Essays on weakly sustainable local development in Indonesia

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The sustainable development rule identified by Hartwick [1977] provides a working hypothesis to examine the roles of economic growth, natural resource rents, human capital and financial capital in maintaining sustainable path of development. Such rule has been useful as one among many diagnostics to highlight paths of development of countries in the world and their sustainability. The rule however has never been used to examine and inform paths of development and their sustainability of regions within a country. Hundreds of regions or districts in Indonesia, due to the process of decentralisation in the last decade, have some flexibilities in formulating and pursuing paths of development. These policies have implications on the extraction of natural resource rents, human capital formation and financial capital accumulation at the regional level. These essays will apply Hartwick's rule to examine Indonesia's and the region's paths of development over the last decade. These essays could inform interested policy makers and point to sustainable paths of developments for this country and the regions.

1 Theory of weak sustainability

The main principles of Hartwick's rule can be seen in the simplest set up of a closed economy (see Barbier [2005]). There is an exhaustible stock of natural resource, N, and social welfare is determined solely by broad consumption, C. The main question is: what is the criterion for 'weak sustainability' or for non-declining welfare/consumption over time when development entails depletion of exhaustible natural resources? Crucial to this rule is the conversion of exhaustible natural resource to other forms of capital such as human capital and financial capital. Let natural resource extraction rate be r, all other forms of capital K, its rate of depreciation δ, labour L, and social discount rate ρ. The objective of the economy is to maximise sum of utility $U(C)$ over time,

$$max \int_0^\infty U(C)e^{-\rho t}dt$$

where utility is concave, subject to

$$\dot{K} = F(K, L, r) - C - f(r, N) - \delta K, \dot{N} = -r, K(0) = K_0, N(0) = N_0$$

where $F(.)$ is the aggregate production function and $f(.)$ is the cost of resource extraction. The resulting Hamiltonian is

$$H = U(c) - \lambda(F(K, L, r) - C - f(r, N) - \delta K) - \mu r$$

where λ and μ are the costate variables for capital and natural resource respectively. The first order conditions are $\frac{dH}{dC} = 0$ giving $U_c = \lambda$, and $\frac{dH}{dr} = 0$ giving $\lambda(F_r - f_r) = \mu$. Take $U(C)$ to be linear so that $U(C) = U_c C$. Substituting this into the Hamiltonian while making use of the constraints gives

$$H = U_c C + U_c \dot{K} - U_c(F_r - f_r)r.$$

Take consumption to be the numeraire and let $\frac{H}{U_c}$ be the dollar value of sustainable welfare or sustainable net product, SNP, then the last equation becomes

$$\text{SNP} = \frac{H}{U_c} = C + \dot{K} - (F_r - f_r)r = \text{NNP} - (F_r - f_r)r$$

where NNP is the net national product as conventionally defined in national accounts: i.e. the gross national product less any depreciation in value terms of accumulated capital stock. In the SNP equation, the deduction term $(F_r - f_r)r$ is known as the "Hotelling rent" from exhaustible or non-renewable resource rent extraction. It expresses the value of the amount of the exhaustible resource that is "used up" to produce goods and services in the economy today. The SNP equation shows that a true measure of sustainable net product must account for the depreciation of both the reproducible capital and the exhaustible natural resource.

Hartwick's rule follows simply form this sustainable net product equation. The rule states that the condition for sustaining consumption is that investment in the capital asset must equal the depreciation of the exhaustible natural resource. Sustainable consumption means $dC \geq 0$; thus from the SNP equation, the net growth of capital $\dot{K}$ must exceed or equal the Hotelling rents. Or, all the Hotelling rents must be reinvested in reproducible capital.

A direct measure of weak sustainability criterion called adjusted net savings can be derived from the SNP equation. An accounting relationship for the economy equates gross saving to gross investment: $S = I$. Gross investment accounts for both capital increases and its depreciation: $I = \dot{K} + \delta K$. However, as the SNP equation shows, such conventional account is inadequate unless net savings is adjusted for depreciation in the value of exhaustibel natural resource, in this case expressed in the Hotelling rent. Thus a measure of adjusted net savings S_a becomes

$$S_a = \dot{K} - \delta K - (F_r - f_r)r.$$

The equation for adjusted net savings provides a direct indication of how the economy (regional or national) measures up to Hartwick's rule and the weak sustainability criterion. For instance, $S_a < 0$ implies an unsustainable path of development due to inadequate creation of reproducible capital to offset the depreciation in natural resource.

2 Applications on development and governance

One essay takes up the adjusted net savings equation and use it to examine the development paths of Indonesion regions because most of the regions rely on some forms of natural resource extraction (both point form and diffuse form of natural resource). The idea is not only to identify those regions with positive adjusted net savings but to identify factors sepecific to the regions that can lead to weakly sustainable development. In its analytical implementation, the essay must adjust to the fact that natural resources tend to straddle regional boundaries such as in the case of mineral seams. This straddling across boundaries manifest in a spatial autoregressive process. A model suitable for this application is a spatial autoregressive model [Kelejian and Prucha, 1999]. Moreover, regional specific factor such as the culture of the region may be variably conducive to certain developmental path. Such time-invariant cross-regional factor is likely to be unobserved or unobservable and yet remains important. Including such factor is desirable to arrive at net effects of natural resource and other capital on weakly sustainable development. The spatial autoregressive model will need to be extended. The final applied model is the spatio-temporal autoregressive model with random effects for time-invariant regional factor [Kapoor et al., 2007].

Another essay will focus on the analytical and modelling implications of the Hotelling rent and its conversion to other forms of capital such as human capital. Extraction of such rent and its ultimate conversion are subject to the political economy of Indonesia and the regions. In this essay, aspects of local and national governance will be chosen to highlight the political economy of the regions. These aspects include: political representation, measures of corruption, civil society representation, rule of law and rights of common. Essentially, political economy considerations are seen from the perspective of governance. The question here focus on forms of governance that are effective in extracting rent from natural resource, in avoiding capture of local governments to special interests, and in converting the Hotelling rent to human capital formation.

3 Spatio-temporal models weakly sustainable development

In the spatio-temporal model the data are distributed according to the following

$$y_{it} = X_t\beta + u_{it}$$

where y_{it} denotes the vector of observations of the dependent variable at time t, X_t the matrix of observations of exogeneous regressors in period t, β is the parameter vector, and u_{it} captures the disturbance term. This in turn captures the spatial autoregressive process as follows

$$u_{it} = \omega W u_{it} + \epsilon_{it}$$

where W is the weighting matrix of known constants (related to spatial contiguity), ω is a scalar autoregressive parameter, and ϵ_{it} is innovations in period t.

To allow for innovations to correlate temporally due to time-invariant factor such as regional culture above, the following error-component structure for ϵ is assumed

$$\epsilon_i = (e_T \otimes I_i)\mu_i + \nu_i$$

where μ_i represents the time invariant region specific factor, ν_i contains the error components that vary both spatially and temporally.

References

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