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Capital Investment *versus* Utilization in Business Performance and Economic Growth

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ABSTRACT

Critical review of investment-economic performance literatures in economics and strategic management indicates that more capital *investment* does not seem to contribute to higher national economic growth or to higher corporate profitability. Instead, greater *utilization* of capital and human resources does seem to contribute to economic performance.

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I. INTRODUCTION

Attempts to improve business performance and achieve higher growth rates of national product often begin with the factor of investment in capital equipment and associated technology, in part to reduce expensive labor and management inputs. "'Economic growth depends on the accumulation of capital' seems as near a truism as can be found in economic theory," according to Gordon Winston (1974: 1312). This has been the dominant "neoclassical" view of economists and of business and governmental leaders seeking to invigorate business performance and economic growth through capital investment, though recently with qualifications (cf. Council of Economic Advisers, 1983: ch. 4; 2001: 27-29, 43, 182; 2005: ch. 1 and 2; Denison, 1983; Maddison, 2001: 101-3, 125, 131, 136, 139, 142).

An alternate view questions the central position accorded capital investment in models of business performance and economic growth, as well as the ability of managers to make optimal decisions (Simon, 1979). Robert Solow's (1957) analysis over 40 years found only a minor effect of investment on US economic growth, while Simon Kuznets (1973: 258) observed that attempts to account for growth rates in aggregate production models have resulted mainly in an unexplained residual, that is, in a "measure of our ignorance." Edward Denison (1980: 220) found that: "Capital is not *the* source of growth despite the contrary view common in financial circles and on Capitol Hill." Referring to Franke's (1979) cross-national analysis using data from his 1967 book, Denison (1980: 220-1) noted that "whatever relationship does exist results more from the effect of rapid growth on investment than from the effect of investment on growth." This at first seems peculiar, since it is in capital that new technology is embodied and might be expected to contribute to economic performance. But the paradox is explained, according to Denison (1979: personal communication), by the fact that only a relatively small portion of investment embodies new technology from which one might at least learn something and might benefit *eventually*, as in the case of the computer revolution's adverse effects on the financial industry (Franke, 1987) but eventual benefits for the economy as a whole (Brynjolfsson and Hitt, 1998; Franke and Barrett, 2004).

Murray Foss (1981: 58) commented that "the contribution of fixed capital to output growth, while considerable, in a sense has been smaller than commonly thought," while Winston (1974: 1315) warned that "an increase in investment brought about by a policy of low capital prices [as in earlier command economies, or as recently in the United States] may *reduce* the rate of growth by reducing utilization more than investment is increased." Indeed, the World Bank (1996: 2) found for centrally-planned economies that "despite high investment rates—returns to capital formation began a steady and rapid descent in the mid-1950s." Analyzing data from this issue of the *World Development Report*, Franke's (1999) cross-national regression analyses for the 1980s and early 1990s showed *adverse* effects of higher investment on subsequent growth.

Theory and evidence which seem convincing exist for both perspectives: According to some authors, "strong investment is essential to rapid growth" (Council of Economic Advisers, 2001: 43), which was supported cross-nationally by Hagen and Hawrylyshyn (1969), Humphries (1976), Husain (1967), Robinson (1971), and Sommers and Suits (1971). Others expressed reservations, in some cases demonstrating

that magnitudes of capital intensity (capital:labor ratio, sometimes represented by capital:output ratio) and addition to capital stock are not a controlling or even an important positive determinant of business performance or economic growth (Buzzell and Gale, 1987: ch. 7; Clark, 1961; Denison, 1964; 1980; 1983; Franke, 1973; 1975; 1979; 1987; 1999; 2000; 2004; Franke and Edlund, 1992; Hamberg, 1969; Mass and Senge, 1981; Morgan, 1969; Solow, 1957; 1962). Proponents of a dominant role for investment show great impact of more investment upon economic growth even for samples much like those used to demonstrate no impact. These are directly opposing findings about a central issue of business and economic behavior, calling for incisive analysis if we are to suggest ways to obtain better business and national economic performance.

We seek to discover how conflicting findings could have been obtained using similar data and analytical procedures. This critical review and further analysis evaluate national economies since the mid-1800s, and especially over the past half-century, to see whether or not greater capital investment does lead to greater rates of economic growth. This work raises strategic and operational issues, both for business organizations and for public policy, about whether increasing capital intensity might aid profitability and growth, and whether policies of downsizing and outsourcing are likely to be successful beyond short-term reduction of labor costs. Above all, this analysis implies a shift of emphasis in strategies for improving profitability and economic growth, away from a central focus on higher capital intensity and greater capital investment and toward more effective utilization of capital and labor.

In section II, examination of the data used in the two conflicting sets of studies suggests that differences of *relative* time period in which investment and growth are measured explain most of the differences in investment-growth correlations obtained. Furthermore, since time periods up to six years for investment and economic growth data might well be too short to allow reliable interpretation, data for two half-century periods also are analyzed, including period-to-period investment-growth correlations as well as contemporaneous calculations. In section III, measures of industrial investment growth *rates* are calculated for nine nations, to replace the crude *ratios* of investment to national product employed in all other studies. Cross-national correlations of these investment growth rates with growth rates of real gross domestic product per capita are presented for various periods and time lags. In section IV, cross-national and time-series U.S. analyses examine regression effects of economic growth upon capital investment and capital utilization to demonstrate the importance of *using* capital to achieve economic performance. Finally, in the discussion and conclusion of sections V and VI, those relationships which do seem to exist among capital investment and intensity, capital utilization, and business performance and economic growth are summarized and interpreted. A more *capitalistic* focus appears to have social benefits including increased employment, consumption, and demand as well higher economic growth rates and higher profitability of capital.

II. CONFLICTING EVIDENCE

Five cross-national studies support strongly the role of greater investment in promoting more rapid economic growth—Hagen and Hawrylyshyn 1969; Humphries 1976; Husain 1967; Robinson 1971; and Sommers and Suits 1971. All five studies relate

investment ratio ($\Delta K/Y$, where ΔK = capital change or investment and Y = GNP) to economic growth rate ($\Delta Y/Y$) for relatively large samples of nations during the post-World War II period. The results are relationships which are uniformly positive, strong, and significant. For example, Summers and Suits obtained a Pearson correlation coefficient of .52 ($p < .001$) for 67 nations in relating investment ratio (gross fixed capital investment as percent of gross national product) to the 1960-66 growth of GNP per capita.

In sharp contrast, a number of empirical findings from studies during the same era dispute the theory that greater investment leads to greater economic growth. Daniel Hamburg (1969: 473) concluded from his review of eight cross-sectional analyses and one time-series analysis that they show "little connection between investment ratios and growth rates." Similar conclusions were drawn by Johnson and Chiu (1965) and by Theodore Morgan (1969: 397-8), who pointed out that "low correlation does not disprove the existence of causation, nor would high correlation prove it. What is proved is that any causation between conventional investment and measured income growth was (in these countries, for these periods of time, and granting the data are reasonably accurate) unimportant compared to other influences."

Contrast between the two sets of findings is stark: Investment seen as the primary factor in economic growth *versus* as an insignificant or at most secondary factor. An initial attempt at resolution was provided by Sommers and Suits (1971: 126-127), who in reflecting upon the contrast between Hamberg's and their own results suggest that "the most important source of difference in results is merely the size of the samples employed." Sommers and Suits also applied their investment and growth data selectively to the smaller samples of nations used in several of Hamberg's analyses. In each case they obtained a significant correlation where Hamberg showed none. Thus the contradiction remains, illuminated rather than resolved by Sommers and Suits' replications. Resolution must be sought through examination of further differences between studies which show conflicting evidence regarding the benefits of greater investment.

A. The Time Dimension

Several studies exploring factors in economic performance have stressed the importance of attention to *time lags* where effects reasonably can be expected to take some time to occur (Barrett and Franke, 1970; Franke, 1974; 1999; 2005; Franke and Barrett, 1975; 2004; Franke, Edlund, and Oster, 1990; Greene, 1973; Kenny, 1979; also see comments on direction of causation by Denison, 1967: 121; 1980). In the common investment-economic growth model, the primary *causal relationship* would seem to require that capital investment take place prior to at least some of the period for which economic growth is measured, so that sufficient time is allowed for construction, start up, and the beginning of production and sales. Although the need to allow for time was noted by Denison, explicit attention to time lags generally has been neglected, but can be addressed for cross-sectional data using Lazarsfeld's technique of cross-lagged panel analysis (Blalock 1985) and for time-series data using Campbell and Stanley's (1966) "quasi-experimental" approach from psychology and "Granger analysis" (Granger 1969) from econometrics.

When time lags are examined in the studies which show significant investment ratio-economic growth relationships, it generally is found that investment data are for periods *following* the periods of economic growth by averages of several years. Thus these significant correlations show that greater economic growth is followed by—rather than follows upon—greater investment:

For example, Sommers and Suits (1971) related cross-nationally growth of per capita gross national product over 1960-66 to gross capital formation as a percentage of GNP during 1966, for an average investment-to-economic growth time lag from 1966 to 1963 of *minus* three years. The time lag in Humphries' (1976) study averages *minus* 1½ years, and that in Husain's (1967) study *minus* 4½ years. In other cases of significant relationship, investment period and economic growth period are *concurrent*: Robinson's (1971) growth of GNP over 1958-66 was related to investment ratio for the average of the six years of 1957-59 and 1965-67. But our correlations of this economic growth rate with investment ratios--separately for 1957-59 and for 1965-67--show significance for the latter investment period only, with a time lag averaging *minus* four years.

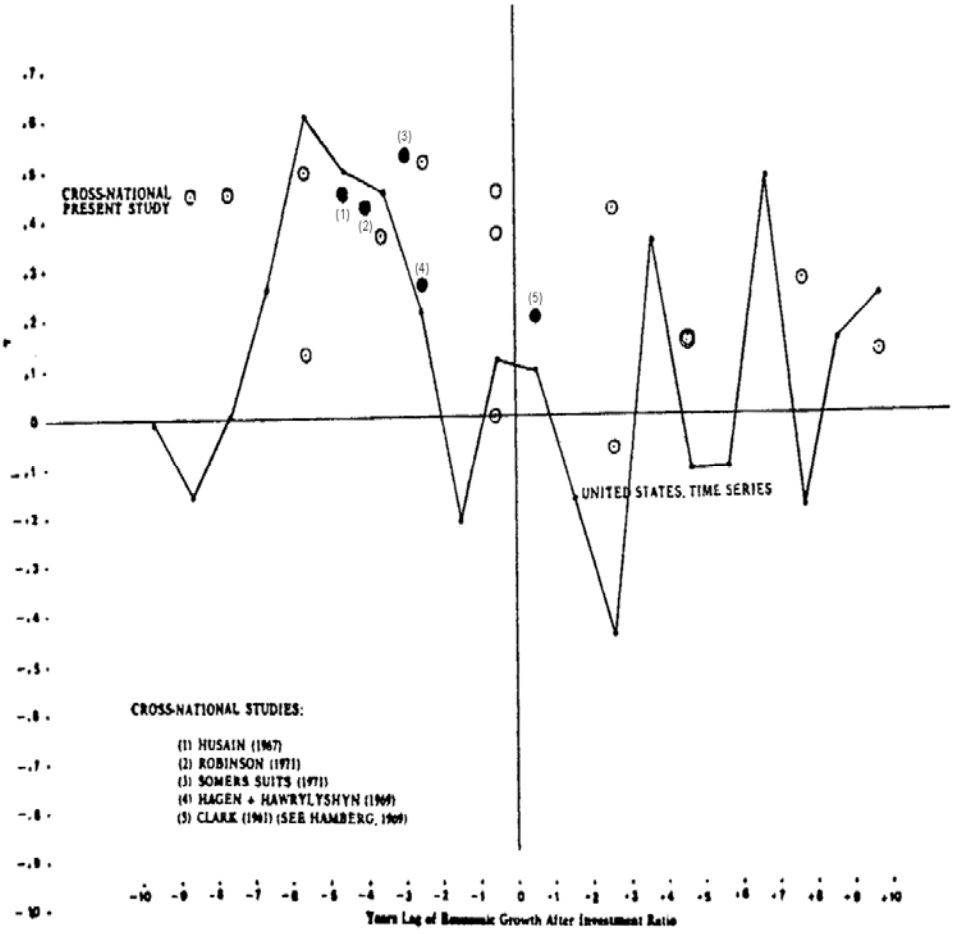
Similarly in Hagen and Hawrylyshyn's (1969) study, growth of gross domestic product over 1960-65 was related to the investment ratio average during 1960-65. In this single case, for 1960-65 economic growth, our correlations with early and with later investment ratios—for 1960 and for 1966—were significant with both *forward* and *backward* time lags. But our correlations of their growth of GDP over 1955-60 with earlier and with late investment ratio—for 1953 and for 1960—showed significance only with the backward time lag (for 1955-60 growth with 1960 investment). In Husain's (1967) study, 1950-59 growth of GDP was related to 1959 investment ratio, for an average investment-growth lag of *minus* 4½ years. Husain, Humphries, and Sommers and Suits found significant relationship of investment ratio to *preceding* economic growth, and Robinson's significant relationship was backward lagged as well. Only Hagen and Hawrylyshyn's results for 1960-65 stand up to this causal analysis, while the results for 1955-60 also were backward lagged.

The temporal results are pictured in the correlogram of Figure 1 (Franke, 1973). Results of further Pearson correlations for the 1950s and 1960s across some 70 nations (similar to the analyses of Sommers and Suits, 1971) are provided in open circles of Figure 1, arranged according to mean time lags of economic growth after investment ratio. The points connected by lines in Figure 1 show correlations over the 1950s through early 1970s of U.S. economic growth with gross fixed capital investment as a percent of GNP, again with results presented by mean time lags (positive and negative) of growth after investment.

These analyses show that economic growth is related to investment later (backward), but mostly not to investment earlier (forward). In Figure 1, for example, Clark's (1961) forward lag of ½ year, like the forward and concurrent studies of Hamberg (1969), shows no significant relationship of investment and economic growth. As a whole, the studies which purport to show significant benefits of investment to growth instead show that greater economic growth contributes to greater investment—a finding often noted (e.g., by Evans, 1969: 95-105), but which in absence of evidence for an investment-to-economic growth relationship seems of limited importance.

Figure 1
Correlogram of growth in national product with investment

RATIO. Cross-National and Longitudinal



In brief, consideration of the time dimension seems to reconcile the conflicting evidence of the two sets of studies. Together, these reanalyses indicate that more investment results from but does not stimulate more economic growth. However, the data which have been analyzed in most studies are for investment ratios over periods of 1 to 6 years and for growth rates of national product over periods of 5 or 6 years. These short time periods do not allow effects of ordinary business cycles upon investment-growth relationships to be disregarded (Kennedy, 1998; Shapiro, 1996). Similarly, these short and overlapping periods do not allow elimination of concern over possible contemporaneous relationships which might confuse causal interpretation.

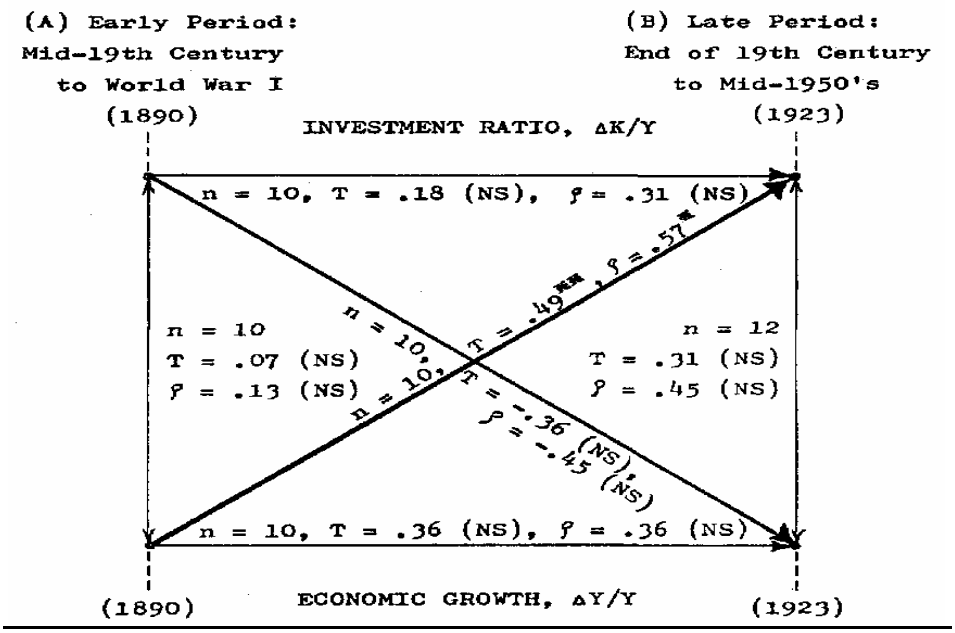
B. Long-Term Analysis

Simon Kuznets (1961) presented data extending over two half-century periods for both investment ratio and economic growth. He showed concurrent rank-order correlations of investment ratio with economic growth rate to be nonsignificant within each of the two long periods. Period (A) extends from the mid-19th century to World War I (for 10 nations) and period (B) from the end of the 19th century to the mid-1950s (for 12 nations), with data taken here as available and usually excluding the years of World Wars I and II. Median years are 1890 for period (A) and 1923 for period (B). Kuznets' analyses showed for the 10 and 12 relatively developed nations which were compared that "little association exists between capital formation proportions and rates of growth" (p. 21). Even over these extended periods, there was no evidence of contemporaneous association. However, analysis of concurrent sets of data does not allow the direct testing of either the investment-causes-growth or the growth-causes-investment viewpoint, since neither variable has priority.

The Kuznets analysis can be taken a step further by correlating each set of data in period (A) with the other in period (B), to give an indication of long-term causal relationship between investment and growth. With some overlap in the periods, time lags of about 33 years (median year (A) to median year (B)) allow a generation's time lapse for effects of either investment or growth rate to be felt upon the other variable. Correlations thus time-lagged could indicate intergenerationally a forward relationship (investment before growth) or a backward one (investment after growth). In addition, the concurrent investment-economic growth correlations of Kuznets can be recalculated using alternate statistical procedures, and coefficients of stability can be figured separately for investment ratio and economic growth rate over the ⅓ century time lag. The correlation coefficients calculated are Spearman's rho and Kendall's tau, the latter also used by Kuznets (1961). Pearson's r for the sample sizes of 10 or 12 is subject to outlier distortion, and thus is not used (cf. Bass and Franke, 1972; Franke, Hofstede, and Bond, 1991: 167).

Results are presented in the cross-lagged diagram of Figure 2. They (1) replicate Kuznets' finding of no concurrent association between investment ratio and economic growth, (2) show little stability over time for either investment ratio or economic growth rate, and (3) show no positive long-term impact of investment ratio upon economic growth. But (4) there is a significant relationship of economic growth rate to investment ratio some 33 years later. These results correspond well to Kuznets' (1961: 55-6) conclusions that capital formation "is a factor that yields highly variable and uncertain results in terms of rates of growth," and that rise in capital formation is a "response to the … rise in per capita income." Indeed, nations experiencing relatively high rates of long-term economic growth tended to be those which expended relatively high proportions of gross national product upon investment in the generation following rather than in the generation preceding economic growth. The further results using Kuznets' data seem to justify the concern expressed by Hamberg (1969), Morgan (1969), and Denison (1967; 1980) regarding the major causal role assigned investment in economic growth models. However, there remains some doubt as to the meaningfulness of the conclusions of Kuznets, Hamberg, and Morgan, due to a question whether the particular *measure* of investment which has been used truly represents the factor of investment in economic growth models.

Figure 2
Cross lagged diagram for the two half-century periods of the Kuznets long term analysis: investment ratio and the economic growth of nations



NOTE.--Arrows point in direction(s) of possible causation; n = number of countries involved in cross national correlations; T = Kendall tau; ρ = Spearman rho.
* p < .10, 2-tailed. ** p < .05, 2-tailed.
(NS) = nonsignificant (p > .10, 2-tailed).

III. INVESTMENT RATE-ECONOMIC GROWTH RELATIONSHIPS

A. Data

As Everett Hagen and Oli Hawrylyshyn (1969: 72) noted, "in a regression analysis explaining growth rates, the ideal variable one would use to account for the role of capital in production is the rate of growth of capital stock." Investment rates (ΔK/K) are related to investment ratios (ΔK/Y), assuming stability in capital: output ratios (K/Y), since ΔK/K = (ΔK/Y)/(K/Y). "However, for a cross-section of diverse economies … the assumption that the average capital output ratio is constant over the sample is untenable." Unfortunately, since investment *rate* data are unavailable for most nations, all of the national comparisons reviewed above use the inferior measure of investment as a *ratio* to national product.

Edward Denison (1967) developed data for nine developed nations from which investment rates can be calculated over two five-year and one two-year periods (Table 1 below). Using data for these nations over 1950-62 from his page 120 for ΔK/Y and page 138 for ΔK/K, these measures of investment show a Spearman's rank-order

correlation, ρ, of .45, which is nonsignificant—justifying his comment (p. 121) that "the rate of increase in the stock of physical capital [ΔK/K] is not measured by investment ratios [ΔK/Y]"—at least not very well measured, and inadequate for use in analyzing relationships to economic growth rates for small samples of nations.

From calculations using data from Denison (1967: ch. 12) are obtained the percentage rates of increase per year in stock of gross enterprise structures and equipment over 1950-55, 1955-60, 1955-62, and 1960-62 for nine developed nations, presented in Table 1. The sample of nations includes the United States and eight Western European nations, with 500 million total population and production of nearly half of total world GNP (World Bank 1979). The investment figures are rates of investment growth rather than ratios to national product, specifically representing investment rates for use in production.

Data for national product growth per capita per year are obtained from Denison, Hagen and Hawrylyshyn, Kravis and his associates, the OECD, and the UN, as indicated in Table 1. Per-capita growth of real product is chosen as an indicator of improved material welfare, against which to balance the sacrifice of savings and investment. Economic growth rates based on conventional currency exchange values, over the six separate five-year periods between 1950 and 1980 and over the 1955-62 period studied by Denison (1967), are supplemented by growth rates based on purchasing power within each nation, for 1950-60, 1960-70, and 1970-74, to assure that results are not simply artifacts of method of calculation of national product. In order to determine whether relationships between capital investment and national product growth are affected by initial levels of capital intensity (capital stock per worker) and of national product per capita, these data are obtained from Denison, Kravis, and Hagen and Hawrylyshyn, as noted in Table 1, and employed in multivariate analyses in the second results section.

B. Results: Correlations between Capital Growth and Production Growth

Using the data for nine nations from Table 1, systematic evaluation can be made of all relationships between the growth rates of capital stock (ΔK/K) and the growth rates of national product (ΔY/Y). When attention is paid to the time lags between measures of these two correlated variables, it can be inferred if there is a "forward" effect, with more capital investment apparently causing more economic growth, or if there is a "backward" effect, with economic growth apparently causing more investment.

In the matrix of Table 2, correlations of investment rate with economic growth rate (ΔK/K with ΔY/Y) for various periods and time lags are outlined by a first rectangle where economic growth rates are based on purchasing power, and by a second rectangle where economic growth rates are based on exchange rates. Correlation coefficients are Pearson rank-order, to compare directly with subsequent regression equations, but indications are provided of significance levels using Spearman ρ and Kendall τ, which are preferred for small samples. There are three significant correlations for the purchasing power data and five for the exchange rate data--all for periods of economic growth preceding or preceding and lapping into periods of capital growth. For both sets of relationships of capital growth with economic growth, there is no significant correlation when economic growth is taken to be strictly concurrent or follows capital growth--by up to 25 years later.

Table 1
Capital growth, capital stock per worker, and growth and level of national product per capita

Variable Year(s)	USA	Belg.	Den.	Fr.	Ger.	Neth.	Nor.	UK	Italy	Mean	S.D.
Enterprise Structures and Equipment											
Growth Rate: ΔK/K, %/Year											
(1) 1950-55	4.14	2.78	4.70	3.33	4.46	3.42	4.50	2.75	3.17	3.69	0.76
(2) 1955-60	3.95	3.04	4.57	3.69	6.17	4.69	4.21	2.90	3.49	4.08	1.00
(3) 1955-62	3.38	3.00	4.80	3.81	6.13	4.72	4.02	3.15	3.86	4.10	0.99
(4) 1960-62	2.10	3.03	5.57	4.26	6.27	4.95	3.69	3.90	4.92	4.30	1.29
Stock Per Worker: K/L, % of U.S. Level											
(5) 1950	100	68	47	43	37	52	68	39	30	53.8	21.7
(6) 1955	100	65	52	44	36	50	75	37	28	54.1	22.6
(7) 1960	100	67	57	49	43	57	86	40	29	58.7	22.6
National Product Per Capita (Based On Purchasing Power)											
Growth Rate: ΔY/Y, %/Year/Capita											
(8) 1950-60	1.5	2.4	2.9	3.9	7.2	3.0	2.1	3.1	4.4	3.39	1.68
(9) 1960-70	2.6	5.1	4.2	5.3	4.3	6.0	4.9	2.0	6.1	4.50	1.41
(10) 1970-74	2.7	5.1	2.6	4.5	3.1	3.6	4.3	2.2	2.3	3.38	1.05
Level: Y, 1965 US $/Year/Capita											
(11) 1950	2612	1358	1436	1201	966	1175	1358	1436	653	1355	535
(12) 1960	3034	1729	1912	1760	1942	1578	1669	1942	1001	1841	533
(13) 1970	3940	2837	2892	2884	3081	2707	2695	2502	1939	2831	529
National Product Per Capita (Based On Currency Exchange Rates)											
Growth Rate: ΔY/Y, %/Year/Capita											
(14) 1950-55	2.5	2.7	0.8	4.0	8.9	4.7	2.7	2.1	5.7	3.79	2.41
(15) 1955-60	0.4	1.9	4.0	3.7	5.1	2.9	2.0	2.1	5.1	3.02	1.58
(16) 1955-62	1.0	2.6	4.2	3.8	4.1	2.5	2.4	1.7	5.1	3.04	1.33
(17) 1960-65	3.1	4.3	4.1	3.7	3.5	3.7	4.6	2.4	4.3	3.74	0.69
(18) 1965-70	2.0	4.4	3.7	4.5	3.7	4.5	3.8	1.9	5.3	3.76	1.14
(19) 1970-75	1.5	3.2	1.4	3.2	1.5	2.5	3.8	1.7	1.6	2.27	0.92
(20) 1975-80	2.6	3.0	2.6	3.0	3.8	1.4	4.0	1.6	3.3	2.81	0.88
Level: Y, 1965 US $/Year/Capita											
(21) 1950	2630	1137	1363	1098	848	880	1207	1292	527	1220	588
(22) 1955	2975	1299	1418	1336	1298	1107	1379	1433	695	1438	620
(23) 1960	3035	1427	1725	1603	1665	1278	1523	1590	891	1637	582
(24) 1965	3536	1761	2109	1922	1977	1532	1907	1790	1100	1959	662
(25) 1970	3904	2184	2529	2395	2371	1909	2298	1967	1424	2331	724
(26) 1975	4206	2557	2711	2804	2554	2160	2769	2140	1542	2605	724

SOURCES.--Variables (l)-(4), growth rates of gross stock of enterprise structures and equipment, %/year, calculated from E. F. Denison, Why Growth Rates Differ (Washington, D.C.: Brookings,1967), table 12-1. **Variables (5)-(7)**, indices of net stock of enterprise structures and equipment per civilian employed (United States = 100), from Denison, table 12-13. Growth rates and levels of purchasing power national product per capita: **Variables (8)-(13)** calculated from I. B. Kravis, "A Survey of International Comparisons of Productivity," Economic Journal 86 (March 1976), table 1; I. B. Kravis, A. W. Heston, and R. Summers, "Real GDP Per Capita For More Than One Hundred Countries," Economic Journal 88 (June 1978), table 4;

and (for the base U.S. figures) from the Economic Report of the President: 1981 (Washington, D.C.: U.S. Government Printing Office, 1981), tables B-2 and B-26. Growth rates of exchange value national product per capita: **Variables (14) and (16)** from Denison, table 2-2; variables (15) and (17) from E. E. Hagen and O. Hawrylyshyn, "Analysis of World Income and Growth, 1955-1965," Economic Development and Cultural Change 18 no. 1, pt. 2 (October 1969), tables 10D and 10E; **Variables (18) and (19)** from National Accounts of OECD Countries: 1976 (Paris: Organization for Economic Co-Operation and Development, 1978), vol. 1; and **variable (20)** from: National Accounts of OECD Countries: 1976, vol. 1; Economic Report of the President: 1981, table B-107; "Toward More Balanced Growth," OECD Observer (July 1980), tables 2 and 3; United Nations Statistical Yearbook: 1978, table 181; and United Nations Demographic Yearbook: 1978, table 5. Levels of exchange value national product per capita: Variable (24) from Hagen and Hawrylyshyn, tables 5A and 6A, and **Variables (21)-(23), {25), and (26)** calculated from variables (24) and (14), (15), and (17)-(19).

The importance of time lags in investment rate-economic growth relationships can be demonstrated by a correlogram plotting all of the correlation coefficients in the rectangles of Table 2 against the time lags between the midpoints of the periods for the variables. Figure 3 shows correlations of $\Delta K/K$ with $\Delta Y/Y$ which are significant only for investment *following* economic growth by one to six years. The strongest relationship, r and $\rho = .90$ ($p < .01$), is for a "backward" lag averaging 3½ years, i.e., of economic growth explaining investment growth, rather than the reverse.

The cross-sectional results in Table 2 and Figure 3 show significant, positive cross-national correlation coefficients of economic growth rates with capital growth rates that occurred, on average, one to six years *later*. The correlations peak at .90, or 81% variance explanation, with a backward time lag averaging 3½ years. Thus, using high-quality data, we can explain differences in growth rates of capital very well, but can explain differences in growth rates of national product per capita not at all.

These results are similar to those obtained using investment ratios ($\Delta K/Y$) rather than investment rates ($\Delta K/K$) to correlate with per-capita economic growth rates ($\Delta Y/Y$)--although the latter are weaker, as would be expected from less accurate representation of investment. As indicated in Section IIA and Figure 1, the results of the five large-sample cross-national studies published between 1967 and 1976 show significant but weaker backward relationships. The publications claiming investment ratio to be a major factor determining economic growth rate now appear based on the choice of backward time lags for relationships of investment with economic growth. Most of the significant relationships in Section IIA and Figure 1 are for investment ratios ($\Delta K/Y$) *following* economic growth ($\Delta Y/Y$) by backward lags averaging ½ to 8½ years.

In general, empirical bivariate analyses do not support the theory that stimulating investment is likely to lead to increasing economic growth rates. But economic growth does seem to have contributed to the subsequent growth of capital stock.

Table 2
Correlation matrix: Pearson r

Variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Enterprise Structures and Equipment													
Growth Rate: ΔK/K, %/Year													
(1) 1950-55	1.00												
(2) 1955-60	.74**	1.00											
(3) 1955-62	.64**	.96**	1.00										
(4) 1960-62	.30	.66**	.84**	1.00									
Stock Per Worker: K/L, % of U.S. Level													
(5) 1950	.23	-.13	-.39	-.80**	1.00								
(6) 1955	.33	-.09	-.35	-.76*	.99**	1.00							
(7) 1960	.41	-.01	-.27	-.70	.96**	.99**	1.00						
National Product Per Capita (Based on Purchasing Power)													
Growth Rate: ΔY/Y, %/Year/Capita								"Backward" Lags (ΔY/Y Before ΔK/K)					
(8) 1950-60	.11	.61	.73	.78**	-.70**	-.72**	-.69**	1.00					
(9) 1960-70	-.08	.15	.25	.37	-.33	-.32	-.27	.21	1.00				
(10) 1970-74	-.14	-.10	-.17	-.27	.26	.26	.32	-.18	.46	1.00			
Level: Y, 1965 US $/Year/Capita								"Forward" Lags (ΔK/K Before ΔY/Y)					
(11) 1950	.23	-.16	-.38	-.73	.88*	.87**	.82	-.65**	-.67**	-.08	1.00		
(12) 1960	.34	-.10	.12	-.51	.74	.73	.69	-.33	-.75**	-.14	.93*	1.00	
(13) 1970	.44	.28	-.05	-.42	.77	.76	.74	-.24	-.50	.09	.85	.94**	1.00
National Product Per Capita (Based on Currency Exchange Rates)													
Growth Rate: ΔY/Y, %/Year/Capita								"Backward" Lags (ΔY/Y Before ΔK/K)					
(14) 1950-55	.05	.61	.64	.55	-.43	-.48	-.45	.87*	.37**	-.04	-.54**	-.29	-.14
(15) 1955-60	.12	.45	.66**	.90**	-.86**	-.83**	-.80**	.83**	.51	-.21	-.83**	-.65	-.55
(16) 1955-62	.12	.30	.50	.76*	-.74*	-.71*	-.69	.65*	.62	-.10	-.78*	-.68	-.56
(17) 1960-65	.26	.10	.12	.14	-.01	.06	.11	-.06	.77*	.50	-.40	-.54**	-.32
(18) 1965-70	-.14	.09	.23	.42	-.45	-.44	-.41	.30	.98**	.41	-.75**	-.81**	-.58
(19) 1970-75	-.17	-.25	-.30	-.32	.20	.24	.31	-.33	.43	.89*	-.12	-.27	-.13
(20) 1975-80	.45	.31	.26	.11	.01	.07	.12	.34	.27	.30	-.23	-.15	-.00
Level: Y, 1965 US $/Year/Capita								"Forward" Lags (ΔK/K Before ΔY/Y)					
(21) 1950	.27	-.14	-.36	-.69	.85*	.84**	.79*	-.60**	-.69**	-.14	.99**	.94*	.85
(22) 1955	.31	-.02	-.25	-.65	.84	.82*	.77	-.47*	-.68**	-.13	.97**	.97**	.90
(23) 1960	.39*	.09	-.14	-.54	.78	.77	.72	-.36	-.68**	-.15	.94*	.98**	.93**
(24) 1965	.43**	.11	-.13	-.54	.80	.80	.76	-.38	-.64**	.11	.94*	.97**	.94**
(25) 1970	.47*	.15	-.09	-.52	.81	.81	.78	-.37	-.56	-.02	.91*	.95**	.96**
(26) 1975	.45	.11	-.14	-.58	.85**	.86**	.84**	-.42	-.50	.12	.90	.92	.95**

Table 2 (continued)

Variable:	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
National Product Per Capita (Based on Currency Exchange Rates)													
Growth Rate: ΔY/Y, %/Year/Capita													
(14) 1950-55	1.00												
(15) 1955-60	.62	1.00											
(16) 1955-62	.45	.95**	1.00										
(17) 1960-65	.02	.28	.50	1.00									
(18) 1965-70	.38*	.62	.74	.77*	1.00								
(19) 1970-75	-.16	-.28	-.17	.50	.35	1.00							
(20) 1975-80	.36	.30	.42	.60	.32	.27	1.00						
Level: Y, 1965 US $/Year/Capita													
(21) 1950	-.51**	-.77*	-.72*	-.40	-.76**	-.18	-.17	1.00					
(22) 1955	-.35**	-.72	-.70*	-.43	-.75**	-.21	-.11	.98**	1.00				
(23) 1960	-.29	-.63	-.62	-.45	-.74**	-.26	-.07	.96*	.99**	1.00			
(24) 1965	-.30	-.63	-.60	-.37	-.71*	-.22	-.01	.96*	.98**	1.00**	1.00		
(25) 1970	-.28	-.59	-.55	-.29	-.62	-.16	.04	.93*	.96**	.98**	.99**	1.00	
(26) 1975	-.31	-.64	-.58	-.21	-.57	-.00	.09	.92*	.94*	.95**	.97**	.99**	1.00

NOTE.--For the Pearson product-moment correlation coefficients, r, single underlining indicates two-tailed significance level of $p < .10$ and double underlining of $p < .05$. For the rank-order correlation coefficients not shown (Spearman rho and Kendall tau), * indicates that both show two-tailed significance levels of $p < .10$ and ** indicates levels for both of $p < .05$.

IV. RESULTS FOR ECONOMIC GROWTH BY MULTIVARIATE ANALYSIS: CONSIDERING CAPITAL INVESTMENT AND CAPITAL UTILIZATION

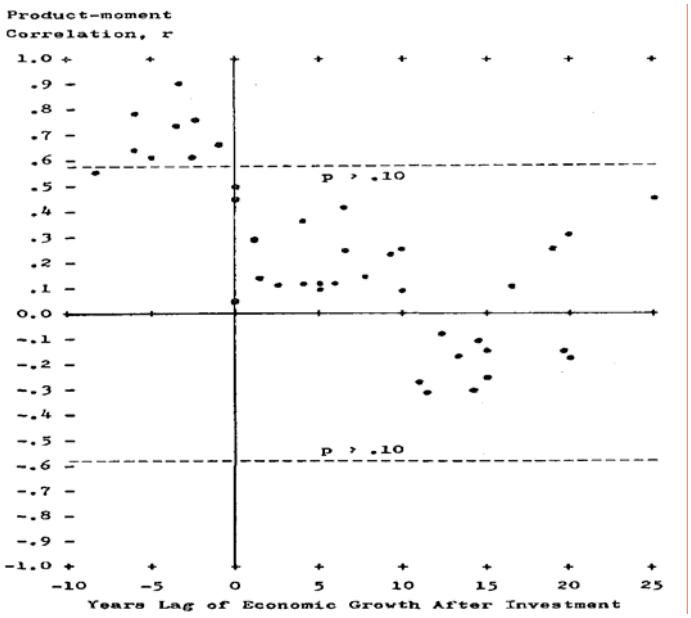
A. Cross-National

Using the data derived primarily from Denison (1967), regression equations also were calculated, regressing stepwise across nations each of the economic growth rates in Table 1 (variables 8-10 and 14-20) upon all initial and other earlier measures of capital intensity (variables 5-7) and upon all initial and other earlier measures of levels of national product per capita (variables 11-13 and 21-26), as well as upon all concurrent and earlier measures of growth rates of enterprise structures and equipment (variables 1-4), also in Table 1. Only for exchange-rate economic growth over 1955-60 does earlier investment rate enter a regression equation:

$$\Delta Y/Y\ (1955\text{-}60) = 4.12 - 0.068 * K/L\ (1950) + 0.70 * \Delta K/K\ (1950\text{-}55)$$
$$t = 5.59,\ p < .01 \qquad t = 2.00,\ p < .10$$
$$R^2 = 78.84\%$$

A similar but slightly weaker model is obtained using K/L (1955). These results indicate that capital intensity had a *negative* effect--supportive of a finding at the business unit level by Buzzell and Gale's (1987: ch. 7): "Capital intensity can upset the applecart." But in this case there was a secondary benefit from more capital investment, perhaps due to recovery in European nations whose capital structure had been devastated by World War II.

Figure 3
Correlogram: cross national correlations of investment rate with economic growth rate over various time lags



Cross-national data including capital utilization as well were developed by Franke (1975) for eight nations: Bulgaria, Czechoslovakia, Hungary, Poland, the Soviet Union, the United Kingdom, the United States, and Yugoslavia, with (A) real capital utilization rates as percents of 8,760 hours per year in the early 1960s, (B) gross capital investment as percent of GNP about 1960, and (C) economic growth rates per capita over 1960-1970. Capital utilization was related nonsignificantly with capital investment across nations (Spearman's $\rho = .36$). As in most of the correlations presented in sections A and B, the correlation of investment ratio with subsequent economic growth also was related nonsignificantly ($\rho = .49$). However, capital utilization did relate significantly with subsequent economic growth ($\rho = .74$, $p < .05$, two-tailed).

B. Time-Series for the United States

Year-by-year data for (A) real GDP growth rates, (B) capacity utilization rates in manufacturing (including lags back to three years earlier and growth rates of this

variable with lags back to three years), and (C) gross fixed capital investment as a percentage of GDP (including lags back to three years earlier, and growth rates of this variable with lags back to three years) are obtained from calculations using data from Tables B-1, B-3, and B-54 of the Council of Economic Advisers' (2005) *Economic Report of the President: 2005* and from similar tables in the CEA's (1991) *ERP: 1991*.

Stepwise multiple regression of (A) growth of real GDP over 1953-2004 upon these levels and growth rates of (B) capital utilization and of (C) investment ratio provides the following equation:

$$\Delta Y/Y(1953\text{-}2004) = -2.664 + 0.522^{*}\ \text{CapUtChange (concurrent)} + 0.074\ ^{*}\ \text{CapUtLevel (lagged 1 yr.)}$$

$$t = 13.040,\ p < .0005 \qquad t = 2.107,\ p = .040$$

$$R^2 = 79.8\%,\ \text{adjusted } R^2 = 79.0\%,\ \text{Durbin-Watson Coef.} = 1.689$$

(DW non-significant, indicating that model is well specified).

The stepwise regression analytical approach, with controls for significance ($p < .05$), multicollinearity (tolerance > .75), and autocorrelation (Durbin and Watson, 1950; 1951), is described by Franke (1980). In this case, in the presence of a measure of capital utilization (overstated but probably useful as a relative index--cf. Berndt and Morrison, 1981; Franke, 1975), no measure of concurrent or earlier capital investment entered the equation.

V. DISCUSSION

By attending to chronological sequence, it is seen that analysis of investment-economic growth differences among nations does not confirm the investment-causes-growth hypothesis, but instead supports relationships in which the order of events is reversed (Table 2 and Figures 1, 2, and 3). This questioning of a causal role for investment also uses time-series data for the United States (see sections IIA and IVB and Figure 1).

Cross-national and time-series U.S. analyses support the observation that business and governmental leaders are not "economic man" omnipotent decision-makers, and that the true levels of capital utilization in developed economies at or under some 50% of the 8,760 hours available in a normal year (Costa, 1998; Foss, 1981; Franke, 1975; Hamermesh, 1998; Mayshar and Halevy, 1997; Shapiro, 1996) are *not* optimal. Economic growth rate relationships to capital utilization as well as investment, using a small sample of nations and using U.S. time-series data over 51 years in Section IV indicate that utilization rather than investment is important for increasing economic performance.

We have raised questions about the wisdom of over-investing--up to the ratios to GDP of 40% or more attained in centrally-controlled economies according to the World Bank (1996) and Franke (1975; 1999)--, and have shown that even investment ratios which are below 20% in the United States may not be low enough to make investment a limiting factor in subsequent economic growth. As suggested by Franke (1973), it does not appear that capital investment is a "critical" or limiting factor in economic growth in the post-World War II period. In addition, Figure 2, drawing on Kuznets' historical data, suggests that even a century and more ago there was no economic growth benefit from higher investment.

Of course, there are limitations to the present work. The cross-national and time-series positive findings for utilization of capacity (capital and labor) are not yet fully developed. However, the nonsignificant results for effects of capital investment seem well established. The present macroeconomic findings might provide a basis for strategic management interventions (as suggested by Buzzell and Gale, 1987, and Franke and Edlund, 1992). Articles in this Winter 2007 issue of the *International Journal of Business* provide steps supporting more effective utilization of human and capital resources: John Grant suggests broad and systematic information scanning and sophisticated long-term focus for strategic management. Bernard Bass suggests rational leadership suited to corporate situations at hand, including "more judicious capital investment" (p. 35). Gerald Barrett opposes irrational personnel policies imposed by anti- or a-scientific regulators, which might reduce effective utilization of human and capital resources. Scott Armstrong and Kesten Green oppose the currently dominant management fad established by Michael Porter (but also used earlier by Japanese strategic managers). It is shown to diminish human cooperation and thereby profitability and even survival of American corporations, in part perhaps through "competitive" but less profitabile overinvestment and high capital intensity. The concluding quantitative case analysis of General Electric by a team of four authors (Franke et al. 2006) indicates that policies of acquisition and downsizing, and thus of increasing capital intensity, might not improve corporate profitability--in a long-term statistical appraisal of a corporation following guidelines set down in the first article by Grant (2007) building on his work with associates (Summer et al., 1990).

VI. CONCLUSION

In summary, critical review with further analyses shows that higher ratios and rates of capital investment do not lead to higher rates of economic growth. This macroeconomic result parallels findings for business units and corporations that higher capital intensity does not benefit profitability. Instead, higher rates of utilization of capital and labor can benefit corporate profitability and national economic growth.

Our results raise the question for economic policy and strategic management whether a focus on increasing capital investment while restraining or reducing labor costs--thus increasing capital intensity--can be expected to benefit demand creation, employee development, national economic performance, corporate profitability, and ultimately competitiveness and survival. It appears instead that a truly capitalistic focus might be more useful--an approach encouraging only the moderate investment needed to embody new and useful technology, together with raising capital utilization above the less than fifty percent of total time available that is common in most manufacturing and service industries.

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REFERENCES

Armstrong JA, Green KC. 2007, "Competitor-oriented Objectives: The Myth of Market Share." *International Journal of Business* **12**(1), Special Issue on "Taking Business Seriously," Winter.

Barrett GV. 2007. "Logical and Legal Limitations in Applying Social Sciences to Business." *InternationalJournal of Business* **12**(1), Special Issue on "Taking Business Seriously," Winter.

Barrett GV, Franke RH. 1970. "'Psychogenic' Death: A Reappraisal." *Science* **167**: 304-306.

Bass BM. 2007b, "Executive and Strategic Leadership," *International Journal of Business* **12**(1), Special Issue on "Taking Business Seriously," Winter.

Bass BM, Franke RH. 1972, "Societal Influences on Student Perceptions of How to Succeed in Organizations." *Journal of Applied Psychology* **56**: 312-318.

Berndt ER, Morrison CJ. 1981. "Capacity Utilization Measures: Underlying Economic Theory and an Alternative Approach." *American Economic Review* **71**(2): 48-52.

Blalock HM (ed). 1985. *Causal Models in Panel and Experimental Designs. Aldine*: New York.

Brynjolfsson E, Hitt LM. 1998. "Beyond the Productivity Paradox." *Communications of the ACM* **41**(8): 49-55.

Buzzell RD, Gale B. 1987. *The PIMS Principles: Linking Strategy to Performance*. *Free Press*: New York.

Campbell DT, Stanley JC. 1966. *Experimental and Quasi-Experimental Designs for Research*. , *Rand McNally*: Chicago, IL.

Clark C. 1961. *Growthmanship: A Study in the Mythology of Investment. Barrie and Rockliff*: London, UK.

Council of Economic Advisers. 1981. *EconomicReport of the President: 1981*. United States Government Printing Office: Washington, DC.
Council of Economic Advisers. 1983. *EconomicReport of the President: 1983*. United States Government Printing Office: Washington, DC.
Council of Economic Advisers. 1991, *EconomicReport of the President: 1991*. United States Government Printing Office: Washington, DC.
Council of Economic Advisers. 2001. *EconomicReport of the President: 2001*. United States Government Printing Office: Washington, DC.
Council of Economic Advisers. 2005. *EconomicReport of the President: 2005*. United States Government Printing Office: Washington, DC.
Costa DL. 1998. "The Unequal Work Day: A Long-term View." *American Economic Review* **88**(2): 330-334.
Denison EF. 1964, "The Unimportance of the Embodied Question." *American Economic Review* **54**: 90-94.
Denison EF. 1967. *Why Growth Rates Differ: Postwar Experience in Nine Western Countries*. *Brookings*: Washington, DC.
Denison EF. 1979. "Personal Communication at U.S. Department of Commerce with Richard H. Franke."
Denison EF. 1980. "The Contribution of Capital to Economic Growth." *American Economic Review* **70**: 220-224.
Denison EF. 1983. "The Interruption of Productivity Growth in the United States." *Economic Journal* **93**: 56-77.
Evans MK. 1969. *Macroeconomic Activity*. *Harper and Row*: New York.
Foss MF. 1981. "Long-run Changes in the Workweek of Fixed Capital." *American Economic Review* **71**(2): 58-63.
Franke RH. 1973. "Critical Factors in the Post-war Economic Growth of Nations: Review of Empirical Studies and Implications for Participative Organization." In *Participation and Self- Management*, Eugen Pusić (ed). University of Zagreb: Zagreb, Yugoslavia; **5**: 107-119.
Franke RH. 1974. "An Empirical Appraisal of the Achievement Motivation Model Applied to Nations." Doctoral dissertation, University of Rochester (*Dissertation Abstracts International* **34**(4): 1959-B.)
Franke RH. 1975. "Motivation, Capital, and Economic Performance." Paper presented to the annual meeting of the American Psychological Association, Chicago, IL (29 pages).
Franke RH. 1979. "Investment for Economic Growth?" Paper presented to the annual meeting of the American Association for the Advancement of Science, Houston, TX.
Franke RH. 1980. "Worker Productivity at Hawthorne." *American Sociological Review* **45**: 1006-1027.
Franke RH. 1987. "Technological Revolution and Productivity Decline: Computer Introduction in the Financial Industry." *Technological Forecasting and Social Change* **31**: 143-154.
Franke RH. 1999. "Transformation of the Second World from Plan to Market: Economic Effects of Culture, Convergence, and Investment." *International Journal of Business* **4**(1): 39-52.

Franke RH. 2000. "Taking Business Seriously: Applying the Comprehensive Method of Quantitative Case Analysis to the Performance of Business Organizations." Paper presented to the faculty of the University of Bremen, Bremen, Germany.

Franke RH. 2004. "Technical Change and the Aggregate Production Function—Some Further Corrections." Paper presented to the annual meeting of the American Association for the Advancement of Science, Seattle, WA (February 15, 6 pages).

Franke RH. 2005. "Environmental Effects on Capability and Productivity over Fifty Years." Paper Presented to the annual meeting of the American Association for the Advancement of Science, in Symposium, "Shaping the Future: Environmental Pollution, Population Change, and Economic Productivity," Washington, DC.

Franke RH, Barrett GV. 1975. "The Economic Implications of Malnutrition: Comment." *EconomicDevelopment and Cultural Change* **23**: 341-350.

Franke RH, Barrett GV. 2004. "A New Strategic Era: Beyond the Computer and Innovation Paradoxes." Paper presented to the annual meeting of the Strategic Management Society, San Juan, Puerto Rico.

Franke RH, Edlund TW. 1992. "Development and Application of a Longitudinal Procedure for Quantitative Case Analysis." In *Forging New Partnerships with Cases, Simulations, Games, and other Interactive Methods*. Hans E. Klein (ed). WACRA--World Association for Case Method Research and Application: Needham, MA; 361-372. [Baltimore Gas and Electric Co.]

Franke RH, Edlund TW, Oster F, III. 1990. "The Development of Strategic Management: Journal Quality and Article Impact." *Strategic Management Journal* **11**: 243-253.

Franke RH, Hofstede G, Bond MH. 1991. "Cultural Roots of Economic Performance," *Strategic Management Journal* **12**: 165-173.

Franke RH, Mento AJ, Prumo SM, Edlund TW. 2007. "General Electric Performance over a Half Century: Evaluation of Effects of Leadership and Other Strategic Factors by Quantitative Case Analysis." *International Journal of Business* **12**(1), Special Issue on "Taking Business Seriously," Winter.

Granger CWJ. 1969. "Investigating Causal Relations by Econometric Models and Cross-spectral Methods." *Econometrica* **37**(3): 424-438.

Grant JH. 2007. "Advances and Challenges in Strategic Management." *International Journal of Business* **12**(1), Special Issue on "Taking Business Seriously," Fall.

Greene CN. 1973. "Causal Connections among Managers' Merit Pay, Job Satisfaction, and Performance." *Journal of Applied Psychology* **58**: 95-100.

Hagen EE, Hawrylyshyn O. 1969. "Analysis of World Income and Growth, 1955-1965." *Economic Development and Cultural Change* **18** (October): 1-183.

Hamberg D. 1969. "Savings and Economic Growth." *Economic Development and Cultural Change* **17** (July): 460-482.

Hamermesh DS. 1998. "Work or Leisure: A Changing Decision?" *American Economic Review* **88**(2): 321-325.

Humphries J. 1976. "Causes of Growth." *Economic Development and Cultural Change* **24** (January): 339-353.

Husain IZ. 1967. *Economic Factors in Economic Growth*. Allied Publishers Private Limited: Bombay, India.

Johnson DW, Chiu JS. 1965. "Growth and Investment According to International Comparisons: A Comment." *Economic Journal* **75**: 626-630.

Kennedy JE. 1998. "An Analysis of Time-series Estimates of Capacity Utilization." *Journal of Macroeconomics* **20**(1): 169-187.

Kenny DA. 1979. *Correlation and Causality*. John Wiley and Sons: New York.

Kravis IB. 1976. "A Survey of International Comparisons of Productivity." *Economic Journal* **86(**341): 1-44.

Kravis IB, Heston AW, Summers R. 1978. "Real GDP per Capita for More Than One Hundred Countries." *Economic Journal* **88** (350): 215-242.

Kuznets S. 1961. "Quantitative Aspects of the Economic Growth of Nations. VI. Long-term Trends in Capital Formation Proportions." *Economic Development and Cultural Change* **9** (July): 1-123.

Kuznets S. 1973. "Modern Economic Growth: Findings and Reflections." *American Economic Review* **63**: 247-258 (Nobel Prize lecture in Stockholm, Sweden).

Maddison A. 2001. *The World Economy: A Millennial Perspective*. Development Centre of the Organization for Economic Co-Operation and Development: Paris, France.

Mass NJ, Senge PM. 1981. "Reindustrialization: Aiming for the Right Targets." *Technology Review* **83** (August/September): 56-65.

Mayshar J, Halevy Y. 1997. "Shiftwork." *Journal of Labor Economics* **15**(1), Part 2: S198-S222.

Morgan T. 1969. "Investment *versus* Economic Growth." *Economic Development and Cultural Change* **17** (April): 392-414.

Organization for Economic Co-Operation and Development. 1978. *National Accounts of OECD Countries: 1976*. Organization for Economic Co-Operation and Development: Paris, France.

Organization for Economic Co-Operation and Development. 1980. "Toward More Balanced Growth." *OECD Observer* (July).

Robinson S. 1971. "Sources of Growth in Less Developed Countries: A Cross-section Study." *Quarterly Journal of Economics* **85** (August): 391-408.

Shapiro MD. 1996. "Macroeconomic Implications of Variation in the Workweek of Capital." *Brookings Papers on Economic Activity* 2: 79-119.

Simon HA. 1979. "Rational Decision-making in Business Organizations." *American Economic Review* **69**(4): 493-513.

Solow RM. 1957. "Technical Change and the Aggregate Production Function." *Review of Economics and Statistics* **39**: 312-320.

Solow RM. 1962. "Technical Progress, Capital Formation, and Economic Growth." *American Economic Review* **52**(2): 76-86.

Sommers PM, Suits DB. 1971. "A Cross-section Model of Economic Growth." *Review of Economics and Statistics* **53** (May): 121-128.

United Nations 1979a. *United Nations Demographic Yearbook: 1978*.

United Nations 1979b. *United Nations Statistical Yearbook: 1978.*

Winston GC. 1974. "The Theory of Capital Utilization and Idleness." *Journal of Economic Literature* **12**(4): 1301-1320.

World Bank. 1979. *1979 World Bank Atlas*. World Bank: Washington, DC.

World Bank. 1996. *From Plan to Market: World Development Report 1996*. Oxford University Press: Oxford, UK.