9.67 | 9.67 | 9.67 | 9.67 | 11.50 | 11.49 | 11.50 | 11.49 |
| Q1-2009 | 9.64 | 9.73 | 9.64 | 9.73 | 11.59 | 11.56 | 11.59 | 11.56 |
| Q2-2009 | 9.66 | 9.79 | 9.66 | 9.79 | 11.64 | 11.62 | 11.64 | 11.62 |
| Q3-2009 | 9.67 | 9.85 | 9.67 | 9.85 | 11.67 | 11.68 | 11.67 | 11.68 |
| Q4-2009 | 9.73 | 9.91 | 9.73 | 9.91 | 11.73 | 11.74 | 11.73 | 11.74 |
| Q1-2010 | 9.85 | 9.98 | 9.85 | 9.98 | 11.80 | 11.81 | 11.80 | 11.81 |
| Q2-2010 | 9.87 | 10.04 | 9.87 | 10.04 | 11.86 | 11.87 | 11.86 | 11.87 |

Legend: SFW = Standard Framework; EMFW = Environmental Macroeconomic Framework

Inflation

Consider first the observation with reference to π_t ; (Figure-2 and Table-2A). Both the expected and observed values of inflation elicited from the environmental macroeconomic framework are consistently higher than those from the standard framework. This is to be expected given the smaller denominator in (20) compared to

that in (10). Note though that the observed value of inflation with reference to the standard framework coincides with the reported value of inflation.

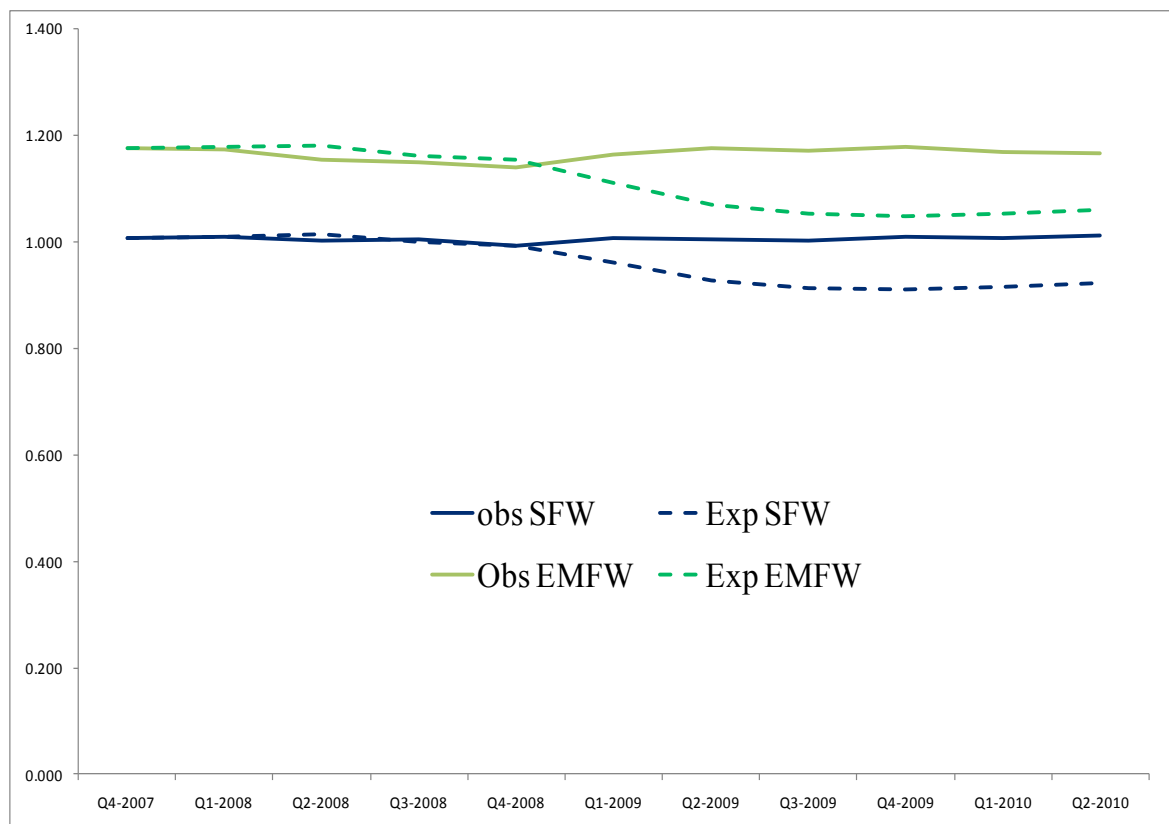


Figure-2: Observed Vs Expected Inflation Levels (Q4-2007 to Q2-2010)

During the period Q4-2007 to Q2-2008, the RBA felt compelled to raise interest rates. As per the minutes of a board meeting (Reserve Bank of Australia 2008), there were expressed concerns with inflationary forces and pressures on productive capacity. Hence the RBA intervened by raising interest rates. Such intervention was dramatically reversed from the third quarter of 2008. Nevertheless, the reported values of inflation remained steady despite the RBA's varying intervention (tightening as well as loosening). The presence of environmental capacity constraints is a likely cause for the unresponsiveness of inflation to the interventions as discussed below. It is further noteworthy that the expected level of inflation generated by the environmental macroeconomic framework gets closer to the reported value of inflation during the stimulus period.

A comparison of the snap-shots for Q4-2007 derived from the standard and environmental macroeconomic frameworks quite clearly shows presence of an environmental capacity constraint which was not recognized. As such, the rate increases during the earlier parts of the study period might have been unwarranted. Instead various efforts to enhance environmental capital capacity might have been order. The case for this argument is illustrated in Figure-3.

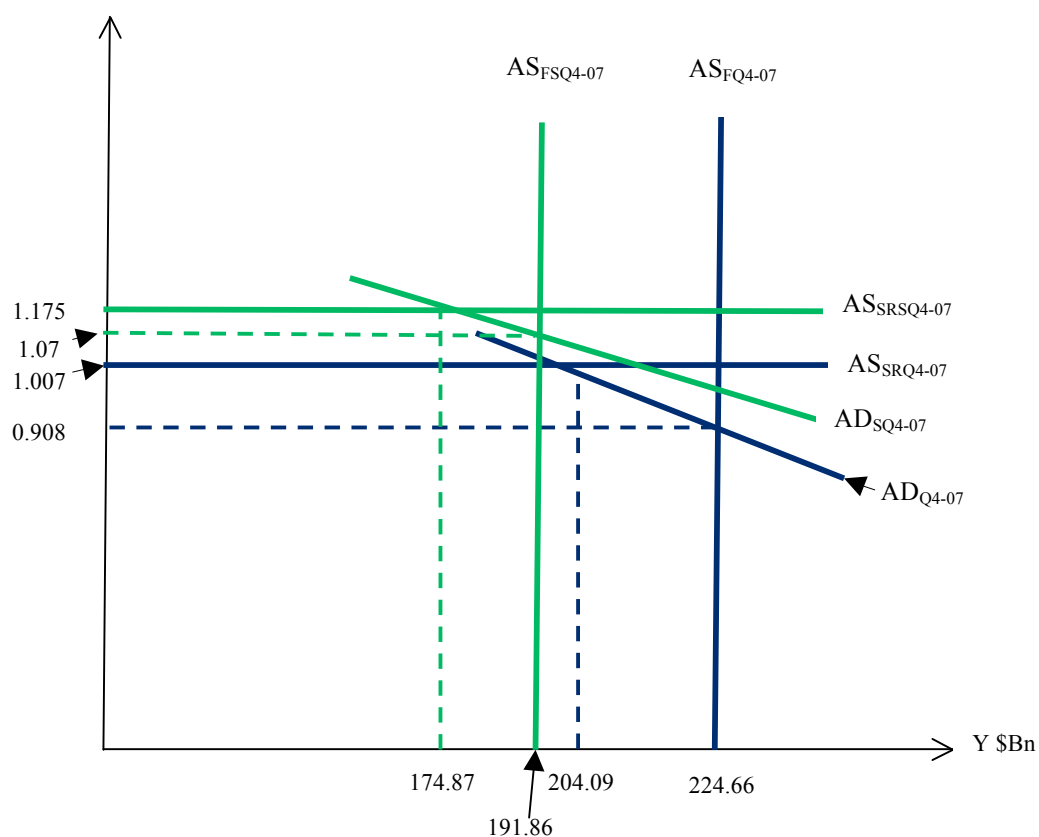


Figure-3: Snap-Shot of AS-AD Framework (Q4-2007)

Note that the observed level of Y in the standard framework ($Y_{Q4-07} = \$204.09$ Billion) exceeds the capacity level of Y in the environmental macroeconomic framework, namely ($Y_{FSQ4-07} = \$191.86$ Billion). That is, KN capacity is an unrecognized driver of inflation. A closer scrutiny of Table-2 reveals that ($Y_t > Y_{FS_t}$) for all time periods considered here. Further, the analysis here has been confined to CO₂ pollution abatement. The capacity restriction would undoubtedly be more stringent had all

other sources of *KN* degradation such as toxic contamination of land and water resource systems and loss of *KN* endowments due to bush fires and floods were recognized.

Income and Output

It appears that the effects of the GFC were recognized in Australia during Q3-2008 when the observed income paths began their decline. A comparison of incomes (Figure-4 and Table-2B) reveals that the observed income paths for both Y_t and Y_{tS} were in excess of their corresponding expected trajectories until Q4-2008. Subsequent to this period, the observed paths fell below the expected trajectories.

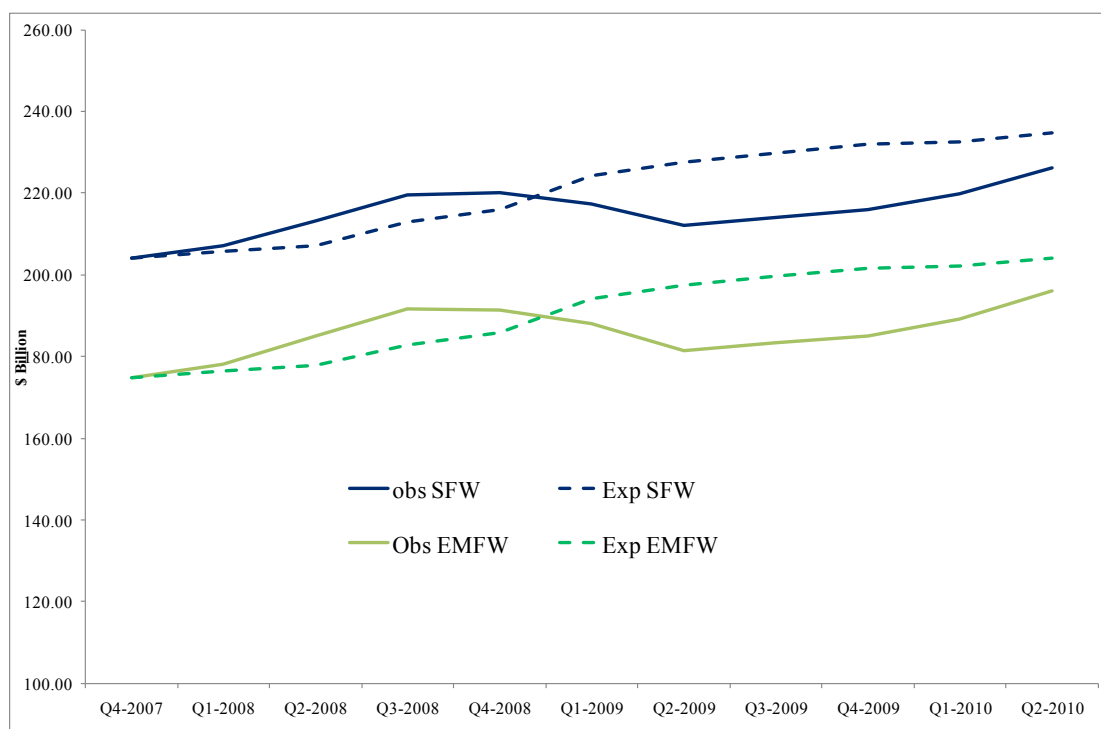


Figure-4: Observed Vs Expected Income Levels (Q1-2007 to Q2-2010)

Despite the activation of the stimulus package and the relaxation of monetary policy, from Q3-2008 onwards, the observed paths had not converged with the expected trajectories. However, the decline in Y_t that was prompted by the GFC had not propelled it below Y_{tS} or even the corresponding expected trajectory of Y_{tS} . The rescue measures were put in place well before this could happen. Had policy planning been premised on environmental macroeconomic frameworks, the rescue efforts would have

entailed measures pertaining to KN capacity expansion. Besides, rescue measures themselves could have been better articulated towards lifting the paths of Y_{IS} rather than Y_t .

Employment and Wages

Table-3 provides the information on average (quarterly) wages across the eleven quarters considered in terms of both frameworks.

Table-3: Employment and Wages

| Period | W (\$) | W_S (\$) | W_{SF} (\$) | ΔW_S | ΔW_{SF} |
|---------|------------|------------|---------------|--------------|-----------------|
| Q4-2007 | 11772.9273 | 11361.4438 | 9521.978824 | 0.0350 | 0.1912 |
| Q1-2008 | 11694.9590 | 11374.2487 | 9602.308896 | 0.0274 | 0.1789 |
| Q2-2008 | 11718.4033 | 11647.1552 | 9794.653278 | 0.0061 | 0.1642 |
| Q3-2008 | 11938.4172 | 11885.6062 | 10008.79045 | 0.0044 | 0.1616 |
| Q4-2008 | 12067.9129 | 11870.8089 | 9975.876299 | 0.0163 | 0.1734 |
| Q1-2009 | 12539.7857 | 11737.9634 | 9764.203363 | 0.0639 | 0.2213 |
| Q2-2009 | 12679.4267 | 11419.8108 | 9478.866235 | 0.0993 | 0.2524 |
| Q3-2009 | 12770.9192 | 11496.4360 | 9522.469139 | 0.0998 | 0.2544 |
| Q4-2009 | 12774.9384 | 11498.1882 | 9537.93904 | 0.0999 | 0.2534 |
| Q1-2010 | 12636.9522 | 11553.2272 | 9647.728997 | 0.0858 | 0.2365 |
| Q2-2010 | 12703.2361 | 11831.4068 | 9848.855817 | 0.0686 | 0.2247 |

The final two columns portray the percentage reduction in wages that is required for compliance with the outcomes of the environmental macroeconomic framework in terms of prevailing employment (ΔW_S) and full employment (ΔW_{SF}). This reduction ranges between 0.44 to 9 percent for prevailing employment and 19 to 25 percent for the attainment of full employment. Quite clearly the wage reductions required for compliance with both sustainability and full employment are substantial. However, such wage reduction across the board may not be pertinent in the context of some serious distributional issues in Australia raised by Atkinson and Leigh (2006); for

example, the richest 10 percent held nearly 31 percent of national income in 2002. The implication of the analysis here is the need for exploring the feasibility of a wages policy that combines distributional and sustainability concerns.

IV CONCLUSION

As illustrated above, relative to the environmental macroeconomic framework, the application of the standard macroeconomic framework over-states targets and performance. This was illustrated above with reference to:

- The persistence of inflation despite the opposing methods of intervention and the near correspondence between the observed levels of inflation with the levels identified by the environmental macroeconomic framework; and
- The inability of the stimulus to deliver on expected income and employment targets.

The limited effectiveness of the stimulus can be also explained by recourse to the multiplier. For example, the multiplier for consumption expenditure in the context of the standard macroeconomic framework is certainly larger than that of the

environmental framework; that is, $\left\{ \frac{1}{(1 - \beta(1 - \tau))} \right\} > \left\{ \frac{1}{(1 - \beta(1 - \tau)(1 - \eta))} \right\}$.

Further, the use of the environmental macroeconomic framework would prompt the search for policy initiatives that target the goal of sustainability. Such initiatives would focus on minimizing the extent of environmental capital depreciation; and examples of these include: the development of renewable and low green house emission technologies instead of further exploration for fossil fuels; and the promotion of innovative closed-loop production systems that reuse wastes and emissions. As indicated, there is also a need to revisit the subject of wage policy because wage reductions can help attain sustainable income and employment targets. However, such

reductions must take cognizance of distributional issues. Finally, environmental macroeconomics may not be as empty as Daly (1992) suggests.

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APPENDIX

Table A-1: (d/dt) Values for Pertinent Variables and Coefficients
(Based on quarterly data Q1-2001 to Q2-2010)

| Variable or Coefficient | (d/dt) |
|-------------------------|--------|
| λ_t | 0.998 |
| θ_t | 1.002 |
| α_t | 1.004 |
| Φ_t | 1.0015 |
| β_t | 0.996 |
| I_t | 1.0114 |
| G_t | 1.011 |
| M_t | 1.0416 |
| P_t | 1.0076 |
| V_t | 1.0011 |
| KM_t | 1.0125 |
| L_t | 1.0063 |
| L_{Ft} | 1.0054 |
| P_{KMt} | 0.992 |
| $r (+)$ | 1.0517 |
| $r (-)$ | 0.922 |