THE SCARCITY OF ENVIRONMENTAL CAPITAL AND ECONOMIC GROWTH: A COMPARATIVE STUDY OF AUSTRALIA AND THE UNITED STATES*

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ABSTRACT

The paper employs a methodology that enables the elicitation of the price and quantity of environmental capital (KN) at an aggregate macroeconomic level. The stock of KN considered here is confined to the air-shed of an economy that gets utilized in the process of economic growth. A time series study of the prices and quantities of KN enables an appreciation of the changing value of nature in economic growth. Despite improvements in the rate of utilization of KN, there is insufficient evidence of decreasing scarcity of KN in the case of both Australia and the United States.

ALL FIGURES AND TABLES ARE AT THE END OF THE PAPER

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1. INTRODUCTION

Widely held views in neoclassical economics are that any advent of scarcity of environmental capital (*KN*) would be offset by advances in technology; (Nordhaus 1972, 1992; World Bank 1992) and hence economic growth could continue unhindered. This concurrence followed the evidence of the declining trend in real world prices of natural resources alongside the display of improvements in productivity indexes that portray advances in technology with reference to the utilization of *KN*. Because world prices may not always adequately indicate scarcity, in this paper, the presence of scarcity is tested by recourse to an alternative methodology that rests on the quantification of *KN* as an aggregate endowment that gets utilized in the formation of national income (*Y*). The central assumption is that, the natural endowments of an economy can be aggregated into stocks as analogues of the stock estimates of manufactured capital (*KM*) that are presented in the statement of national accounts. As indicated below, the estimation of the price of *KN* also depends on the use of a proxy to estimate the payments that accrue to *KN* so that the values reported in national accounts can be adjusted to describe the distribution of *Y* between *KM*, labor (*L*) and *KN*.

2. THE METHOD OF VALUATION

The starting premise is that a Cobb-Douglas factor utilization function in the context of full utilization of resources and constant returns to scale validly describes the distribution of *Y* between manufactured capital (*KM*), labor (*L*) and *KN*; [Hartwick (1978, 1991) and Solow (1986)]:

$$Y = \alpha (KM)^{\theta_s} (L)^{\lambda_s} (KN)^{\eta_s} \qquad (1)$$

Where θ_S, λ_S, and η_S are shares of *Y* accruing respectively to *KM, L* and *KN* and
$(\theta_S+\lambda_S+\eta_S) = 1$ in the context of constant returns to scale.

In the mean time however, the widely used descriptor of *Y* can be discerned from the Income Approach to National Income Accounts (IANA). In this approach *Y* is completely exhausted between two quantities, namely the Compensation to Employees (*CE*) – the sum of payments that accrue to *L*, and Operating Surplus (*OS*) – the sum of payments that accrue to *KM*. Hence the widely cited C-D function that describes the distribution of *Y* between *KM* and *L* is consistent with the definitions contained in the IANA; that is:

$$Y = \alpha(KM)^{\theta_I}(L)^{\lambda_I} \qquad (2)$$

Where θ_I and λ_I are shares of *Y* accruing respectively to *KM* and *L* and
$(\theta_I + \lambda_I) = 1$ in the context of constant returns to scale.

Because in the IANA, *Y* is exhausted between *CE* and *OS*, it follows that in equation (2):

$$\theta_I = \left[\frac{OS}{Y}\right] \qquad (3)$$

and

$$\lambda_I = \left[\frac{CE}{Y}\right] \qquad (4)$$

The subscripts "$_S$" and "$_I$" are introduced above in order to distinguish equation (2) from the premised valid descriptor of Y, namely equation (1).

The contention herein is that the function inferred from the IANA (equation 2) is an inadequate descriptor of *Y* because it does not account for the role *KN* as well as the complete utilization of resources. Given that *KN* plays an explicit role in the

formation of Y (Marshall, 1891; Fisher 1904)[1], it is reasonable to suppose that the payments owing to KN are dispersed within CE and OS. That is CE and OS overstate the payments owing to L and KM respectively. If the payments that need to be made to KN, hereafter denoted as C_{EM}, are determined exogenously by proxy, then the value of η_S in equation (1) can be ascertained; that is:

$$\eta_S = \left[\frac{C_{EM}}{Y}\right] \tag{5}$$

The estimation of θ_S and λ_S from θ_I and λ_I will then depend on how C_{EM} is distributed between OS and CE. A convenient way to perform this estimation would be to assume that the distribution of C_{EM} between OS and CE follows the ratio $[\theta_I{:}\lambda_I]$. However, the contribution to C_{EM} does not come from those who are employed alone. It does emanate from those who are employed as well as unemployed. Hence, the value of λ_I is adjusted downwards to a lower value, say λ_A, by distributing the value of CE amongst the entire labor force as follows:

$$\lambda_A = \frac{CE}{L_F} * L * Y^{-1} \tag{6}$$

Where L denotes the actual number of employed and L_F the size of the labor force. The estimation of θ_S and λ_S now be made on the assumption that: $[\theta_I{:}\lambda_A] = [\theta_S{:}\lambda_S]$. From here it follows that:

$$\lambda_S = \frac{\lambda_A(1-\eta_S)}{(\theta_I + \lambda_A)} \tag{7}$$

Note that in the formulations given above we have two sets of coefficients $[\theta_S, \lambda_S,$ and $\eta_S]$ and $[\theta_I$ and $\lambda_I]$ such that:

[1] That nature is capital was a central premise in Marshall's Principles of Economics and Irving Fisher's conceptual development of a theory of capital rested on the premise that nature is capital.

$$Y = \begin{cases} \alpha[KM]^{\theta_I}\,[L]^{\lambda_I} \\ \alpha[KM]^{\theta_S}\,[L]^{\lambda_S}\,[KN]^{\eta_S} \end{cases} \tag{8}$$

Hence it follows that

$$[KM]^{(\theta_I-\theta_S)}\,[L]^{(\lambda_I-\lambda_S)}\,[KN]^{-\eta_S} = 1 \tag{9}$$

From (9), the size of KN can be defined as:

$$KN = [KM]^{[(\theta_I-\theta_S)/\eta_S]}\,[L]^{[(\lambda_I-\lambda_S)/\eta_S]} \tag{10}$$

From here it is possible to define the price of *KN* for a given period, namely P_{KN} as:

$$P_{KN} = \frac{[\eta_S * Y]}{KN} \tag{11}$$

The point estimates of *KN* and P_{KN} are now illustrated below for Australia and the United States.

3. EMPIRICAL ANALYSIS

The data for the analysis was taken from the following website of the OECD: http://www.sourceoecd.org/content/html/index.htm. This source has time series data on various macroeconomic aggregates for the period 1980 – 2000 and the analysis here is presented for this period. The Income Accounts are used to compile the data on *Y*, *OS* and *CE* at constant 1995 prices. We define *Y* as Gross Domestic Product (GDP) less Net Taxes (NT). The size of *KM* is computed in constant 1995 prices using the perpetual inventory method (OECD 1992). This method makes use of the data on Gross Capital Formation and the Consumption of Fixed Capital that are presented in the Expenditure Accounts. The pertinent macroeconomic aggregates that have been used here are displayed in Table-1.

As per the discussion above, the estimation of KN and P_{KN} rests on the estimation of C_{EM}. Owing to the ready availability of data for the estimation of costs of air pollution abatement at the national level, we equate C_{EM} to these costs and confine our definition of KN to the air-shed of the economy. Although our proxy value for C_{EM} is most likely to be an under-estimate, it serves at least as an illustration for applying the methodology that has been advanced here.

A proxy for the valuation of air quality in air-sheds can be drawn from the work of Hartman, Wheeler and Singh (1997) as part of the Industrial Pollution Project of the World Bank. Using scientific data and a range of approximations, it is possible to estimate the quantities of key pollutants that would emerge from energy consumption of economies that are typically dependent on fossil fuels. These pollutants, namely NO_X, SO_2, CO, CO_2, and Particulates, are regarded as important because of their impacts on the productivity of economic systems. The World Bank project also identified abatement costs for the emissions of these pollutants. This information has been used to estimate the value of C_{EM} as the sum of the pollution abatement expenditure for each year from 1980 to 2000 for the two countries; (Please see Table-2).

The information on C_{EM}, together with the macroeconomic aggregates Y, OS,CE, and L_F enables the estimation of point estimates for the two sets of coefficients [θ_S, λ_S, and η_S] and [θ_I and λ_I]. These in turn enable the application of equations (10) and (11) above for the display of KN and P_{KN} as point estimates; (Table-3 and Figure -1). Following Jorgenson's (1967) theory of capital pricing, P_{KN} has been disaggregated into two components, namely an interest rate (ι_{KN}) and a depreciation rate (δ_{KN}). These component estimates are also presented in Table-3, and the

underlying method of dis-aggregation is presented in the Appendix. Should the scarcity of KN be on the decline, then the point estimates P_{KN} should reveal a distinct downward trend. Such a trend is not observed for both the United States and Australia. Instead, we observe a slightly increasing trend for P_{KN} and its components (ι_{KN} and δ_{KN}) over the past twenty years. This increase is more pronounced for the United States than for Australia.

The point estimates can be now used in testing the co-existence of improved efficiency of resource usage and increasing resource scarcity. The improved efficiency of resource use can be examined by recourse to the following ratios $\left[\frac{KN}{Y}\right], \left[\frac{KN}{KM}\right], and \left[\frac{KN}{L}\right]$, (each of which exposit the amount of KN that is utilized respectively by one unit of Y, KM and L). All three ratios display distinct downward trends for the United States, whilst such a downward trend is explicit in the case of Australia only for $\left[\frac{\mathrm{KN}}{\mathrm{Y}}\right]$; (Table-4 and Figure-2) For comparative purposes, the trend on the amount of KM that is utilized by a unit of Y, that is, $\left[\frac{KM}{Y}\right]$ is also included in Table-4 and Figure-2. It is quite evident that the rate of improvement in the utilization of KN has been far better than that of KM. For example, in the case of Australia, the rate of improvement in the utilization of KN with reference Y is on average around 0.19 units per year. That is, on average between successive years, each unit of Y requires 0.19 less units of KN. This rate of improvement for KM is only around 0.075 units per year. For the United States, the rate is far more significant for KN, namely an improvement of 0.31 units per year and is somewhat modest for KM, namely 0.025 units per year. A closer examination

of total factor productivity (α in Table –3) reveals that both countries have averaged approximately a one percent improvement over the past twenty years. These trends give clear support for the existence of technological improvements with reference to resource use.

These price trends do not also sit well with the generalizations of Nordhaus (1973, 1992) who estimated the real relative price of minerals with respect to labour. His observation was that the relative price of minerals had fallen over 70 year period (1900 to 1970). As indicated earlier, similar observations of declining trend were made by the World Bank (1992) on the long-run prices of nonferrous metals between 1900 and 1991. In our study, the ratios of P_{KN} with the price of KM (P_{KM}) and wages (W), that is, $\left[\frac{P_{KN}}{P_{KM}}\right]$ and $\left[\frac{P_{KN}}{W}\right]$ does not display a significantly decreasing trend. Instead, the unit value of KN relative to that of KM and L has been increasing; Table-3 and Figure-3.

However, the price analyses of the Nordhaus-World Bank vein suffer from at least two shortcomings. First, the price estimates had not accounted for the value of environmental amenities and services. For example, the extraction of a tonne of coal does not merely involve labour and capital. Such extraction involves the clearing of forests, the loss of ecological systems, and the possible contamination of ground and surface water systems. Had the costs of these environmental externalities been included, it is possible that the trend in relative prices may have been different. It is this shortcoming that we have addressed in this paper. Our analysis shows that over a 20 year period the real price of the air-shed increased by at least 15 percent for both countries; (Table-2)

The second shortcoming is that the Nordhaus-World Bank price trend analyses assumed the world market for natural resources to be competitive. This is hardly the case. Most resource producers are developing countries, and most resource buyers are the industrial countries. Michael Todaro's (2001) cogent discussion reveals that nearly ninety percent of the resources are used up by either industrial countries or powerful corporations within such countries. In other words, the decline in resources prices is also due to the monopsony type purchasing behaviour of the industrial countries. The declining price trends might not have been as dramatic as perceived by the World Bank (1992) had the imperfect competition aspect been recognised and shadow prices used.

Given the above limitations of the previous scarcity analyses, it is pertinent to conclude that the claim of declining natural resource scarcity in the context of resource conserving technological change can be tenuous to say the least.

5. CONCLUSIONS

A simple analytic framework for the valuation of KN at the aggregate level has been presented here. As indicated, these values can be estimated directly from the national accounts with the aid of some simplifying assumptions. This is clearly advantageous in the context of sparse data for environmental variables. At the same time the analysis provides useful information for economic planning at the national level in at least two ways. First, it has been possible to determine the relative importance of KN in terms of its size and price. For example, the air-shed was worth nearly 8% of national income in 2000 in both Australia and the United States.

Second, the evidence of real natural resource scarcity despite the possible existence of associated technological advances implies that the mitigation of resource scarcity should occupy an important component of natural resource management. Because our case of KN is an air-shed, the trends of P_{KN} and associated relative price ratios show clearly that Australia's air-shed is becoming increasingly scarce. Technology might assist us to exist with less of an air-shed. But it might not be able resolve how we could exist without one.

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APPENDIX-2: DISAGGREGATION OF P_{KN} INTO COMPONENTS

In order to disaggregate P_{KN} into its components of an interest rate (ι_{KN}) and depreciation rate (δ_{KN}), we first estimate the price of KM and its components and employ the principle of equivalence as outlined below. Because we use equation (1) as the basis, we denote the price of KM as P_{KMS} and this can be estimated from the adjusted value of operating surplus, namely OS_S. That is:

$$P_{KMS} = (OS_S)/[KM(t)] \qquad \text{(A-1)}$$

The IANA also provides data on the consumption of fixed capital [$KM_C(t)$]. Hence the depreciation rate of KM for any given year can be directly estimated from the IANA as:

$$\delta_{KM} = [KM_C(t)]/[KM(t)] \qquad \text{(A-2)}$$

It is now possible to estimate the interest rate component of P_{KMS} as a rate that is implied from the IANA:

$$\iota_{KM} = P_{KMS} - \delta_{KM} \qquad \text{(A-3)}$$

We now assume that the interest rate of KN can be proportionately adjusted by the ratio $[P_{KN}(t)]/[P_{KM}(t)]$. That is:

$$\iota_{KN} = \iota_{KM} * [P_{KN}(t)]/[P_{KM}(t)] \qquad \text{(A-4)}$$

Hence the depreciation rate of KN can be estimated by making use of our estimates of P_{KN}:

$$\delta_{KN} = P_{KN} - \iota_{KN} \qquad \text{(A-5)}$$

Table - 1: Pertinent Macroeconomic Aggregates

Year	Y (1995 $\$10^6$)		KM (1995 $\$10^6$)		KM_C (1995 $\$10^6$)		L (10^3)		OS (1995 $\$10^6$)		CE (1995 $\$10^6$)	
	AUS	USA	AUS	USA	AUS	USA	AUS	USA	AUS	USA	AUS	USA
1980	286240	4384501	1631653	14202494	48321	553034	6284300	107061	122412	1540472	163828	2844028
1981	292684	4491426	1676094	14653983	49654	579518	6416500	108050	121608	1616038	171077	2875388
1982	285817	4446967	1702403	14939602	50114	601787	6414900	106749	114593	1590480	171224	2856487
1983	301609	4582017	1734482	15265401	52701	603528	6300400	107810	132164	1667939	169445	2914078
1984	313856	4963463	1773088	15790079	54486	613660	6493900	112604	137355	1860645	176500	3102818
1985	327449	5165850	1812554	16275414	58560	637519	6697500	115205	144153	1933746	183296	3232104
1986	337047	5304067	1845518	16738582	62810	665485	6974500	117171	150554	1950569	186493	3353498
1987	353328	5540180	1883350	17192873	66081	686181	7128800	120474	163982	2052471	189346	3487708
1988	368749	5824713	1930527	17633231	68669	710689	7181700	123927	174059	2186010	194690	3638702
1989	383662	5951937	1979241	18082454	68784	739633	7716300	126755	176383	2238103	207279	3713834
1990	382921	6036349	2005771	18482700	69646	747089	7836600	128341	174428	2234236	208493	3802113
1991	384312	6001167	2023064	18773263	70715	757585	7667900	127080	176822	2218493	207489	3782674
1992	398225	6160752	2046154	19092027	72965	779878	7612200	127238	185641	2264990	212585	3895762
1993	411268	6309815	2073041	19475726	76285	785754	7644800	129770	192213	2327748	219055	3982067
1994	427544	6567182	2108451	19941242	78242	831716	7885500	132799	197197	2459079	230347	4108103
1995	443787	6784000	2140654	20421542	78584	849600	8128200	135672	202687	2577000	241100	4207000
1996	462101	7034965	2177423	20955736	79296	877016	8324200	138018	207453	2718937	254648	4316028
1997	484396	7361741	2219811	21587309	83944	915371	8386600	141184	222131	2882338	262264	4479404
1998	508743	7743053	2270918	22306893	88886	960363	8553100	144309	229452	2997203	279291	4745849
1999	529444	8084094	2322947	23063037	93930	1015407	8747400	146982	240098	3104503	289346	4979591
2000	539798	8461072	2359145	23847657	97472	1068512	9009400	149731	245503	3212591	294295	5248481

Table 2 Point Estimates of C_{EM} from Energy Consumption Data (LCU, 1995 Base Year Estimates)

Year	Energy KwH (10^6)		NO_x ($\$10^6$)		SO_2 ($\$10^6$)		CO ($\$10^6$)		Parts ($\$10^6$)		CO_2 ($\$10^6$)		C_{EM} ($\$10^6$)	
	AUS	USA	AUS	USA	AUS	USA	AUS	USA	AUS	USA	AUS	USA	AUS	USA
1980	808894.69	22996665	68.92	1452.51	54.04	1138.82	28.72	605.20	3.31	69.73	24483.23	515976.18	24638.22	519242.44
1981	813969.49	22449751	69.35	1417.97	54.38	1111.73	28.90	590.81	3.33	68.07	24636.83	503705.06	24792.79	506893.64
1982	848338.11	21532793	72.28	1360.05	56.67	1066.33	30.12	566.68	3.47	65.29	25677.08	483131.29	25839.63	486189.63
1983	836855.55	21496804	71.30	1357.78	55.91	1064.54	29.71	565.73	3.42	65.18	25329.54	482323.80	25489.88	485377.03
1984	878550.46	22567936	74.86	1425.43	58.69	1117.59	31.19	593.92	3.59	68.43	26591.54	506356.79	26759.87	509562.16
1985	918035.95	22489704	78.22	1420.49	61.33	1113.71	32.59	591.86	3.76	68.19	27786.66	504601.50	27962.56	507795.75
1986	920839.39	22568459	78.46	1425.46	61.52	1117.61	32.69	593.93	3.77	68.43	27871.52	506368.51	28047.95	509573.95
1987	959773.66	23303165	81.78	1471.87	64.12	1154.00	34.07	613.27	3.93	70.66	29049.96	522853.11	29233.86	526162.90
1988	994138.67	24332731	84.71	1536.90	66.41	1204.98	35.29	640.36	4.07	73.78	30090.10	545953.49	30280.58	549409.52
1989	1041419.59	24889366	88.73	1572.06	69.57	1232.55	36.97	655.01	4.26	75.47	31521.18	558442.71	31720.72	561977.79
1990	1076440.00	24784224	91.72	1565.41	71.91	1227.34	38.22	652.25	4.40	75.15	32581.16	556083.63	32787.41	559603.78
1991	1083347.94	24805342	92.31	1566.75	72.37	1228.39	38.46	652.80	4.43	75.21	32790.25	556557.46	32997.82	560080.61
1992	1112551.92	25219173	94.80	1592.89	74.32	1248.88	39.50	663.69	4.55	76.47	33674.18	565842.58	33887.35	569424.51
1993	1146129.37	25725541	97.66	1624.87	76.57	1273.95	40.69	677.02	4.69	78.00	34690.49	577203.95	34910.09	580857.80
1994	1153821.91	26250735	98.31	1658.04	77.08	1299.96	40.96	690.84	4.72	79.60	34923.32	588987.74	35144.39	592716.18
1995	1199123.19	26816050	102.17	1693.75	80.11	1327.96	42.57	705.72	4.90	81.31	36294.48	601671.71	36524.23	605480.45
1996	1218763.85	27701510	103.85	1749.68	81.42	1371.81	43.27	729.02	4.99	84.00	36888.95	621538.78	37122.47	625473.28
1997	1328611.88	27832678	113.20	1757.96	88.76	1378.30	47.17	732.47	5.43	84.39	40213.78	624481.79	40468.34	628434.92
1998	1339118.41	27940863	114.10	1764.79	89.46	1383.66	47.54	735.32	5.48	84.72	40531.78	626909.13	40788.36	630877.63
1999	1402247.85	28418439	119.48	1794.96	93.68	1407.31	49.78	747.89	5.74	86.17	42442.56	637624.51	42711.23	641660.84
2000	1417921.49	29106374	120.81	1838.41	94.72	1441.38	50.34	765.99	5.80	88.25	42916.96	653059.71	43188.63	657193.75

Table 3: The Size and Price of KN and Coefficients for Estimation

Year	θ_l		λ_l		θ_s		λ_S		η_s		KN		P_{KN}		ι_{KN}		δ_{KN}	
	AUS	USA	AUS	USA	AUS	USA	AUS	USA	AUS	USA	AUS	USA	AUS	USA	AUS	USA	AUS	USA
1980	0.428	0.351	0.572	0.649	0.407	0.315	0.507	0.566	0.086	0.118	4515189	58039945	0.005	0.009	0.003	0.006	0.002	0.003
1981	0.415	0.360	0.585	0.640	0.397	0.326	0.519	0.561	0.085	0.113	4764521	59329865	0.005	0.009	0.003	0.005	0.002	0.003
1982	0.401	0.358	0.599	0.642	0.386	0.331	0.523	0.560	0.090	0.109	5186775	65615275	0.005	0.007	0.003	0.005	0.002	0.003
1983	0.438	0.364	0.562	0.636	0.432	0.338	0.483	0.556	0.085	0.106	5765514	67068210	0.004	0.007	0.003	0.005	0.002	0.003
1984	0.438	0.375	0.562	0.625	0.429	0.343	0.486	0.555	0.085	0.103	5700645	60996984	0.005	0.008	0.003	0.006	0.002	0.003
1985	0.440	0.374	0.560	0.626	0.429	0.342	0.485	0.560	0.085	0.098	5671323	60404656	0.005	0.008	0.003	0.006	0.002	0.003
1986	0.447	0.368	0.553	0.632	0.433	0.336	0.484	0.568	0.083	0.096	5573527	61536027	0.005	0.008	0.003	0.005	0.002	0.003
1987	0.464	0.370	0.536	0.630	0.449	0.336	0.468	0.569	0.083	0.095	5616376	59009246	0.005	0.009	0.003	0.006	0.002	0.003
1988	0.472	0.375	0.528	0.625	0.461	0.337	0.457	0.569	0.082	0.094	5998684	56158237	0.005	0.010	0.003	0.007	0.002	0.003
1989	0.460	0.376	0.540	0.624	0.438	0.336	0.479	0.570	0.083	0.094	5432495	55130631	0.006	0.010	0.004	0.007	0.002	0.003
1990	0.456	0.370	0.544	0.630	0.435	0.331	0.480	0.576	0.086	0.093	5632927	57089709	0.006	0.010	0.003	0.007	0.002	0.003
1991	0.460	0.370	0.540	0.630	0.447	0.335	0.467	0.571	0.086	0.093	6299946	62951954	0.005	0.009	0.003	0.006	0.002	0.003
1992	0.466	0.368	0.534	0.632	0.458	0.336	0.456	0.571	0.085	0.092	6760556	66875052	0.005	0.009	0.003	0.006	0.002	0.003
1993	0.467	0.369	0.533	0.631	0.462	0.336	0.453	0.572	0.085	0.092	7002249	66202478	0.005	0.009	0.003	0.006	0.002	0.003
1994	0.461	0.374	0.539	0.626	0.453	0.340	0.464	0.570	0.082	0.090	6944518	64315813	0.005	0.009	0.003	0.006	0.002	0.003
1995	0.457	0.380	0.543	0.620	0.446	0.344	0.472	0.567	0.082	0.089	6785807	62943379	0.005	0.010	0.003	0.006	0.002	0.003
1996	0.449	0.386	0.551	0.614	0.437	0.349	0.482	0.562	0.080	0.089	6872501	62978229	0.005	0.010	0.003	0.007	0.002	0.003
1997	0.459	0.392	0.541	0.608	0.446	0.354	0.470	0.561	0.084	0.085	6903842	61681505	0.006	0.010	0.004	0.007	0.002	0.003
1998	0.451	0.387	0.549	0.613	0.440	0.350	0.480	0.569	0.080	0.081	7083885	61666437	0.006	0.010	0.004	0.007	0.002	0.003
1999	0.453	0.384	0.547	0.616	0.440	0.347	0.480	0.573	0.081	0.079	6967140	62464077	0.006	0.010	0.004	0.007	0.002	0.003
2000	0.455	0.380	0.545	0.620	0.437	0.343	0.483	0.579	0.080	0.078	6736251	63382724	0.006	0.010	0.004	0.007	0.003	0.003

Table 4: Measures of Factor Productivity and Relative Prices

Year	α		KN/KM		KM/Y		KN/Y		L/Y		KN/L		P_{KN}/P_{KM}	
	AUS	USA	AUS	USA	AUS	USA	AUS	USA	AUS	USA	AUS	USA	AUS	USA
1980	0.081	0.083	2.767	4.087	5.700	3.239	15.774	13.238	21.955	24.418	0.718	0.542	0.073	0.082
1981	0.080	0.085	2.843	4.049	5.727	3.263	16.279	13.210	21.923	24.057	0.743	0.549	0.072	0.077
1982	0.076	0.084	3.047	4.392	5.956	3.360	18.147	14.755	22.444	24.005	0.809	0.615	0.074	0.070
1983	0.084	0.087	3.324	4.393	5.751	3.332	19.116	14.637	20.889	23.529	0.915	0.622	0.058	0.066
1984	0.085	0.092	3.215	3.863	5.649	3.181	18.163	12.289	20.691	22.687	0.878	0.542	0.061	0.071
1985	0.087	0.093	3.129	3.711	5.535	3.151	17.320	11.693	20.454	22.301	0.847	0.524	0.062	0.071
1986	0.088	0.093	3.020	3.676	5.476	3.156	16.536	11.602	20.693	22.091	0.799	0.525	0.062	0.071
1987	0.092	0.095	2.982	3.432	5.330	3.103	15.896	10.651	20.176	21.746	0.788	0.490	0.060	0.075
1988	0.095	0.098	3.107	3.185	5.235	3.027	16.268	9.641	19.476	21.276	0.835	0.453	0.056	0.079
1989	0.093	0.098	2.745	3.049	5.159	3.038	14.160	9.263	20.112	21.296	0.704	0.435	0.066	0.082
1990	0.091	0.096	2.808	3.089	5.238	3.062	14.710	9.458	20.465	21.261	0.719	0.445	0.067	0.081
1991	0.093	0.096	3.114	3.353	5.264	3.128	16.393	10.490	19.952	21.176	0.822	0.495	0.060	0.075
1992	0.097	0.097	3.304	3.503	5.138	3.099	16.977	10.855	19.115	20.653	0.888	0.526	0.055	0.072
1993	0.099	0.098	3.378	3.399	5.041	3.087	17.026	10.492	18.588	20.566	0.916	0.510	0.054	0.073
1994	0.100	0.101	3.294	3.225	4.932	3.036	16.243	9.794	18.444	20.222	0.881	0.484	0.054	0.075
1995	0.100	0.103	3.170	3.082	4.824	3.010	15.291	9.278	18.316	19.999	0.835	0.464	0.057	0.076
1996	0.101	0.106	3.156	3.005	4.712	2.979	14.872	8.952	18.014	19.619	0.826	0.456	0.057	0.077
1997	0.106	0.109	3.110	2.857	4.583	2.932	14.252	8.379	17.314	19.178	0.823	0.437	0.059	0.076
1998	0.108	0.111	3.119	2.764	4.464	2.881	13.924	7.964	16.812	18.637	0.828	0.427	0.057	0.076
1999	0.110	0.112	2.999	2.708	4.388	2.853	13.159	7.727	16.522	18.182	0.796	0.425	0.059	0.076
2000	0.110	0.114	2.855	2.658	4.370	2.819	12.479	7.491	16.690	17.696	0.748	0.423	0.062	0.077

Figure-1A: Trends of P_{KN} and its Components - Australia

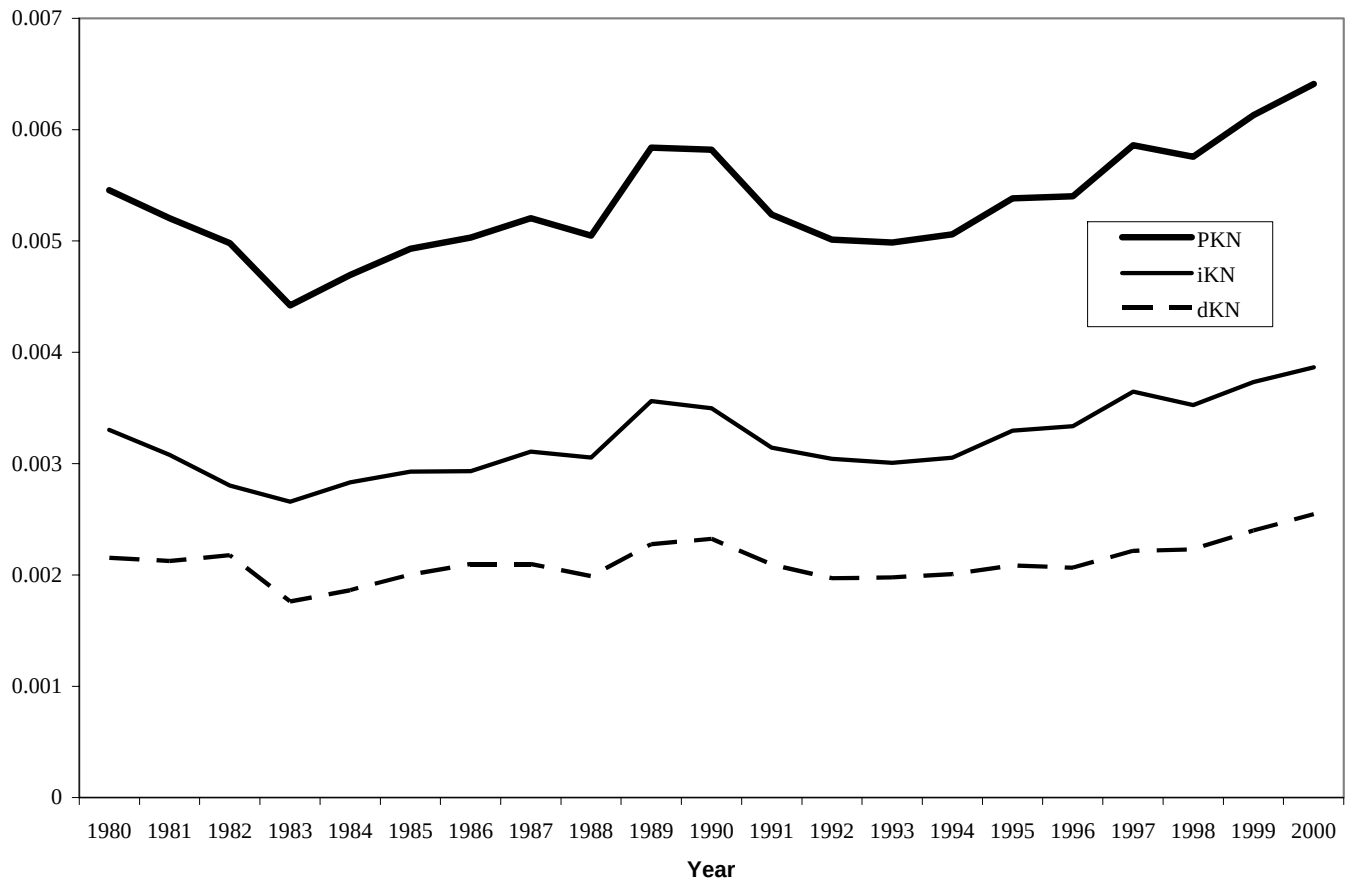

Figure-1B: Trends of P_{KN} and its Components - USA

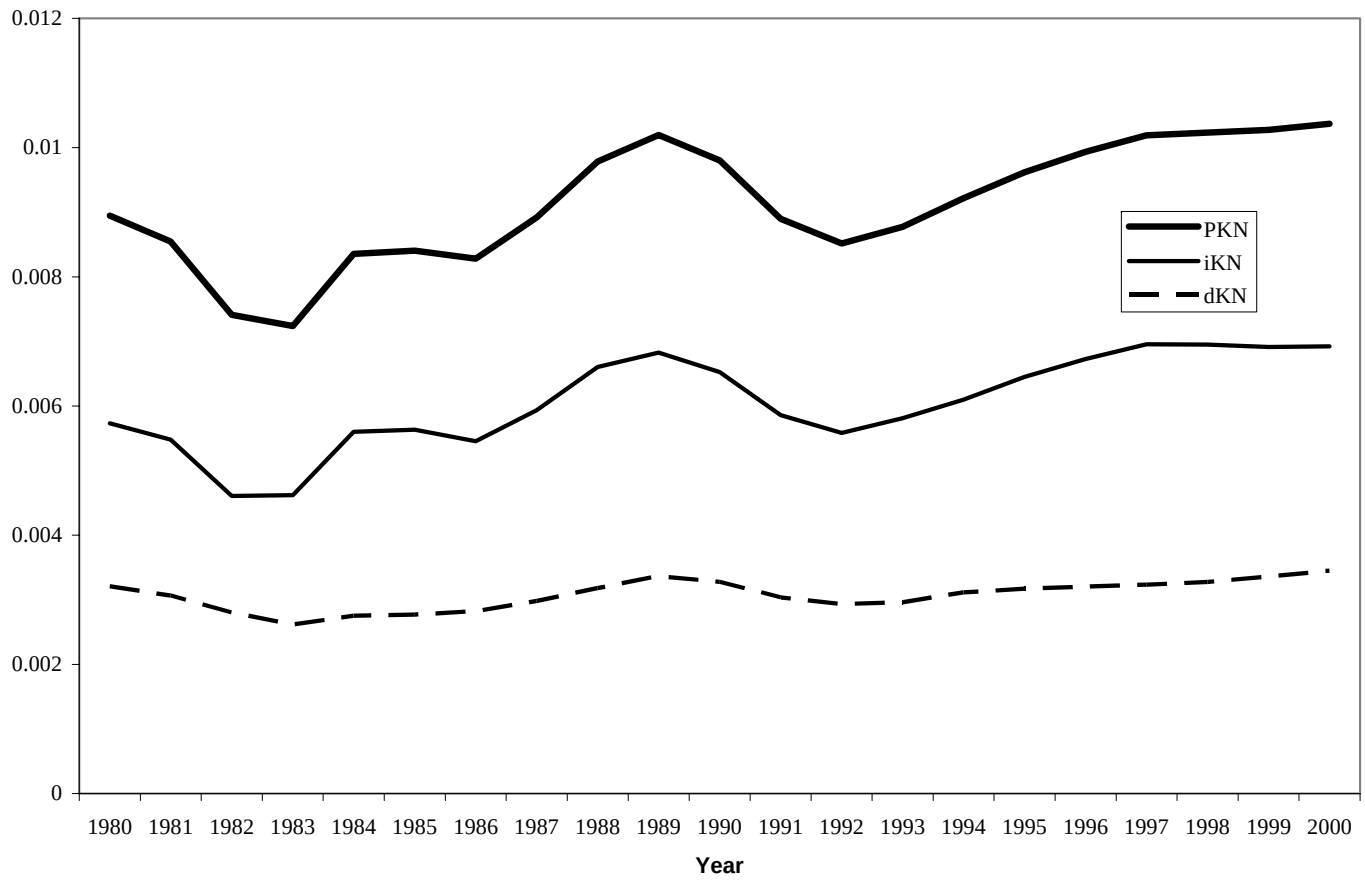

Figure-2A: Trends in Indexes of Productivity Change - Australia

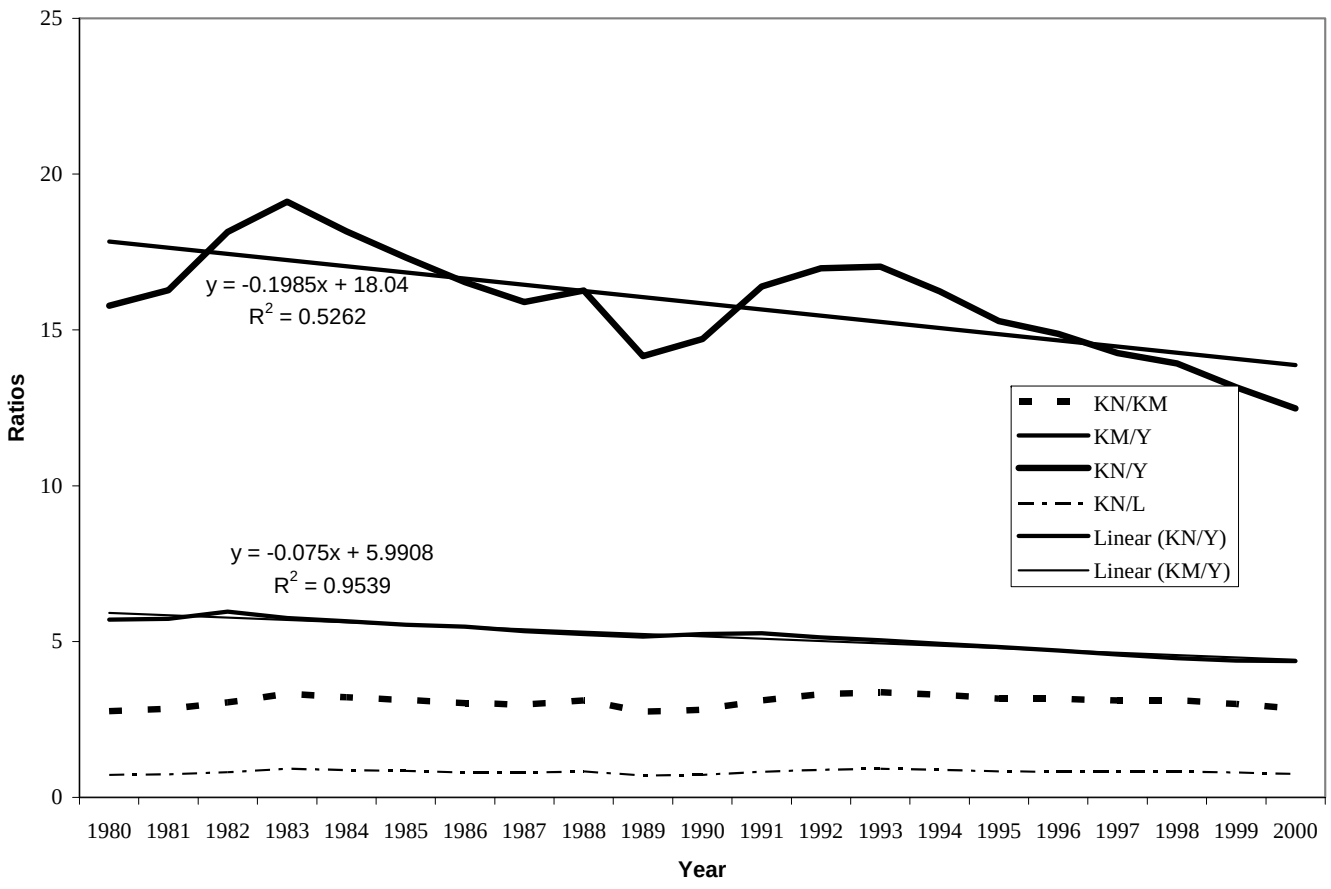

Figure-2B: Trends in Indexes of Productivity Change - USA

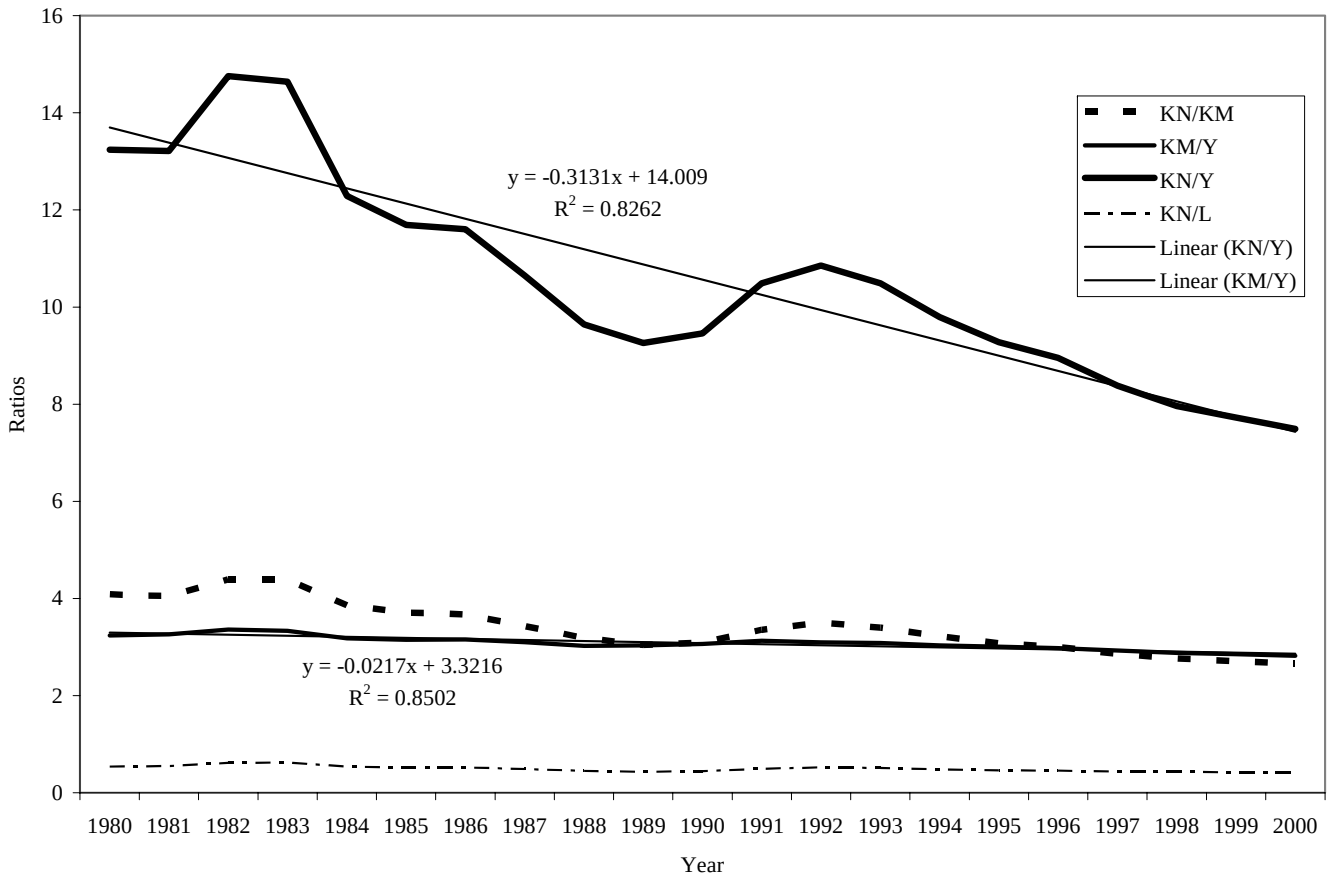
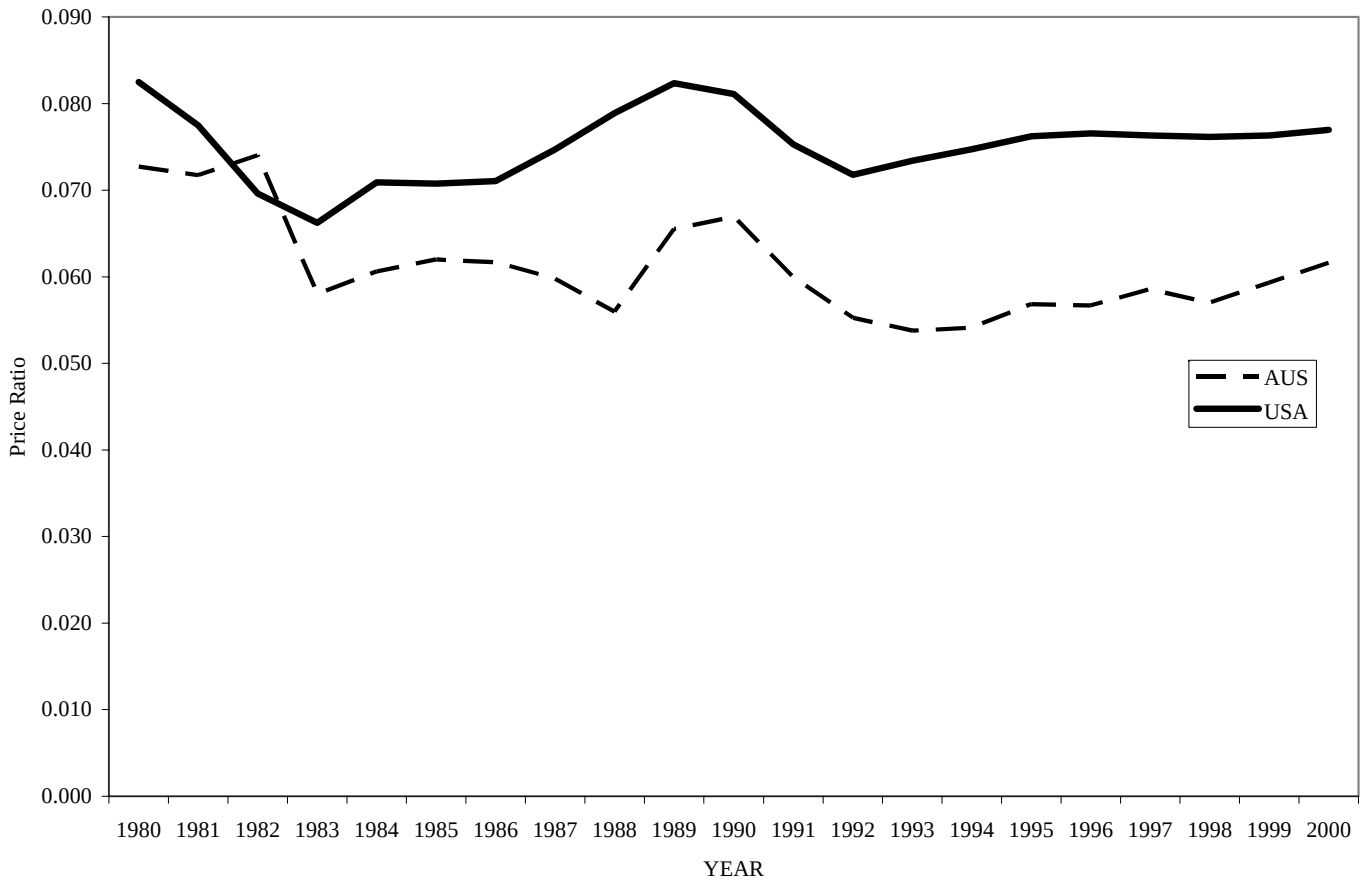
Figure-3: PKN/PKM