IMF *Staff Papers*
Vol. 42, No. 3 (September 1995)

Paradise Lost? Growth, Convergence, and Migration in the South Pacific

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This paper examines the growth experience of nine South Pacific countries during the period 1971–93, using the analytical framework of the Solow-Swan neoclassical growth model, panel data, and Chamberlain's Π-matrix estimator. The speed of convergence of South Pacific countries to their respective steady-state levels of per capita GDP, after controlling for the important regional effects of net international migration, is estimated at a relatively fast 4 percent per year. In addition, private and official transfers emanating from regional donor countries have kept the dispersion of real per capita national disposable income constant over the period, despite a significant widening in the regional dispersion of real per capita GDP. [JEL F22, O47, O56]

IN RECENT DECADES the economies of the independent island nations of the South Pacific have exhibited anemic growth performances. This has occurred against a macroeconomic background characterized by rapidly accelerating external assistance, a relatively high level of investment, a large and pervasive public sector, and an open trading regime. This pattern of slow (and even negative) rates of growth of per capita incomes contrasts with the advances made, particularly in the 1980s, in

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the developing island economies of the Indian Ocean and the Caribbean. Using the analytical framework of the Solow-Swan (1956) neoclassical growth model, this paper examines the growth performance of nine South Pacific nations over the period 1971–93.

These nine countries include seven developing island economies—Fiji, Kiribati, Papua New Guinea, Solomon Islands, Tonga, Vanuatu, Western Samoa—and their developed neighbors, Australia and New Zealand.[1] The latter two economies are included because of their close economic links to the island economies in the areas of trade, exchange rate management, private and public transfer payments, international migration, and private capital flows.

To the best of the authors' knowledge, this paper represents the first formal empirical analysis of growth in the above-named island economies.[2] Moreover, apart from work by De Gregorio (1992) for Latin America, Easterly and Levine (1994) for Africa, and Cohen and Hammour (1994) for several Middle Eastern and North African countries, there has been little work specifically focusing on the process of economic growth in regions containing developing economies.

Two questions are explored in this paper—has there been convergence in real per capita incomes for these island economies over the period 1971–93, and at what speed have these economies converged to their long-run levels of real per capita income? Using an estimation technique that is robust to both the presence of unobserved country-specific effects and to errors in variables in the measurement of real per capita income, the conclusion reached is that, after controlling for investment and migration, the nine island economies have been converging (in terms of real per capita gross domestic product (GDP)) relatively rapidly. Indeed, the island economies have been converging toward their respective steady-state levels of per capita GDP at a speed of about 4 percent per year. This result is interesting as it indicates that, were the poor countries of the South Pacific to attain rates of savings, productivity growth, and population growth similar to those of the rich countries, per capita incomes in the former would grow significantly faster than those in the

[1] The dates of independence of the seven developing island economies were: Fiji (1970), Kiribati (formerly known as the Gilbert Islands, 1979), Papua New Guinea (1975), Solomon Islands (1978), Tonga (1970), Vanuatu (formerly known as the New Hebrides, 1980), and Western Samoa (1962); these are collectively denoted as the PAC7 in this paper. When Australia and New Zealand are added, the group is denoted collectively as the PAC9.

[2] Earlier discussions of the economic problems of South Pacific islands can be found in Shand (1980), Tisdell and Fairbairn (1984), Fairbairn (1985), Guest (1986), Falvey (1986), Smith (1987), Pollard (1987), Browne and Scott (1989), World Bank (1993), and Cole (1993), among others.

latter. In addition, it is found that net private and official transfers have ensured that the dispersion of real per capita national disposable income in the region has remained relatively constant over the period, despite a widening in the dispersion of real per capita GDP.

I. Overview of South Pacific Economies

Although the region does not suffer from levels of extreme poverty, and while all members of the PAC9 are both islands and ex-colonies of European colonial powers, the geographic and demographic differences among them are more readily apparent than the similarities (see Table 1). The PAC9 range from the relatively rich, populous yet sparsely populated Australian continent to the relatively poor, small populations of densely populated atolls such as Kiribati. While they have relatively small land areas, the PAC7 countries possess large sea areas and quite high population densities; they are also characterized by high fertility rates and declining mortality rates. Moreover, the key contribution of international migration in lowering national population growth rates is evident, particularly for the high net emigration countries of Tonga, Western Samoa, and (after 1987) Fiji.

The main economic characteristics of the PAC7 at the time of independence were: a strong reliance on agricultural activity, both in subsistence (fishing, coconuts) and export-oriented (coffee, sugar, and copra) agriculture; high population growth rates, abated somewhat by emigration to New Zealand and Australia; and a lack of diversification in production, which exacerbated the effects of terms of trade shocks in raising the variability of national incomes (Browne and Scott (1989)). In the decades since independence, policymakers in the island economies have maintained a high level of public investment, largely financed from bilateral official grants.[3] Centralized wage determination is still a feature of island labor markets, as is the dominance of public sector employment and public sector activity. Moreover, net current account receipts from services and transfers have grown dramatically since the early 1970s, more than offsetting the islands' ongoing trade deficits, and exchange rates have generally been pegged to those of major trading partners (chiefly Australia and New Zealand). Three additional key influences on the rate of economic growth achieved since independence have been the frequency and severity of natural disasters (cyclones and floods); bouts of

[3] While aggregate investment as a share of GDP has been high for the PAC7 (Table A1), their rates of economic growth have been low. Accordingly, the implicit incremental capital output ratio for the islands must be quite large.

Table 1. *Comparative Demographic and Geographic Indicators*

	1993 population (thousands)	Annualized population growth rate 1971–93 (percent)	Land area (sq. km)	Sea area (thousand sq. km)	Density (persons/sq. km) 1993	Life expectancy at birth (years) 1992	Infant mortality rate (per 1,000 live births) 1992	Total fertility rate (births per woman) 1992
Fiji	771	1.68	18,272	1,290	42	71.5	23.0	3.0
Kiribati	77	2.05	690	3,550	112	58.2	60.0	3.8
Papua New Guinea	3,920	2.[illegible]6	462,243	3,120	8	55.9	54.0	4.9
Solomon Islands	352	3.36	27,556	1,340	13	61.9	43.8	5.8
Tonga	98	0.64	747	700	131	67.9	21.0	3.6
Vanuatu	160	2.96	12,190	680	13	62.7	45.0	5.3
Western Samoa	166	0.60	2,935	120	56	65.5	25.0	4.5
Australia	17,660	1.56	7,713,360	. . .	2	76.7	7.0	1.9
New Zealand	3,460	0.88	270,990	. . .	13	75.7	7.3	2.1

Sources: World Bank (1994); United Nations (1993); IMF staff estimates; South Pacific Commission (1993); and authors' calculations.

political uncertainty; and the emigration of nationals with high stocks of human capital.[4]

The PAC7 countries do face special problems in being among the smallest nations in the world: they have very rapid rates of population growth and are dispersed across wide expanses of the Pacific, relatively distant from major world markets. However, these features should not and do not imply that there is little scope for economic growth. In response to several development issues outlined by de Vries (1973), both Srinivasan (1986) and Cole (1993) have argued that many of the problems allegedly faced by small, isolated island economies (such as a lack of domestic economies of scale, vulnerability to external economic and climatic shocks, remoteness, and lack of access to capital markets) either are not peculiar to them, or can be addressed through appropriate policy measures; they are neither a necessary nor a sufficient barrier to sustained economic growth.[5] Moreover, the growth-enhancing aspects of island economies are not trivial. Relative to other developing countries, the PAC7 have a high level of basic subsistence income; highly educated, well housed, and healthy populations; access to large flows of international transfer payments; and a tradition of conservative macroeconomic management.

Notwithstanding these observations, at first glance economic growth among the PAC7 has been disappointing over the period 1971–93 (Table 2). Annualized real (1990 Australian dollars, A$) per capita GDP growth rates for the full sample period ranged from a low of −2.80 percent for Kiribati to a high of 1.54 percent for Tonga. Figures for 1990 per capita GDP range from a low of A$617 for Kiribati to a high of A$2,483 for Fiji.[6]

The path of the logarithm of per capita GDP (in 1990 A$) is reflected in Figure 1. While per capita income growth has been relatively steady for Australia and New Zealand, the same cannot be said for the PAC7: the collapse in Kiribati's per capita GDP after 1979 (owing to exhaustion of its phosphate reserves) is particularly evident, as is the influence of cyclonic destruction in the per capita GDP falls of Western Samoa in 1990

[4] See Cole (1993) on the effects on economic growth of political uncertainty in Papua New Guinea, Vanuatu and Fiji; resource depletion in Kiribati; and cyclonic damage in the Solomon Islands, Fiji, Vanuatu, and Western Samoa.

[5] See Milner and Westaway (1993) for an empirical test that fails to confirm the alleged growth disadvantages of smallness or remoteness for a sample of developing countries. Elek, Hill, and Tabor (1993) examine the positive impact of outward-oriented macroeconomic policies introduced in Fiji after 1987.

[6] The 1990 average exchange rate of the Australian dollar to the United States dollar (US$) was A$1.00 = US$0.7813.

Table 2. *Comparative Economic Indicators*

	Real GDP (1990 A$ million)[b] 1993	Real GDP per capita (1990 A$)[b] 1993	Annualized per capita real GDP growth rate 1971–93 (percent)[c]	ANZ's[a] percentage of all exports (avg. for 1987–93)	ANZ's[a] percentage of all imports (avg. for 1987–93)	ANZ's[a] percentage of all foreign aid[f] (avg. for 1989–92)	Foreign aid per capita (current A$) 1990	Private transfers as percent of GDP (avg. for 1987–93)	Official transfers as percent of GDP (avg. for 1987–93)
Fiji	1,914	2,483	0.94	25.44	48.84	57.85	15	−1.17	1.77
Kiribati	47	617	−2.80	1.27	30.42	33.38	421	11.44	51.73
Papua New Guinea	5,437	1,387	0.64	25.24	49.60	79.21	127	−2.57	6.34
Solomon Islands	285	811	1.31	4.29	42.12	41.07	174	2.17	17.93
Tonga	172	1,762	1.54	33.72	51.28	60.10	389	21.26	6.26
Vanuatu	216	1,346	−0.32	5.19	30.56	37.18	337	5.92	19.24
Western Samoa	159	976	−0.45	56.39	41.49	57.19	160	32.45	12.09
Australia	399,681	22,632	1.56	5.24[d]	4.43[d]	...	...	0.59	−0.09
New Zealand	56,806	16,418	0.87	18.21[e]	21.04[e]	...	...	1.25	−0.10

Sources: World Bank (1994); United Nations (1993); IMF staff estimates; South Pacific Commission (1993); OECD (1994); IMF, *Direction of Trade Statistics*, and authors' calculations.

[a] ANZ denotes Australia and New Zealand.

[b] Converted at period-average 1990 exchange rates to the A$.

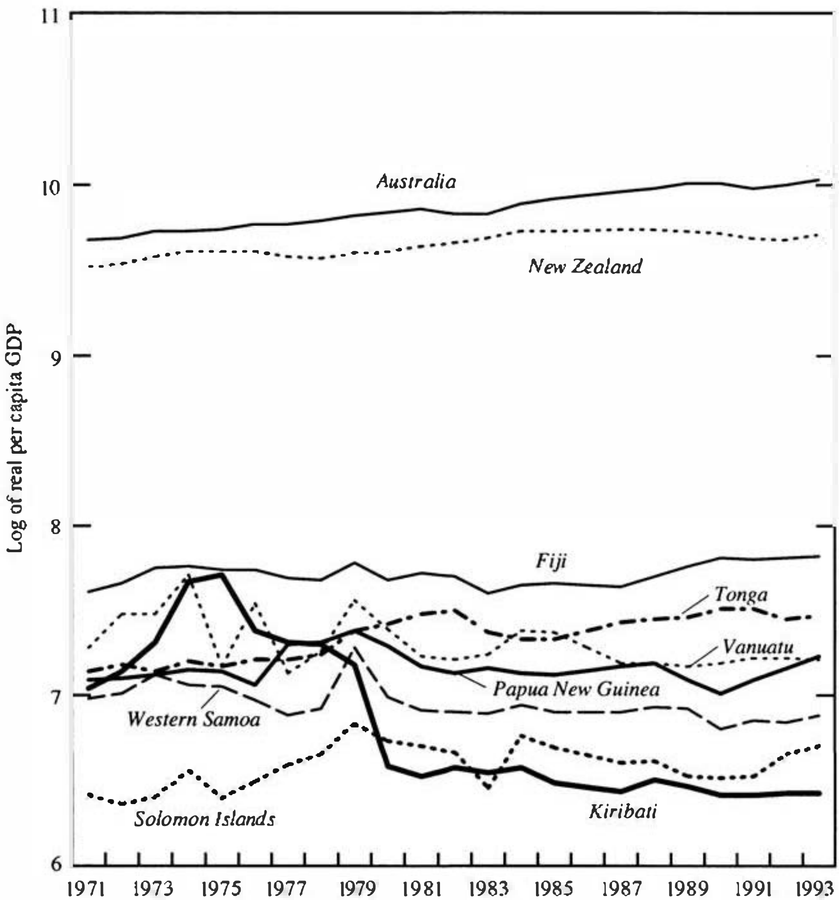
[c] In 1990 A$ terms.

[d] Percentage with respect to New Zealand alone.

[e] Percentage with respect to Australia alone.

[f] Foreign aid is total net official development assistance (ODA), comprising net ODA loans (plus grants) less loan repayments.

Figure 1. *Real (1990 Australian Dollars) Per Capita GDP, 1971–93*



and Vanuatu in 1987, and the effects of the Bougainville political and economic crisis in the per capita GDP fall of Papua New Guinea in 1990.[7] The 1970s was a decade of strong growth performance for the Solomon Islands, which in 1971 was clearly the poorest economy in the PAC7. Moreover, per capita GDP jumped sharply in 1978–79 for all countries

[7]Despite these setbacks, external donors typically increased their aid contributions to more than compensate for any consequent fall in domestic saving and investment (see Section IV).

(apart from Kiribati), reflecting a favorable terms of trade shock arising from high commodity prices for PAC7 exportables. While growth has been relatively slow for all countries in the 1980s, the performance of the Solomon Islands and Papua New Guinea has improved sharply in the 1990s, principally because of higher world prices and greater volumes for their exports of natural resources (particularly timber and minerals).

Private and official transfers as a share of GDP are extremely high when compared with other countries at a similar level of development (Table 2). In the period 1987–93 Kiribati received average annual net transfers equivalent to about 63 percent of its GDP, while the figure for Western Samoa was about 45 percent. Conversely, such transfers were of negligible importance (0.5 percent) for Fiji. It is important to recognize that underlying these totals is the differing contribution of private and official sources: private transfers are the major source of current transfers for the high-emigration countries of Tonga and Western Samoa, while public transfers are of considerably greater relative importance for Kiribati, the Solomon Islands, and Vanuatu.[8]

The PAC7 islands enjoy relatively free access to developed country labor markets in New Zealand and Australia, and migrants' transfers serve to sustain domestic consumption at much higher levels than could be achieved in the absence of migration. Moreover, external assistance to the PAC7 is generous: South Pacific nations are among the highest per capita aid recipients in the world (World Bank (1993)).[9] The percentage share of total net bilateral official development assistance (ODA) provided by Australia and New Zealand (ANZ) is sizable, ranging from a period-average low of 33 percent for Kiribati to a high of 79 percent for Papua New Guinea between 1989–92 (Table 2). ANZ also dominate as sources of PAC7 imports, and are an important destination for exports from some PAC7 countries, (particularly Western Samoa and Tonga), yet relatively unimportant for others (Vanuatu, Kiribati, and Solomon Islands).

[8] See Shankman (1976), Connell (1980), and Brown and Connell (1993) for analyses of migration and private transfers in the South Pacific.

[9] Such external assistance (along with private transfers) can adversely affect the recipient country if it raises the value of its real exchange rate, thus dampening the competitiveness of tradable goods and services—the "Dutch disease" effect of van Wijnbergen (1984). In the South Pacific this real appreciation most commonly occurs because of rising public sector wages in the presence of pegged nominal exchange rates. Private and official transfers to the PAC7 have risen greatly in importance since the early 1970s. For the period 1971–75 they averaged 3.25 and 11.21 percent of GDP, respectively; the corresponding figures for the period 1989–93 were 10.01 and 16.10 percent, respectively.

II. Concepts of Convergence

Barro and Sala-i-Martin (1992a) take a Cobb-Douglas production function in units of effective labor, and a representative consumer with a utility function exhibiting constant intertemporal elasticity of substitution; log-linearize the resultant equations of motion about the steady state; and derive the dynamic equation for the average growth rate of per capita output, y, over any given interval between 0 and T:

$$T^{-1}\ln(y_T/y_0) = (1 - e^{-\beta T})T^{-1}\ln(\hat{y}^*/\hat{y}_0) + g, \qquad (1)$$

where β is the speed of convergence;[10] T is the length of the time interval; $\hat{y}$ is output per unit of effective labor; the asterisk superscript denotes steady-state values; and g is the exogenous rate of labor-augmenting technical progress. In equation (1) convergence is conditional, as what drives β is the level of $\hat{y}_0$ for each economy relative to its *own* $\hat{y}^*$ and g, which need not be homogeneous across economies.

A version of equation (1) that applies for discrete periods for any given economy i gives the geometric average growth rate over the interval $t - r$ and t as:

$$\ln(y_{i,t}/y_{i,t-r}) = C_i - (1 - e^{-\beta r})\ln(y_{i,t-r}) + \epsilon_{i,t}, \qquad (2)$$

where i indexes the economy; r is the length of the observation interval; t is time; $y_{i,t-r}$ is real per capita GDP for each economy at time $t-r$, the beginning of the subperiod; $y_{i,t}$ is real per capita GDP at time t; β is the convergence coefficient; $\epsilon_{i,t}$ is an independent error term; and the country-specific constant is $C_i = g_i r + (1 - e^{-\beta r})[\ln(\hat{y}_i^*) + g_i(t - r)]$. If we had instead assumed (as do Barro and Sala-i-Martin (1992a)) that all PAC9 economies have the same steady-state levels of real per capita GDP and steady-state growth rates (that is, $\hat{y}^* = \hat{y}_i^*$ and $g = g_i$), then C_i would equal C and equation (2) would imply absolute convergence, if $\beta > 0$.

Two measures of convergence follow from equation (2). The first, known as β-convergence, asks whether initially poor economies tend to grow faster than initially rich ones (that is, whether there is mean rever-

[10] For a Cobb-Douglas production function in intensive form, where output per worker is a function of capital per worker, and assuming a constant saving rate (as do Solow (1956) and Swan (1956)), there is a closed-form solution for the convergence coefficient: $\beta = (1 - \alpha)\cdot(g + n + \delta)$, where α is the share of capital in output, n is the rate of population growth, δ is the depreciation rate, and g is the long-term rate of growth of GDP. In the case of a variable saving rate (where saving is a function of the per capita capital stock) and production functions that are not Cobb-Douglas, β is determined not only by α, g, n, and δ, but also by the parameters of preferences and technology.

sion in the level of real per capita GDP across economies). Another concept is σ-convergence, which considers the decline of the cross-sectional dispersion of real per capita GDP over time. That is, it asks whether the standard deviation of the logarithm of per capita GDP (the coefficient of variation) is shrinking across economies over time. Barro and Sala-i-Martin (1992a) note that β-convergence is a necessary but not a sufficient condition for σ-convergence, as a positive β will tend to reduce σ_t (the dispersion of $\ln(y_{i,t})$ in equation (2)) for a given distribution of $\epsilon_{i,t}$, but new exogenous shocks to $\epsilon_{i,t}$ will tend to raise σ_t.

III. Data

We consider the period 1971–93, using data on nine South Pacific countries: Australia, Fiji, Kiribati, New Zealand, Papua New Guinea, Solomon Islands, Tonga, Vanuatu, and Western Samoa. Lack of consistently derived data has previously precluded a detailed analysis of the pattern of South Pacific growth; a relatively long time series of such data has been collected and utilized here for the first time.[11]

The 1971–93 period is, in turn, broken down into five nonoverlapping subperiods with a length of four years each, and the subperiod 1991–93, with two years.[12] The output data used are per capita GDP in constant (1990 A$) prices, derived from: national data on GDP,[13] movements in the national GDP deflator (or consumer price index), midyear population, and average 1990 local currency exchange rates to the A$.[14] Other

[11] The data are largely taken from consistent international sources, to aid in comparability across countries and through time. The major sources are: South Pacific Commission for population, migration, and population density; the IMF and the Asian Development Bank for national income, price deflator, private and public transfers, and investment; United Nations for sectoral shares of GDP: and United Nations and South Pacific Commission for education. See the Appendix for further details.

[12] The maintained hypothesis is that each subperiod is long enough to ascertain those variables that affect long-run growth, without having the results unduly influenced by short-run fluctuations in output induced by movements in the business cycle.

[13] Nominal GDP data for Western Samoa (1971, 1973–74) and Vanuatu (1971–75, 1977–78) were unavailable, and have been estimated using monetary data and an import demand equation, respectively. These values are close to estimates available from alternative sources for isolated years of these subperiods (Shand (1980); Fairbairn (1985)).

[14] All GDP measures are at market prices, except for Western Samoa, which is at producers' prices. As to PAC7 currency conversions: the official currency of Kiribati is the A$; all other island currencies (except that of Papua New Guinea) are currently pegged to a trade-weighted basket of currencies.

variables used in this study include (all for the initial year of each subperiod): *INV*, the share of aggregate investment in GDP; *AG*, the share of GDP emanating from the agriculture, forestry, and fishing sectors; *PRIM*, primary school enrollments as a share of the population aged 5–14; and *SEC*, secondary school enrollments as a share of the population aged 15–19. An additional explanatory variable used is $(1 + MIG)$, which is the subperiod-average annual net migration as a share of the population at the beginning of each subperiod.[15] Estimates of national disposable income for the PAC9 are also derived, by adding data on net private and official unrequited transfers to national data on GDP. Further details on the definition, derivation, and sources of all the variables used in this study can be found in the Appendix. Table A1 presents summary statistics of the above data for each of the PAC9 countries.

It should be kept in mind that measurement of national income in the island developing countries of the South Pacific is likely to involve error because subsistence activity is often inadequately covered in the national accounts. Moreover, differences exist across the island economies in the methods of estimation used and in the extent of monetization of local economies.[16]

Calculations of national income are converted from local currencies to A$; it is well known that conversion at market exchange rates biases downward the true measure of income in developing countries, since the price of nontradables increases as per capita income increases (Balassa (1964), Bhagwati (1984)).[17] However, the difference between the official exchange rate and the purchasing-power-corrected exchange rate should be reduced the more open are the economies under consideration, as trade should then raise the relative price of nontradables. The PAC7 economies are relatively open when compared with others at a similar stage of development. Notwithstanding these caveats, in Section IV we use an estimation technique that is robust to errors in the measurement of per capita incomes.

[15] Unless otherwise denoted, net migration in this paper is synonymous with net immigration.

[16] Officially recorded private transfers may also underestimate the true amounts, given the presence of transfers in kind and/or transfers made through the informal economy, which in both cases occur outside official banking channels (Brown and Connell (1993)).

[17] For example, Srinivasan (1986) uses data from the International Comparison Project (ICP) to reveal that the ratio of the official exchange rate to the purchasing-power-corrected exchange rate is greater for small developing economies than for all developing economies. Unfortunately, ICP-based purchasing-power-corrected GDP data are not available for all years for all PAC9 countries.

IV. Estimation Techniques and Results

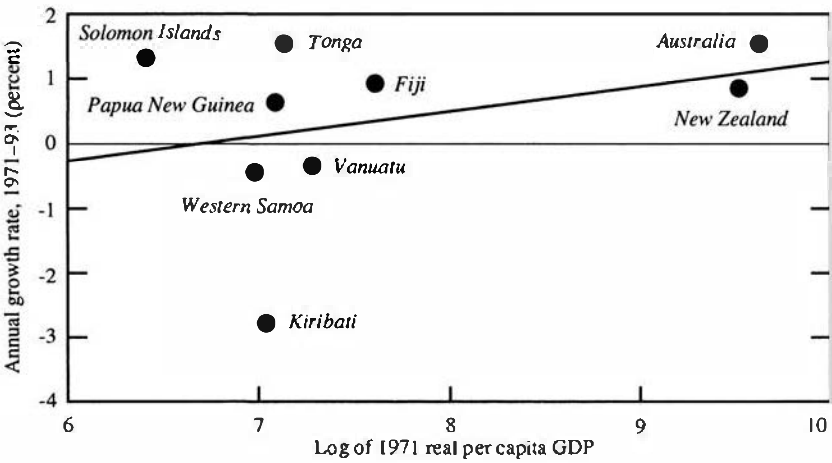
Studies in the empirical growth literature have predominantly been cross-sectional in nature, often using the International Comparison Project (ICP) data of Summers and Heston (1991).[18] Analyses of time-series cross-sectional (TSCS) data in the context of the neoclassical growth model have been previously conducted by De Gregorio (1992), Khan and Kumar (1993), Knight, Villanueva, and Loayza (1993), Keller (1994), and Barro and Lee (1994), among others. Beyond the advantages of TSCS data in increasing the number of degrees of freedom and controlling for the time dimension of the data, its main advantage is that it introduces cross-country heterogeneity in the growth process and allows researchers to control for any potential bias resulting from measurement error in the lagged dependent variable ($\ln(y_{i,t-\tau})$). Controlling for measurement error in per capita income is particularly important given that, as we noted in the previous section, the quality of national income data varies across the PAC9 countries. This section begins with an examination of the relationship between initial income and subsequent growth, and the relationship between initial income and net migration. It then analyzes the results from TSCS estimation of β-convergence in the Solow-Swan (1956) model, and concludes by reviewing the extent of σ-convergence across the PAC9 over the period 1971–93.

Initial Real Per Capita GDP, Subsequent Growth, and Migration

Figure 2 presents the relationship between $\ln(y_{1971})$ and the geometric average rate of growth of per capita incomes between 1971–93: the positive relationship between them indicates β-divergence for the PAC9 countries (the simple correlation between initial income and growth is 0.323). Figure 3 plots the same variables, but excludes Australia and New Zealand, which are highly unlikely to display preferences and technology similar to those of the relatively homogeneous PAC7, and hence are converging to different steady-state levels of per capita income. While Kiribati appears to be an outlier with a period-average per capita growth rate of over −2.5 percent per annum, the resulting inverse relationship

[18]See the studies by Dowrick and Nguyen (1989), Barro (1991), Barro and Sala-i-Martin (1992a and 1992b), Mankiw, Romer, and Weil (1992), Coulomb and Lee (1993), and Cashin (1995), among others. For a critique of such regressions see Levine and Renelt (1992).

Figure 2. *Convergence of Real Per Capita GDP Across Nine South Pacific Countries: 1971 GDP and 1971–93 GDP Growth*

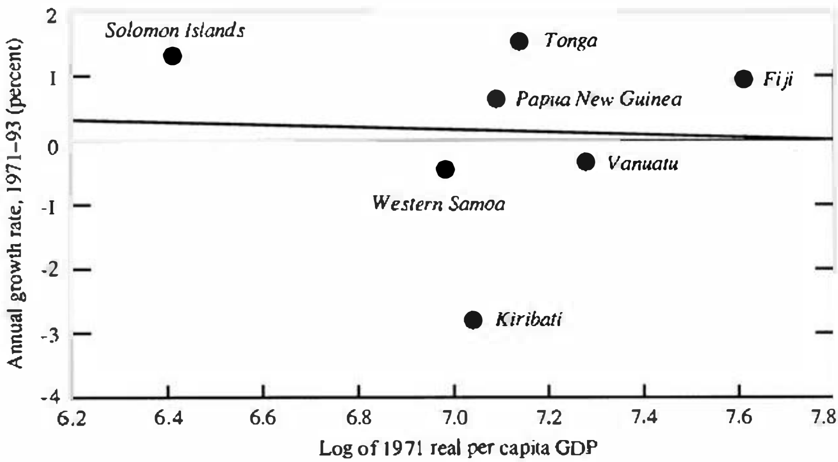


between $\ln(y_{1971})$ and per capita income growth between 1971–93 indicates β-convergence: the simple correlation between them is −0.057. Similarly, Figure 4 displays the long-term relation between the annual rate of net migration between 1971–93 and $\ln(y_{1971})$. The positive association is evident, with the simple correlation between the two of 0.479. As expected, both Western Samoa and Tonga are outliers, with below-average initial incomes and very high net emigration rates of over 1.5 percent per year. Little net migration has occurred in the Solomon Islands, Kiribati, Vanuatu, and New Zealand between 1971–93.

Did the Initially Poor Island Economies Grow Faster than the Initially Rich Ones?

In this subsection we will examine the speed with which the members of the PAC9 approached their respective steady-state levels of per capita GDP, over the period 1971–93. We present two methodologies: the first uses standard time-series cross-sectional estimators (pooled least squares, fixed and random effects), while the second uses Chamberlain's Π-matrix estimator, which, as we will explain below, corrects the deficiencies inherent in the standard estimators. Three key assumptions are made in using either methodology: (1) the speed of convergence is similar across the PAC9 economies, conditional on $\hat{y}^*$ (the steady-state level of

Figure 3. *Convergence of Real Per Capita GDP Across Seven South Pacific Countries: 1971 GDP and 1971–93 GDP Growth*



per capita output); (2) the explanatory variables *INV* and $(1 + MIG)$ condition appropriately for $\hat{y}^*$; and (3) the explanatory variables are exogenous to the dependent variable (the rate of economic growth).

Pooled Least Squares, Fixed (FE) and Random Effects (RE) Estimators

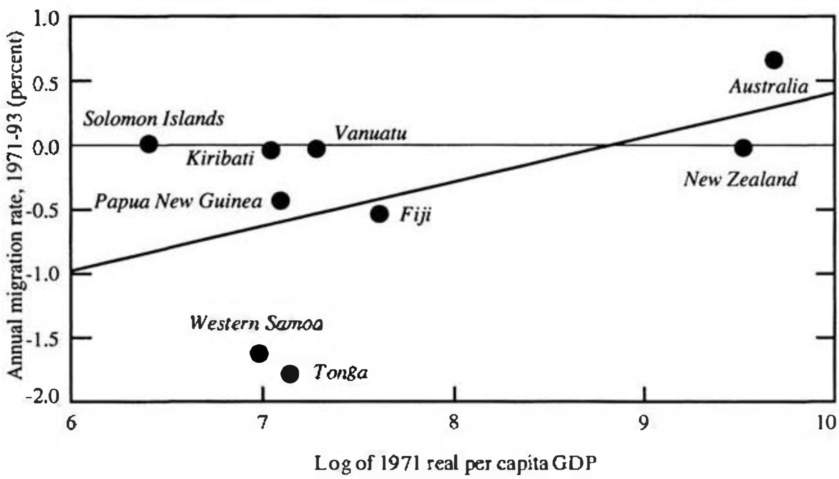
For the countries of the PAC9 and for the five subperiods, ordinary least squares (OLS) regression estimates of equation (2) based on the pooled TSCS data yield the results given in column (1) of Table 3. The dependent variable is the change in the natural log of real per capita GDP over the subperiod $(\ln(y_{i,t}/y_{i,t-r}))$, and the independent variables are an overall constant term and the natural log of real per capita GDP in the initial year of each subperiod $(\ln(y_{i,t-r}))$, where r is the length of each subperiod.[19] The value of the coefficient on $\ln(y_{i,t-r})$ is 0.014 and is not significant, though it implies a value for the speed of convergence of −0.32 percent per year, that is, β-divergence.[20]

This result is not surprising, given that we have not controlled for the

[19] Serial correlation is likely, given the presence of a lagged dependent variable in equation (2), and so all OLS, FE, and RE regressions are estimated with autoregressive (AR1) errors.

[20] The formula for the speed of convergence is: $\gamma = -(1 - e^{-\beta \bar{r}})$, where γ is the value of the parameter on initial income and $\bar{r}$ is the average length of the subperiods in years. Accordingly, $\beta = -(\ln(1 + \gamma)/\bar{r})$, where $\bar{r} = 4.4$ years.

Figure 4. *Net Migration and Initial Real Per Capita GDP: 1971–93*



differing steady states of the developed and developing South Pacific countries.[21] The speed of convergence is relatively faster using FE (column (2)) and RE (column (3)) estimation: β-convergence is observed, at implied speeds of 1.04 and 0.21 percent per year, respectively. While a likelihood ratio (LR) test of the null hypothesis of a constant intercept for all countries is rejected (LR = 35.581, p-value = 0.00001), both the Lagrange multiplier (LM) and Hausman tests argue in favor of the RE model over OLS and FE (Table 3).[22]

When $\ln(INV_{i,t-r})$ is included to control for likely differences in steady states across the PAC9 (column (4)), RE is again the preferred specification, yielding β-divergence, with an implied speed of −0.27 percent per year. The coefficient on $\ln(INV_{i,t-r})$ is found to be positive and statistically significant.[23] Similarly, when $\ln(1 + MIG_{i,t-r})$ is added to capture the

[21] Pooled OLS also assumes that all PAC9 countries have the same level of efficiency in utilizing their factors of production.

[22] Because of the quasi-first-differencing that results from AR1 estimation, the interpretation of the LR statistic is problematic.

[23] Both $\ln(PRIM)$ and $\ln(SEC)$ were tried as variables controlling for the potentially disparate steady states of the developed and developing country members of the PAC9, but yielded disappointing results. This was most likely due to the inability of such measures to control adequately for the differing quality of education stocks across countries. In some regressions $\ln(AG)$ was also added to control for the differing sectoral compositions of the PAC9 countries, but again yielded disappointing results.

Table 3. *Regression Results for the South Pacific, 1971–93*
(Dependent variable is $\ln(y_t/y_{t-r})$)

Variable	(1)	(2)	(3)	(4)	(5)
Constant	−0.132 (0.505)		0.092 (0.383)	0.134 (0.545)	0.195 (0.736)
$\ln(y_{t-r})$	0.014 (0.761)	−0.045 (1.235)	−0.009 (0.376)	0.012 (0.438)	0.0054 (0.188)
$\ln(INV_{t-r})$				0.137 (2.093)	0.133 (2.041)
$\ln(1 + MIG_{t-r})$					1.268 (0.397)
β	−0.0032	0.0104	0.0021	−0.0027	−0.0012
LM Test [p-value]			11.653 [0.0006]	14.056 [0.0002]	12.333 [0.0004]
Hausman Test [p-value]			1.786 [0.181]	0.000 [1.000]	1.107 [0.775]
Autocorrelation of error (ρ)	−0.448	−0.115	−0.103	−0.133	−0.137
Number of observations	45	45	45	45	45
Estimation method	OLS(AR1)	FE(AR1)	RE(AR1)	RE(AR1)	RE(AR1)

Notes: The regressions use time-series cross-sectional (TSCS) techniques to estimate equations of the form

$$\ln(y_{i,t}/y_{i,t-r}) = C_i - (1 - e^{-\beta r})\ln(y_{i,t-r}) + \text{other variables},$$

where $y_{i,t-r}$ is real (1990 A$) per capita GDP in country i at the beginning of each subperiod; $y_{i,t}$ is real per capita GDP at time t; r is the length of each subperiod; C_i is a country-specific constant term; "other variables" are $\ln(INV_{i,t-r})$, the share of investment in GDP for country i at the beginning of each subperiod, and $\ln(1 + MIG_{i,t-r})$, each subperiod's average annual net migration into country i as a share of country i's population at the beginning of each subperiod. See Section III and the Appendix for further details. Beneath the estimated coefficients are (in parentheses) the associated t-statistics; β is the implied speed of convergence. Lagrange multiplier (LM) and Hausman statistics test the null hypotheses that: the variance of the random disturbance for the ith country observation is zero; and the individual effects are uncorrelated with the other regressors, respectively. The p-value (given in square brackets) for each test statistic corresponds to a χ^2 with 1 (LM, columns (3) to (5)), 1 (Hausman, column (3)), 2 (Hausman, column (4)) and 3 (Hausman, column (5)) degrees of freedom, respectively. All regressions are run with a constant term (except FE), a one-factor (country effects) estimation technique, and an autocorrelated (AR1) error structure (reported as ρ). The TSCS techniques used are pooled least squares (OLS), fixed effects (FE), and random effects (RE).

influence of migration on the process of growth (column (5)), the preferred RE specification yields a coefficient on $\ln(y_{i,t-r})$ that is lower, although it still results in slight β-divergence (at −0.12 percent a year). An additional question concerns the assumed exogeneity of $\ln(1 + MIG_{i,t-r})$. It is possible that a country's per capita growth rate and its net migration rate are jointly determined, which could be underpinning the unexpected results of column (5). This question will be examined further below.

Chamberlain's **Π**-*Matrix Estimator*[24]

Assuming that there is a set of variables $\mathbf{x}_{i,t}$, unobserved country-specific effects, μ_i, and time-specific effects, ξ_t, that appropriately control for the economy's steady-state level and growth rate, we can transform equation (2) into the following regression equation:

$$z_{i,t} - z_{i,t-r} = \boldsymbol{\theta}'\mathbf{x}_{i,t} + \gamma z_{i,t-r} + \xi_t + \mu_i + \epsilon_{i,t}, \tag{3}$$

where $z_{i,t} = \ln(y_{i,t})$, and $\gamma = -(1-e^{-\beta r})$. To emphasize the lagged-dependent-variable nature of growth regression (3), we can rewrite it as follows:

$$z_{i,t} = \boldsymbol{\theta}'\mathbf{x}_{i,t} + (1 + \gamma)z_{i,t-r} + \xi_t + \mu_i + \epsilon_{i,t}, \tag{4}$$

We assume that the set $\mathbf{x}$ consists of the following two variables: $\ln(INV_{i,t-r})$, where INV is the percentage of investment in GDP at the start of the period; and $\ln(1 + MIG_{i,t-r})$, where MIG is the subperiod-average annual net migration into an economy as a percentage of its initial subperiod population. We use the variable $(1 + MIG_{i,t-r})$, a monotonic transformation of $MIG_{i,t-r}$, because in many cases MIG is negative, and thus its logarithm is undefined.

While we assume that the independent regressors, $\mathbf{x}$, are well measured in the data, we do allow for the possibility of errors in variables regarding the lagged dependent variable, $z_{i,t-r}$. Observed output may not correspond to the model's output variable for two reasons. First, output may be poorly measured. Second, and most important, observed output has

[24] There are a number of country-specific factors that may be correlated with investment and migration, but for which we have no available information. Chamberlain's (1984) **Π**-matrix estimator proposes to deal with such effects by replacing them with their respective linear predictors, yielding a system of reduced-form regression equations (given in terms of the exogenous variables). The **Π** matrix itself is a matrix of coefficients of the reduced-form system, and is given in detail in equation (6).

a business cycle and a growth (or trend) component. Since our working model explains only the latter, there is a potential estimation bias. Errors in the dependent variable are a potential source of bias because lagged output is one of the regressors.

Let us consider the following estimation strategy. To account for the time effects we process the data by removing the time means from each variable. Then, we can ignore the ξ_t term and the regression can be fitted without a constant (MaCurdy (1982)).

Least-squares estimation ignoring the country-specific effects and the errors-in-variables problem produces biased estimators. In particular, the estimate of $(1 + \gamma)$ in equation (4) is biased in an unknown direction: measurement error biases the estimate downward, while the country-specific effect tends to bias it upward.

Using the FE estimator (or any other panel-data estimator based on time-differencing) to correct for the country-specific-effects bias is inappropriate. The specific-effects bias disappears, but the downward measurement-error bias tends to worsen; this is due to the reduction in "signal" variance brought about by time differencing. Furthermore, given the presence of a lagged dependent variable, time-differenced estimators by construction create an additional downward bias. Therefore, in general, FE and other time-difference methods underestimate $(1 + \gamma)$. In contrast, the direction of bias in the RE estimator is similar to OLS in that it is ambiguous, despite RE's use of a more efficient variance-covariance matrix than OLS. In RE the downward bias of errors in variables remains, as does the upward bias attributable to the neglect of country-specific effects.

Given the above deficiencies of the standard TSCS estimators in the context of growth regressions, we will use the $\mathbf{\Pi}$-matrix estimation procedure outlined in Chamberlain (1984). This procedure allows us to correct for both measurement-error and specific-effects biases. Chamberlain's $\mathbf{\Pi}$-matrix estimation procedure consists of writing both the lagged dependent variable and the country-specific effect in terms of the independent regressors, thus obtaining reduced-form regressions from which to calculate the coefficient estimates of interest.

In order to use this method, we need to make explicit the restrictions that our model imposes on the $\mathbf{\Pi}$ matrix. After removing the time means, our basic model in equation (4) can be written as

$$z_{i,t} = \boldsymbol{\theta}'\mathbf{x}_{i,t} + (1 + \gamma)z_{i,t-1} + \mu_i + \epsilon_{i,t},$$

$$E(\epsilon_{i,t} \mid x_{i,1}, \ldots, x_{i,T}) = 0, \qquad \text{for} \quad t = 1, \ldots, T. \tag{5}$$

Recursive substitution of the z_{t-1} term in each equation gives

$$
\begin{aligned}
z_{i,0} &= z_{i,0},\\
z_{i,1} &= \theta' \mathbf{x}_{i,1} + (1+\gamma) z_{i,0} + \mu_i + \omega_{i,1},\\
z_{i,2} &= (1+\gamma)\theta' \mathbf{x}_{i,1} + \theta' \mathbf{x}_{i,2} + (1+\gamma)^2 z_{i,0} + [1 + (1+\gamma)]\mu_i + \omega_{i,2},\\
z_{i,3} &= (1+\gamma)^2\theta' \mathbf{x}_{i,1} + (1+\gamma)\theta' \mathbf{x}_{i,2} + \theta' \mathbf{x}_{i,3} + (1+\gamma)^3 z_{i,0}\\
&\quad + [1 + (1+\gamma) + (1+\gamma)^2]\mu_i + \omega_{i,3},\\
&\vdots\\
z_{i,T} &= (1+\gamma)^{T-1}\theta' \mathbf{x}_{i,1} + \cdots + \theta' \mathbf{x}_{i,T} + (1+\gamma)^T z_{i,0} + [1 + (1+\gamma)\\
&\quad + \cdots + (1+\gamma)^{T-1}]\mu_i + \omega_{i,T}
\end{aligned}
$$

$$E^*(\omega_{i,t} \mid \mathbf{x}_{i,1}, \ldots, \mathbf{x}_{i,T}) = 0, \qquad \text{for } t = 1, \ldots, T \text{ and } i = 1, \ldots, N.$$

Chamberlain (1984) proposed to deal with the correlated country-specific effect (μ_i) and the initial condition ($z_{i,0}$) by replacing them by their respective linear predictors (given in terms of the exogenous variables) and error terms, which by construction are uncorrelated with the exogenous variables. The linear predictors are given by

$$E^*(z_{i,0} \mid \mathbf{x}_{i,1}, \mathbf{x}_{i,2}, \ldots \mathbf{x}_{i,T}) = \lambda_1' \mathbf{x}_{i,1} + \lambda_2' \mathbf{x}_{i,2} + \cdots + \lambda_T' \mathbf{x}_{i,T}$$

$$E^*(\mu_i \mid \mathbf{x}_{i,1}, \mathbf{x}_{i,2}, \ldots \mathbf{x}_{i,T}) = \tau_1' \mathbf{x}_{i,1} + \tau_2' \mathbf{x}_{i,2} + \cdots + \tau_T' \mathbf{x}_{i,T}.$$

As we will see below, our panel data consists of four cross sections for the exogenous variables **x** and five cross sections for the variable z; the additional cross section for z is given by the initial condition z_0. Thus, the multivariate regression implied by our model is

$$\begin{bmatrix} z_{i,0} \\ z_{i,1} \\ z_{i,2} \\ z_{i,3} \\ z_{i,4} \end{bmatrix} = \Pi \cdot \begin{bmatrix} \mathbf{x}_{i,1} \\ \mathbf{x}_{i,2} \\ \mathbf{x}_{i,3} \\ \mathbf{x}_{i,4} \end{bmatrix} \tag{6}$$

$$\Pi = [\mathbf{B} + \zeta\lambda' + \phi\tau'],$$

where

$$\mathbf{B} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ \theta' & 0 & 0 & 0 \\ (1+\gamma)\theta' & \theta' & 0 & 0 \\ (1+\gamma)^2\theta' & (1+\gamma)\theta' & \theta' & 0 \\ (1+\gamma)^3\theta' & (1+\gamma)^2\theta' & (1+\gamma)\theta' & \theta' \end{bmatrix}$$

$$\zeta\lambda' = \begin{bmatrix} 1 \\ (1+\gamma) \\ (1+\gamma)^2 \\ (1+\gamma)^3 \\ (1+\gamma)^4 \end{bmatrix} \cdot [\lambda_1' \; \lambda_2' \; \lambda_3' \; \lambda_4']$$

$$\phi\tau' = \begin{bmatrix} 0 \\ 1 \\ 1+(1+\gamma) \\ 1+(1+\gamma)+(1+\gamma)^2 \\ 1+(1+\gamma)+(1+\gamma)^2+(1+\gamma)^3 \end{bmatrix} \cdot [\tau_1' \tau_2' \tau_3' \tau_4'].$$

Since we allow for group-wise heteroscedasticity and correlation between the errors of all regressions, we use the seemingly unrelated regression (SUR) estimator.[25]

Table 4 presents the estimated parameters of equation (5) using Chamberlain's Π-matrix procedure. Of particular relevance is the fact that through the Π-matrix procedure, the endogenous variable ($\ln(y_{i,t})$) is not used in its lagged form as a regressor, and so any related errors-in-variables no longer induce biased parameter estimates. However, when the estimation is done assuming no unobserved country-specific heterogeneity, the upward bias arising from country-specific effects remains. Moreover, the bias is clearly greater when $\ln(1 + MIG_{i,t-\tau})$, as a measure of the contribution of net migration to national population growth, is excluded as a regressor.

The estimates of γ obtained conform to our a priori expectations in two key respects. First, estimates that control for country-specific effects produce lower values for γ (higher values for β) than those that do not (-0.159 (column (9), compared with 0.026 (column (8)). When country-specific effects are controlled for, we move from finding β-divergence (columns (6) and (8)) to finding either insignificant β-divergence (column (7)) or β-convergence (column (9)). Moreover, Wald tests of regressions (7) and (9) strongly reject the null hypothesis that there are no country-specific effects (that the coefficients in the linear predictor of μ_i are all equal to zero, H_0: $\tau_1' = \ldots = \tau_4' = 0$). In analyzing the heterogeneous countries of the PAC9 it is clearly important to control for unobserved, country-specific effects. Indeed, the large difference between the cross-sectional estimates of β found in the literature (which center on $\beta = 0.02$ per year) and our preferred estimate of $\beta = 0.0432$ per year is most likely due to the inability of cross-sectional studies to control for country-specific effects.

[25] In Chamberlain's original papers (1982 and 1984), estimation occurs in two steps: first, estimate the unrestricted Π-matrix coefficients; and second, obtain the coefficients of interest by applying a minimum distance estimator to the unrestricted Π-matrix coefficients. In this paper we directly estimate the parameters of interest from the reduced-form regression (equation (6)), because the two-step procedure requires more degrees of freedom than our data set allows for. Our one-step estimator is asymptotically equivalent to the two-step procedure.

Table 4. *Regression Results for the South Pacific Using Chamberlain's Π-Matrix Procedure, 1971–90*

(Dependent variable is $\ln(y_t/y_{t-r})$)

Variable	(6)	(7)	(8)	(9)
$\ln(y_{t-r})$: γ	0.039 (8.552)	0.092 (0.487)	0.026 (15.619)	−0.159 (1.682)
$\ln(INV_{t-r})$: θ_I	−0.061 (1.416)	−0.0602 (1.421)	0.5883 (2.350)	−0.0991 (10.356)
$\ln(1+MIG_{t-r})$: θ_M			0.709 (1.802)	−15.489 (14.615)
β	−0.0094 (8.7149)	−0.0219 (0.5085)	−0.0064 (15.8191)	0.0432 (1.5410)
Wald Test for no specific effects [p-value]		144.599 [0.000]		28.543 [0.000]
Number of observations	36	36	36	36
Specific effects	No	Yes	No	Yes

Notes: The regressions use Chamberlain's (1984) Π-matrix procedure to estimate equations of the form

$$\ln(y_{i,t}/y_{i,t-r}) = C_i - (1 - e^{-\beta r})\ln(y_{i,t-r}) + \text{other variables},$$

where $y_{i,t-r}$ is real (1990 A$) per capita GDP in country i at the beginning of each subperiod; $y_{i,t}$ is real per capita GDP at time t; r is the length of each subperiod; C_i is a country-specific constant term; "other variables" are $\ln(INV_{i,t-r})$, the share of investment in GDP for country i at the beginning of each subperiod, and $\ln(1 + MIG_{i,t-r})$, each subperiod's average annual net migration into country i as a share of country i's population at the beginning of each subperiod. See Section III and the Appendix for further details. Beneath the estimated coefficients are (in parentheses) the associated t-statistics; β is the implied speed of convergence. As explained in Section IV: γ refers to $-(1 - e^{-\beta r})$, the coefficient on $\ln(y_{i,t-r})$; $\theta' = [\theta_I, \theta_M]$ is the vector of coefficients on the explanatory variables, where θ_I is the coefficient on $\ln(INV_{i,t-r})$ and θ_M is the coefficient on $\ln(1 + MIG_{i,t-r})$. "Specific effects" refers to allowance for unobserved, country-specific heterogeneity. The Wald test (and associated χ^2 with 4 (column (7)) and 8 (column (9)) degrees of freedom) pertains to a test of the null hypothesis of no country-specific effects; the p-value for this test is given in square brackets.

Second, estimates that use the migration measure as an explanatory variable produce lower values for γ (higher values for β) than those that do not, even after allowing for cross-country heterogeneity (−0.159 (column (9) compared with 0.092 (column (7)). The latter effect is due to omitted variables bias in columns (6) and (7), when compared with columns (8) and (9). The former two regressions suffer from this bias.

given that net migration is an important part of the growth process in the South Pacific and is positively correlated with $\ln(y_{i,t-r})$.[26] Accordingly, the omission of migration in columns (6) and (7) imparts an upward bias to estimates of γ, which means that the estimated β coefficient will be biased downward—it will appear that initially rich regions grow faster (initially poor regions grow slower), so there is no β-convergence.[27] This conforms with our expectations, given the importance of net migration to several of the PAC9 countries, particularly (in declining absolute value) Tonga, Western Samoa, Australia, Fiji, and Papua New Guinea (Table A1 and Figure 4).

The consistent estimate for γ (-0.159) is reported in column (9) of Table 4, and implies a value for β of 0.0432 [p-value = 0.12]. This result is about twice the typical speed of convergence found in the cross-sectional literature (Barro and Sala-i-Martin (1992a and 1992b)). At such a speed divergences from the steady-state level of per capita income are not very persistent: the half-life of convergence (the time it takes for a typical PAC9 economy to move halfway from its actual per capita income level to its own steady-state level) is a relatively fast 17 years.[28] While such a rapid speed of convergence appears at first glance to be favorable news for the relatively poor members of the PAC9, it should be kept in mind that this is the speed of convergence to each country's own steady-state level of per capita income; it is highly unlikely that such a level is the same for Australia and New Zealand as for members of the PAC7.[29]

[26] The simple correlation of $\ln(y_{i,t-r})$ and $\ln(1 + MIG_{i,t-r})$ is 0.372.

[27] Once the omitted variable bias is corrected by the inclusion of $\ln(1 + MIG_{i,t-r})$, the increase in β reported in column (9) contrasts with the effects on β of the inclusion of migration in typical cross-sectional growth regressions. Barro and Sala-i-Martin (1992b), in their cross-sectional study of the speed of convergence for the states of the United States and the prefectures of Japan, argued a priori that the inclusion of migration should reduce the size of the β-coefficient, given that net migration from poor to rich economies is a source of cross-economy convergence of per capita incomes. However, in such cross-regional regressions it is assumed that $C_i = C$ in equation (2); this is not the case in our cross-country estimates of equations (2) and (5), as reported in Tables 3 and 4, respectively.

[28] The formula for the "half-life" (HL) in years is: $HL = \log(1/2)/\log(1 - \beta)$.

[29] As noted in Section II, using the Cobb-Douglas-based closed-form solution for the speed of convergence from the Solow-Swan (1956) model yields $\beta = (1 - \alpha).(n + g + \delta)$. Assuming that $(g + \delta) = 0.04$ (reflecting the slow rate of exogenous technical change in developing countries); letting $n = 0.025$ (replicating the rapid rate of population growth of the PAC9's developing countries); and assuming that $\alpha = 0.35$ (relatively low capital share of GDP for developing economies) yields a figure for β of 0.042, which is similar to the consistent β-estimate of column (9) of Table 4. In addition, the coefficient on $\ln(INV_{i,t-r})$ is negative in columns (6), (7), and (9), which is not consistent with our a priori expectations. This could arise because of negative correlation between

As mentioned earlier, there is the possibility that, since $\ln(1 + MIG_{i,t-r})$ is a subperiod-average measure of net migration, it may be affected by the rate of growth of subperiod per capita incomes. However, using a Hausman test we cannot reject the hypothesis that $\ln(1 + MIG_{i,t-r})$ is exogenous. The Hausman test for endogeneity was carried out by adding the residuals from a regression of $\ln(1 + MIG)$ on a set of independent variables ($\ln(y_{i,t-r})$, $\ln(INV)$, and $\ln(DEN)$, the log of national population density) to the preferred Chamberlain regression (column (9)). The t-statistic on this variable, 0.0018, was not significant (Nakamura and Nakamura (1981)).[30] Our other explanatory variable is not likely to be endogenous, as the share of investment in GDP at the beginning of each subperiod ($\ln(INV_{i,t-r})$) cannot be caused by economic growth over the subsequent subperiod $\ln(y_{i,t}/y_{i,t-r})$.

It is also of interest that the estimated coefficients on initial income obtained using pooled OLS, FE, and RE regressions (reported in Table 3) agree with our predictions for their divergence from the consistent estimates of column (9) in Table 4. Both the pooled OLS and RE estimates of the coefficient on $\ln(y_{i,t-r})$ are biased upward (0.014 and 0.0054, respectively), indicating that for the PAC9, the country-specific bias exceeds the errors-in-variables bias. The FE estimates (−0.045) are biased downward, as expected, because of errors in variables in the dependent variable.

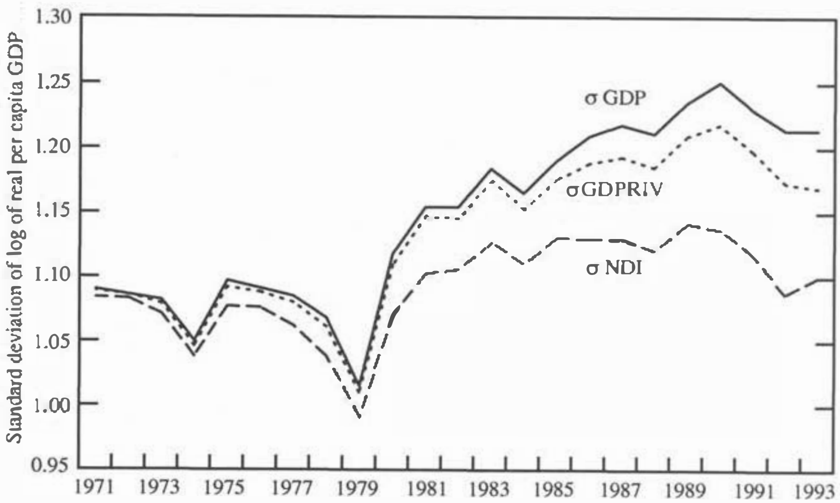
Did the Cross-Country Dispersion of Per Capita Incomes Widen or Narrow?

This subsection examines the absolute convergence of real per capita income across the PAC9; that is, we do not control for the disparate steady states to which the island economies are converging. We do this by estimating the extent of σ-convergence across the PAC9 for the period 1971–93, using as our measure of dispersion the unweighted cross-sectional standard deviation of $\ln(y_{i,t})$, σ_t. Figures 5–8 show the results for three versions of the dispersion of real per capita income across the

$\ln(INV_{i,t-r})$ and the country-specific effects, imparting a downward bias to the coefficient on $\ln(INV_{i,t-r})$. Alternatively, the sign on this coefficient could be correctly picking up the inverse relationship between investment (which is dominated by externally funded public investment) and growth in the PAC7, as previously observed in the literature on South Pacific countries (Browne and Scott (1989), and Cole (1993)).

[30] The R^2 statistics on the instrumenting equations (from which the migration residuals were derived) were: 0.391, 0.392, 0.349, and 0.185, respectively, for the subperiods 1971–75, 1976–80, 1981–85, and 1986–90.

Figure 5. *Dispersion of Real Per Capita GDP: PAC9, 1971–93*

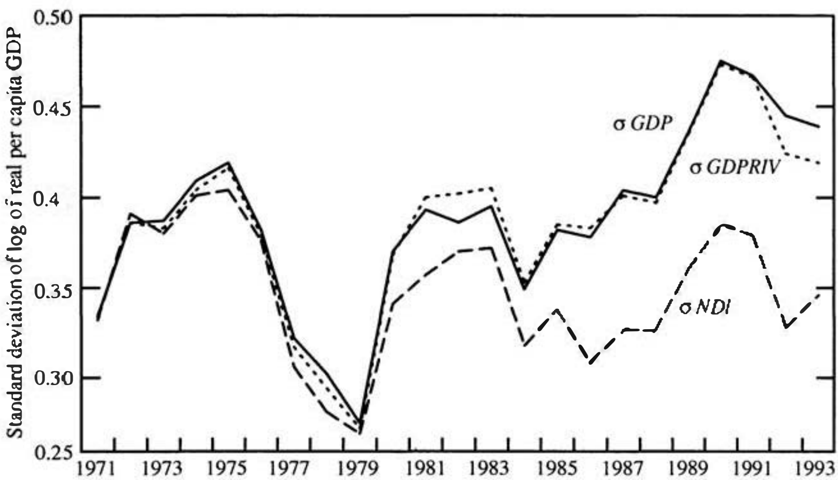


economies: (1) σGDP, the dispersion of real per capita GDP; (2) $\sigma GDPRIV$, the dispersion of real per capita adjusted income (GDP plus net private transfers); and (3) σNDI, the dispersion of national disposable income (GDP plus net private and official transfers).[31] Given the presence of both private and official transfers, which flow from relatively rich to relatively poor economies, it would be expected a priori that the dispersion of per capita income would be greatest for σGDP, followed by $\sigma GDPRIV$, followed by σNDI. For each of the three versions of the dispersal of real per capita income, the countries selected comprise: the PAC9 (Figure 5); the PAC7 (Figure 6); the PAC5: PAC7 less the relatively developed island economies of Fiji and Papua New Guinea (Figure 7); and the PAC4: PAC5 less the atoll microeconomy of Kiribati (Figure 8).

In Figure 5 there is a clear indication of σ-divergence for σGDP over the period 1971–93; there is somewhat less σ-divergence for $\sigma GDPRIV$, and almost no σ-divergence for σNDI. For σNDI, the widest definition of national income, there is only slight σ-divergence over the 1971–93

[31] National disposable income (NDI) represents the total income available to residents of an economy for consumption and saving, excluding any foreign borrowing. However, NDI as measured here differs from the national accounts definition in that there is no allowance for the depreciation of capital stocks or net factor income from abroad.

Figure 6. *Dispersion of Real Per Capita GDP: PAC7, 1971–93*

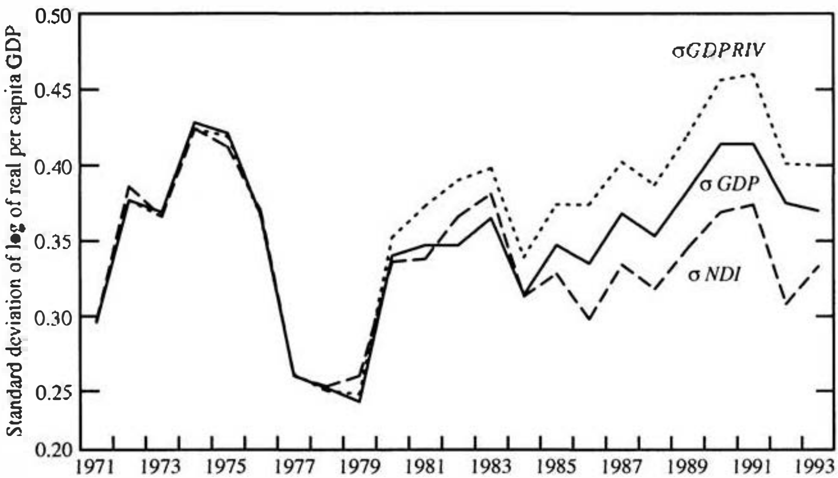


period for the PAC9: σNDI_t rises from 1.084 in 1971 to 1.100 in 1993, after reaching a period high of 1.141 in 1989 and a period low of 1.015 in 1979. For all three measures of σ, the jump in commodity prices in 1979 induced rapid σ-convergence, which was followed by rapid σ-divergence in the early 1980s, slowly rising σ-divergence in the period to 1990, then a resumption of σ-convergence in the early 1990s, as commodity prices recovered. The above results illustrate the sensitivity of incomes in South Pacific countries to fluctuations in their terms of trade.

In a similar manner, σNDI_t for the PAC7 rises from 0.332 in 1971 to 0.346 in 1993, after reaching a period high of 0.404 in 1975, and a period low of 0.269 in 1979 (Figure 6). Indeed, there is σ-convergence for the PAC4 countries (Tonga, Solomon Islands, Vanuatu, and Western Samoa) with respect to σGDP: σGDP_t declined from 0.329 in 1971 to 0.289 in 1993 (Figure 8). Moreover, $\sigma GDPRIV$, $\sigma NDI > \sigma GDP$ after 1977, because of the relatively small receipt of current transfers by the poorest member of the PAC4—the Solomon Islands. Finally, σNDI_t for the PAC4 declines from 0.330 in 1971 to 0.325 in 1993, after reaching a period high of 0.428 in 1972, and a period low of 0.252 in 1978.

While the per capita GDP component of per capita NDI has become more unequal for the PAC9 countries over 1971–93, there has been an increase in net private and public transfers from initially rich economies (Australia and New Zealand) to initially poor economics (the PAC7)

Figure 7. *Dispersion of Real Per Capita GDP: PAC5, 1971–93*

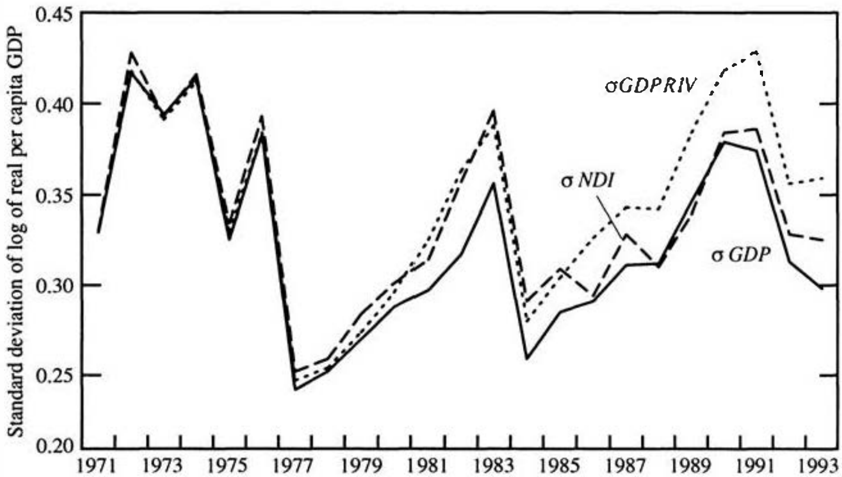


over this same period. The result has been relatively little change in the dispersion of per capita NDI in the South Pacific, as receipts from migrants and intergovernmental transfers have compensated for the widening dispersion of per capita GDP brought about by relatively slow growth in initially poor economies (Figure 5). Whether by accident or design, and particularly since the precipitous fall in the region's terms of trade after 1979, donor countries have varied their migration policies and official transfer payments to maintain the dispersion of PAC9 per capita NDI at about 1.10.[32]

A further useful disaggregation of the data is to examine whether the initially rich PAC7 economies in 1971 (Fiji and Vanuatu) experienced σ-convergence as a subgroup, and whether the initially poor economies (Solomon Islands and Western Samoa) did likewise. The results reveal that while σ-convergence applies for the initially poor economies (σNDI_t falls from 0.280 in 1971 to 0.185 in 1993), there is σ-divergence

[32]Net official transfers to PAC7 countries are likely to affect net migration, to the extent that nationals of countries receiving such transfers are less likely to migrate, and so are less likely to remit private transfers. International transfers of income can also be immiserizing (adversely affecting an economy's terms of trade) if the recipient country has, at the margin, a lower propensity to spend on its main export than the donor country (Bhagwati, Brecher, and Hatta (1983)). However, for most developing countries (including the PAC7) this is unlikely to be the case.

Figure 8. *Dispersion of Real Per Capita GDP: PAC4, 1971–93*



for the initially rich economies (σNDI_t rises from 0.151 in 1971 to 0.189 in 1993).[33]

V. Conclusion

Using time-series cross-sectional data on nine South Pacific countries, this analysis confirms the conditional convergence predictions of the neoclassical growth model (Solow (1956) and Swan (1956)). That is, over the period 1971–90, the nine countries converged on their respective steady-state levels of per capita GDP at the relatively rapid speed of about 4 percent per year. This result is interesting as it indicates that, were the poor countries of the South Pacific to attain rates of savings, productivity growth, and population growth similar to those of the rich countries, per capita incomes in the former would grow significantly faster than those in the latter.

Moreover, during 1971–93 both private and official net transfers, largely emanating from developed countries of the region, acted to prevent a widening of the dispersion of real per capita national disposable

[33] However, there is a caveat to the latter result: σNDI_t was 0.152 in 1991, after having reached 0.218 in 1988. Fiji's relatively better growth performance in 1992 and 1993 increased σNDI_t in those years.

income across the nine countries. However, the dispersion of real per capita GDP, which excludes such transfers, clearly widened over this same period.

The estimation technique used was a methodological improvement over previous work, as it controlled for errors-in-variables bias and unobserved country-specific heterogeneity. We also demonstrated the direction of the biases inherent in parameter estimates emanating from cross-sectional and time-series cross-sectional techniques that erroneously assume that errors-in-variables and country-specific effects are absent from the data.

The developing island economies of the South Pacific clearly have a direct and important role to play in implementing policies that will enhance their rate of per capita GDP growth. At the same time, this analysis reveals that developed countries, through their policies toward official transfers and international labor flows, can ameliorate inequalities in per capita national disposable income across the islands.

APPENDIX

Data Sources and Description of Variables

The basic data used in this study are annual observations for the period 1971–93. This period is, in turn, disaggregated into five subperiods (1971–75, 1976–80, 1981–85, 1986–90, and 1991–93), and some of the data are calculated only for the initial years of each subperiod. All fiscal year data have been converted to calendar years.

The major data sources used were:

IFS—(International Monetary Fund, *International Financial Statistics*)
SPC—(South Pacific Commission, *Statistical Summary*, various issues)
ADB—(Asian Development Bank, *Key Indicators*, various issues)
UN—(United Nations, *Statistical Yearbook for Asia and the Pacific*, various issues)
WB—(World Bank, STARS).

Where the above sources yielded incomplete data, these were supplemented by data from IMF staff estimates, national sources, and interpolation techniques. Country acronyms used here are as follows: Australia (AU), Fiji (FJ), Kiribati (KI), New Zealand (NZ), Papua New Guinea (PNG), Solomon Islands (SI), Tonga (TO), Vanuatu (VA), and Western Samoa (WS).

Country-specific sources of data are as follows:

Y—Nominal GDP at market prices; taken from IFS line 99b for all countries, except for KI (ADB for 1971–87; IMF staff estimates for 1988–93), TO

Table A1. *Summary Statistics of the Data, by Country*

	Average initial per capita real GDP (1990 A$)	Maximum initial per capita real GDP (1990 A$)	Minimum initial per capita real GDP (1990 A$)	Average of sub-period growth rates of real per capita GDP (percent)	Average of sub-period shares of agriculture, forestry, & fishing in GDP (percent)	Average of sub-period shares of investment in GDP (percent)	Average of subperiod primary school enrollments as share of population aged 5–14 (percent)	Average of subperiod secondary school enrollments as share of population aged 15–19 (percent)	Average of subperiod ratios of net migration as share of initial subperiod population (percent)
Australia	18,858.01	21,676.81	16,066.03	1.77	5.42	24.40	71.89	138.74	0.636
Fiji	2,208.87	2,432.83	2,021.22	1.12	20.88	22.48	80.10	56.29	−0.504
Kiribati	870.39	1,606.91	608.15	−1.15	21.78	24.97	85.68	31.20	−0.024
New Zealand	15,395.58	17,138.46	13,569.18	0.89	10.54	24.41	79.82	89.89	0.014
Papua New Guinea	1,219.66	1,302.05	1,164.14	2.04	32.08	27.49	38.53	15.36	−0.443
Solomon Islands	694.56	813.32	608.46	2.44	40.87	24.15	47.02	16.16	0.002
Tonga	1,523.79	1,825.97	1,256.01	1.15	37.73	21.67	70.15	116.73	−1.753
Vanuatu	1,487.25	1,882.23	1,361.47	−1.08	21.02	30.00	65.55	22.64	0.027
Western Samoa	1,013.16	1,077.52	940.15	0.30	44.10	30.80	72.06	86.41	−1.670

Sources: World Bank (1993); Asian Development Bank (1993); United Nations (1993); IMF, *International Financial Statistics*; South Pacific Commission (1993); IMF staff estimates; and authors' calculations.

(Third Development Plan (1976) for 1971–74), VA (calculated from an import demand equation for 1971–75, 1977–78; WB for 1979–81), WS (calculated from the Fisher identity for 1971, 1973–74; Browne and Scott (1989) for 1975–82).

DEF—GDP deflator; taken from IFS line 99bi for all countries, except for KI (ADB for 1971–87; IMF staff estimates for 1988–93), PNG, SI (IFS line 64), TO (ADB for 1971–74), VA (ADB for 1971–75).

POP—Midyear national population; taken from SPC for all countries, except for AU, NZ (IFS line 99z).

INV—Gross fixed capital formation (plus change in stocks) as a share of GDP, for the initial year of each subperiod; taken from IFS line 93e plus 93i, the sum then divided by line 99b, except for KI (ADB for 1972–86: WB for 1992–93), SI (World Bank (1980) for 1971 and 1976; WB for 1981); TO (ADB for 1971–81; World Bank (1993) for 1991); VA (assumed to be the same as FJ for 1971 and 1976; World Bank (1993) for 1981–86): WS (assumed to be the same as FJ for 1971 and 1976; World Bank (1993) for 1981–91).

AG—The share of agriculture, forestry, and fishing in nominal GDP, for the initial year of each subperiod; taken from UN for all countries, except for SI (Solomon Islands (1991) for 1981–91), TO (Third Development Plan (1976) for 1972; National Accounts (1983) for 1971 and 1976), VA (Transitional Development Plan (1978) for 1971 and 1976), WS (Fourth Development Plan (1980) for 1972 and 1978; Fifth Development Plan (1984) for 1981; WB for 1986 and 1991).

PRIM—Children in primary school as a share of all children aged 5–14 years, for the initial year of each subperiod; taken from UN and SPC for all countries, except for KI (Sixth Development Plan (1988) for 1971, 1976 and 1981), SI (British Solomon Islands (1972) for 1971, World Bank (1993) for 1986, 1991), TO (1991 set to equal 1986), VA (1981 set to equal 1978).

SEC—Children in secondary school as a share of all children aged 15–18 years, for the initial year of each subperiod; taken from UN and SPC for all countries, except for SI (British Solomon Islands (1972) for 1971, World Bank (1993) for 1986, 1991), TO (1991 set to equal 1986), WS (1991 set to equal 1986).

DEN—Population density per square kilometer, for the initial year of each subperiod; derived from SPC and WB for all countries.

MIG—Subperiod-average annual net immigration as a share of the population in the initial year of each subperiod; the implied net immigration rate is derived as the difference between the annual rate of population growth and the rate of natural increase (crude birth rates less crude death rates, expressed as a percentage), and is taken from UN and SPC for all countries.

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