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Working Paper No. C95-050

Trade and Growth in East Asian Countries: Cause and Effect?

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Department of Economics, University of California, Berkeley

June 1995

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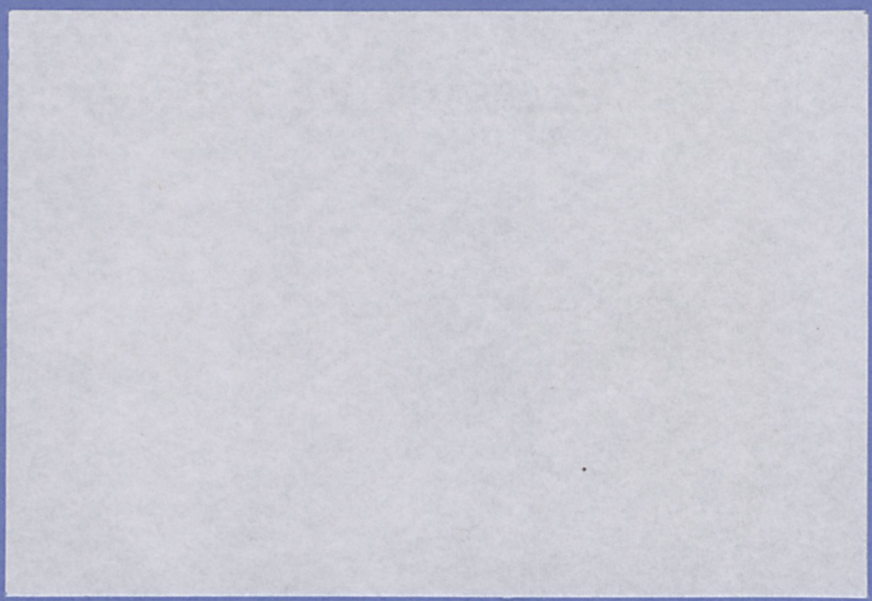

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Key words: export-led growth, Asian miracle, East Asia, gravity model
JEL Classification: O1, O4, O53

This paper was prepared for presentation at a session on *Economic Growth in East Asia* at the American Economic Association meetings in Washington, D.C., Jan. 6, 1995. The authors would also like to thank for support the Institute for International Economics in Washington, D.C., where Frankel was a Senior Fellow when this paper was written; the Center for International and Development Economics Research, funded at U.C. Berkeley by the Ford Foundation; and the Japan-United States Friendship Commission, a U.S. government agency.

Abstract

Estimates of growth equations have found a role for openness, particularly in explaining rapid growth among East Asian countries. But major concerns of simultaneous causality between growth and trade have been expressed. This study aims to deal with the endogeneity of trade by using as instrumental variables the exogenous determinants from the gravity model of bilateral trade, such as proximity to trading partners. Our preliminary finding is that the effect of openness on growth is even clearer when we correct for the endogeneity of openness than in standard OLS estimates. We conclude with estimates of how much has been contributed to East Asian growth by openness (both the exogenous or geographical component of openness and the residual or policy component).

"Trade and Growth in East Asian Countries: Cause and Effect?"

The record of rapid growth that many East Asian countries have attained over the last three decades is so spectacular that it has been claimed as supporting evidence by *both* sides in *each* of three debates (at least). First is the debate on whether the East Asians' success is proof of the superiority of protectionist policies on the one hand, or of outward-oriented policies on the other. Second is the broad debate whether the East Asian phenomenon is evidence of the virtues of government intervention in general, or of laissez-faire market-oriented policies.[1] Third is the debate over whether the statistics support growth based on simple accumulation of the factors of production (labor, education, and especially physical capital), or growth based on improvements in technology and efficiency (measured as an increase in Total Factor Productivity, or the "Solow residual").[2] Finally, in the latter case, there would also be the question whether this increase in technical efficiency was due (i) to superior government policies, in which case East Asia may have valuable lessons for other countries, (ii) to some superior mode of social organization, perhaps some exogenous aspect of Confucian culture, (iii) to simple catch-up with the technologically more advanced

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[1] Examples include Krueger (1990) vs. Pack and Westphal (1986), or the controversy surrounding World Bank (1993), including Rodrik (1994a). Laissez-faire is not the same as outward-orientation, of course, because some governments deliberately use subsidies or an undervalued currency to promote outward orientation.

[2] Young (1992, 1994a, 1994b), Kim and Lau (1994), and Krugman (1994) have upset conventional wisdom by arguing that growth among the four East Asian dragons, especially Singapore, can be explained by simple factor accumulation, with no important residual left over in most cases.

industrialized countries[3], or (iv) to chance.[4]

The subject of this paper is trade-led growth. (In trade, we lump together exports and imports. We hope in a future version of the paper to attempt to distinguish export-led growth from the possibility of technological spillovers that could come via imports as easily as exports.) Quite a few empirical studies of growth rates across countries find that the ratio of exports to GDP, or some other measure of openness, is a significant determinant of growth[5], and often that it is an important determinant for East Asian countries in particular.[6] A typical specification begins with the standard determinants of GDP suggested by neoclassical growth theory, and adds a variable for exports as a share of GDP. For example, Feder (1982) regresses growth rates for 31 semi-industrialized countries [1964-1973] against three variables: investment as a share of income, the rate of growth of the labor force, and the rate of growth of exports (times exports as a share of income). The coefficient on the last variable is highly significant statistically. Similarly, Edwards (1993, p.9-11) regresses the rate of growth of total

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[3] This is the famous convergence hypothesis: Barro (1991), Barro and Sala-i-Martin (1992), and Mankiw, Romer and Weil (1992).

[4] Easterly (1995) and Easterly, Kremer, Pritchett and Summers (1993). The main problem with the chance argument is that the East Asian success stories are all located in the same region. But these authors point out that this ex post reasoning has some pitfalls.

[5] Examples include Michaely (1977), Krueger (1978), Feder (1982), Kohli and Singh (1989), Romer (1989), Quah and Rauch (1990), de Melo and Robinson (1991), DeLong and Summers (1991), Dollar (1992), Edwards (1993a), and van den Berg and Schmidt (1994). Edwards (1993b) and Rodrik (1993) survey the literature.

[6] Four examples are Helliwell (1992), Page (1994), Pack and Page (1994), and Fukuda and Toya (1995). Pack and Page find that manufactured exports, in particular, are important in the growth equation, and that this variable explains part of the East Asian success [and that its coefficient is the same as for other parts of the world]. Bradford (1994) surveys the literature.

factor productivity on two measures of openness -- total trade as a percent of GDP and total tariff revenue as a per cent of trade -- along with some other variables, and finds that "in every regression the proxies for trade distortions and openness are highly significant."

The Problem of Simultaneity Between Trade and Growth

Simultaneity is always a concern however. Rodrik (1994b, p.2), for example, argues that the standard view is "quite misleading on the importance it attaches to the role of export-orientation in the growth performance. It also has backward the causal relationship between exports, on the one hand, and investment and growth on the other."[7] Similarly, Bradford and Chakwin (1993) argue that causality runs from investment to growth and exports, rather than the other way around. Helpman (1988, p.6) asks "Does growth drive trade, or is there a reverse link from trade to growth?"

When the equation features a regression of GDP against exports (or the rates of change thereof), the simultaneity problem is clear: a correlation may emerge simply because exports are a component of GDP, rather than because of any extra contribution that trade makes to growth. Quite a few stories of reverse causality are possible. Many studies have sought to identify some direct measures of trade policy, hoping that they are exogenous.[8] But, aside

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[7] The mechanism of reverse causality that Rodrik has in mind runs as follows: an exogenous increase in investment in a developing country with a comparative disadvantage in producing capital goods, such as Korea, will necessitate an increase in imports of such goods (and in turn an increase in exports to pay for the imports). Levine and Renelt (1992) reach similar conclusions.

[8] Ben-David (1993) focuses on the formation of the European Economic Community during the years 1959-1968 as an exogenous trade liberalization.

from difficulties in measuring trade policies, which are typically serious enough, a fundamental conceptual problem of simultaneity remains (e.g., Sala-i-Martin, 1991). What if free-market trade policies are no more important to growth than free-market domestic policies, but tend to be correlated with them? Then openness will be observed to be correlated with growth, even though trade does not cause growth.

A number of studies have tangled with the challenge posed by simultaneity. Jung and Marshall (1985), Hutchison and Singh (1987, 1992) and Bradford and Chakwin (1993) apply Granger-causality tests to the problem. Esfahani (1991) attempts a simultaneous equation approach. As so often in macro-econometrics, however, the simultaneity problem has remained largely intractable.

What is needed are good instrumental variables, which are truly exogenous, and yet are highly correlated with trade. This paper offers tests with such instruments: trade shares as predicted by the gravity model. The gravity model of bilateral trade, in its most basic form, says that trade between country i and country j is proportional to the product of GDP_i and GDP_j, and inversely related to the distance between them (by analogy to Newton's theory of gravitational attraction between two masses). Other explanatory variables often added include populations (or per capita GDPs), land areas, and dummy variables representing landlockedness, common borders, common languages, and common membership in regional trading arrangements. While the gravity model has long been an ugly duckling of international economics -- obscure and allegedly lacking theoretical foundations -- it has recently enjoyed a swan-like revival. There are at least three reasons for that revival: its empirical success at predicting bilateral trade flows, improved theoretical foundations arising from modern theories

of trade based on imperfect substitutes, and a new interest among economists in geography and trade that seeks to treat countries or regions as physically existing at particular locations in space rather than as disembodied constructs.[9]

Such variables as distances, populations, common borders and common languages, are as close to exogenous as we get in economics. From the viewpoint of a small individual country, the GDPs of trading partners are exogenous as well.[10] Yet these variables are highly correlated with trade. Thus they make good instrumental variables. A very intuitive way to implement the idea is to use the values predicted by the gravity model to instrument for the trade variable in the growth equation (or even to replace it, as in classic Two-Stage Least Squares). If trade still appears to be a significant determinant of growth with this correction (taking care, of course, to use the right standard errors), then we can conclude that the effect is causal and not spurious.

In the latter case, we might also be able to go on and say something particularly interesting for the East Asian countries: to the extent that there is a Solow residual in the growth equation and it is associated with trade, how much of it can be explained by the proximity of the East Asian countries to trading partners with rapid factor accumulation? Is

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[9] The results of one early gravity study were reported in Linneman (1967). The theoretical rationale for the idea that bilateral trade depends on the product of GDPs comes from recent work by Helpman (1987) and Helpman and Krugman (1985, section 1.5); Frankel, Stein and Wei, (1993) elaborate. Frankel (1993) and Frankel and Wei (1994) apply the gravity model to issues of trade blocs in East Asia and elsewhere, and give further references.

[10] For a study like this one that seeks to explain growth for a cross-section of countries, one does not wish to treat GDPs of trading partners as exogenous. But if the standard factor-accumulation terms in a growth regression (labor force growth, investment, and education) can be treated as exogenous in the domestic country, then they can also be considered exogenous in trading partners, as discussed below.

part of the growth residual explained by the trade share residual (i.e., to outward oriented policies, or to other unknown factors, excluding proximity to rapidly growing trade partners)? Or, on the other hand, to put it simply, is it just that they were lucky enough to be located near each other?

Somewhat relevant to this idea are tests in a number of recent papers. DeLong and Summers tested for spatial correlation of residuals in their growth regression, and (surprisingly and surprisedly) failed to find any correlation based on physical proximity. Chua (1993), on the other hand, finds "strong evidence for positive regional spillovers, accounting for about 14 to 18 per cent of a country's growth rate." Elliott (1994) finds spatial correlation in growth, as well as in the residuals from a standard growth regression, particularly among the East Asian countries. A correction for this spatial correlation, analogously to more common corrections for serial correlation, reveals higher standard errors than under usual OLS methods, so that such explanatory variables as education and a dummy variable for Asian growth are no longer statistically significant. As Chua (1993, p.31) notes, "The puzzle of the significant continent dummies is solved...This result rules out the notion that the continent dummies proxied for intrinsic cultural differences or political regime differences across continents." These papers, however, do not focus specifically on trade. They measure spatial proximity by simple dummy variables for common border or common regions, rather than using the full set of variables known to be useful in the gravity literature. As a result, the regional spillover effects found by Chua and Elliott could be due to many possible channels, whereas ours can

be specifically identified with trade links.[11]

The Growth Equation

Here we adopt the "conditional convergence" specification that has become common in the empirical literature on growth. While we consider a number of variants, our basic specification is given by equation (1) below. (See Mankiw, Romer and Weil, 1992, for the theory and testing of this equation, but without the openness term.) The dependent variable is per capita GDP at the end of the sample, 1985. GDP per capita at the beginning of the sample period [1960] appears as an explanatory variable.[12] The other explanatory variables are computed as averages over the sample periods, except for openness which is computed for 1985. The possible endogeneity of openness is the central focus of the paper.

$$Y/pop_{85i} = \alpha + \beta (T/Y)_i + \gamma (I/Y)_i + \delta n_i + \phi SCH_i + \lambda (Y/pop_{60i}) + u_i. \qquad (1)$$

where,

Y is GDP,

pop is the country's working-age population (results were little affected when total population

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[11] Weinhold (1995) has recently extended the approach of these papers, to focus on differences in spatial dependence between industrialized and developing countries, making some use of the gravity equation.

[12] At one extreme, the hypothesis of *un*conditional convergence would predict that *only* lagged income is necessary to predict future income. At the other extreme, the hypothesis that countries are always in their Solow neoclassical growth steady-state equilibrium would predict that lagged income has no effect. Neither polar case seems likely.

was used),

T/Y is total trade (exports plus imports with all countries, not just those in the sample, even though these are a high percentage of world trade) as a share of GDP,

I/Y is gross investment as a share of GDP,

n is the rate of growth of *pop*, plus an allowance of .05 for technological growth plus depreciation of the capital stock

SCH is an estimate of human capital investment based on schooling.

Our sample contains 100 to 150 countries, depending on availability of some variables. Table 1 reports incomes for individual East Asian countries, and for the other countries aggregated by geographical area. In the quarter-century covered here, the East Asians went from an average income per capita that was slightly lower than that of the other non-OECD countries, to a level more than twice that of the others. Their investment shares and schooling levels were not only higher than those of the other non-OECD countries, but almost as high as those of the OECD countries [higher, in the case of Japan]. Certainly these factors are an important part of the East Asians' success. But might the trade share of the East Asian countries, which in Table 1 is on average higher than that for any of the other groups, also be part of the explanation?

The first column of Table 2 reports the results of a conventional OLS regression on Equation 1. The estimated coefficient on beginning-of-sample GDP is .7, indicating a 30% tendency toward conditional convergence over the 25-year period. The coefficients on investment and schooling are highly significant, while the coefficient on the rate of growth of the labor force is not at all significant. The coefficient on openness, the chief focus of our

interest, is of borderline significance in this specification. (It is significant at the 90 per cent level, and just misses significance at the 95 per cent level.) Its point estimate suggests that for every 1 per cent increase in trade as a share of GDP, income per capita increases by .14 per cent.

The Gravity Equation for Determining Trade

A standard gravity equation for bilateral trade between countries i and j is of the form:

$$\log (T_{ij}/Y_i) = a + b \log(Y_j) + c_1 \log(Pop_i) + c_2 \log(Pop_j) + d(Dist_{ij}) + f(Adj_{ij}) + g_1(LL_i) + g_2(LL_j) + h_1 \log(Area_i) + h_1 \log(Area_j) + e_{ij}. \quad (2)$$

Because the aim is to construct a measure of country i's trade share that is exogenous, there is a problem in how to treat the incomes Y_j of the trading partners. Ignoring the endogeneity of Y_j does not seem optimal. In particular, if fitted values were constructed based on actual contemporaneous values of trading partner income, we might pick up spurious correlation due to common growth factors or linkages other than trade. One possible strategy is estimating a version of the equation that includes Y_j, with a coefficient constrained to unity. [We have not yet tried this.] A second strategy is to drop trading partner incomes from the explanatory variables in the gravity model. This is not a very attractive solution either, because income is such an important variable in the gravity model; but the outcome of such estimation of the growth equation using purely "geographic" instrumental variables is reported anyway in column 2 of Table 2. A third strategy, our preferred one for the moment, is to substitute

for Y_j in the trade equation the fitted values of the partner growth rates, based on the factor terms, $(I/Y)_j$, n_j, and SCH_j. [The best alternative may be a fourth strategy: to substitute Y/pop_{60j} for the partner growth terms. We have not yet done this.]

The predicted trade share for country i is the sum of the predicted bilateral trade shares with all of its partners:

$$\widehat{(T/Y)}_i = \Sigma_j [\widehat{(T_{ij}/Y_i)}].$$

The sum is taken not just over the countries covered by the bilateral trade data (63 countries), but over all 150 countries in the Summers and Heston (1991) data set, which covers essentially the entire world. (The growth regressions concentrate on a medium-sized data set of 100 countries, however, because these are the ones for which we have the necessary data on factor accumulation. An Appendix table lists them.[13])

It is a good idea to inspect the first-stage regressions, to make an assessment of the quality of the instruments. In the full gravity model, the correlation between the fitted trade shares and actual trade shares is quite high. When the trading partners' GDPs are excluded, but populations and areas are included, the fitted trade shares still have a relatively high correlation with actual trade shares: 0.57. The t-statistic in a regression of the actual trade share on the fitted share is 8.5. In Frankel and Romer (1994, Table 2), which reports the estimates of equation (2) in full, it is argued that for use in the growth equation, we are only interested in exogenous components of openness *excluding the size of the domestic country.*

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[13] China and Taiwan are included. (They were excluded from Table 2 of the January 1995 version of this paper, because we did not originally have the schooling data for these two.)

The argument is that splitting one country into two independent regions would raise the measured openness (trade/GDP) of each, even though it would at best leave unchanged the physical patterns of exchange of goods, and would thus at best leave unchanged the growth rates of each. (More likely, trade between the two regions would fall, with an adverse affect on income per capita if the hypothesis is correct that appropriately-measured openness helps promote growth.) Holding constant for the area and population of the domestic country in a regression equation for actual openness, the t-statistic on the fitted trade share falls to 3.5. [If size variables are excluded from the beginning, the t-statistic on the "pure geography" model of openness is only 2.8.] Our preferred approach is to add domestic and foreign per capita GDPs back into equation (2), but only in the form of the fitted values of these variables in a conventional growth equation,[14] where the exogenous variables are investment, population growth, and schooling. Under this approach, the t-statistic on the fitted trade share rises back to 3.9, even when controlling for area and population. In short, the geography and gravity models do supply useful instruments for openness.

The second column of Table 4 reports for the East Asian countries the "fitted trade share"[15] alongside the first column, which repeats these countries' actual trade shares. Hong Kong, Malaysia, Singapore, Taiwan and Thailand have actual trade shares in excess of the

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[14] E.g., Mankiw, Romer and Weil (1992).

[15] It is the "blown-up constructed trade share" -- the fitted value in a regression of the actual trade share against the constructed trade share, the latter calculated as the sum (over the trading partners available in our data set) of the bilateral trade flows predicted from the geography equation.

fitted trade share, suggesting that deliberate outward-oriented policies, or an absence of the protectionist policies followed by the average of the 100 countries in the sample, contributed to their relatively high degree of openness. In the case of South Korea, which is more open than the average non-OECD country though less open than the average over the entire sample, the fitted trade share says it should be a bit more open than it is, suggesting somewhat inward-oriented policies. The other countries are less open than the geographical factors predict. To give the reader an idea why specific East Asian countries score high or low on predicted openness, the variables used in the geographical model, averaged for each country over its trading partners, are reported in Table 4b. (These are weighted averages, using actual bilateral trade shares as weights.) All these findings should be regarded as provisional, pending refinement of the estimates.

The Simultaneous-Equation Estimates

As explained above, two methods are used to construct the fitted trade share used in the Instrumental Variables growth regressions in Table 2: the pure geography approach and the gravity approach with partners' factor accumulations used in place of their GDPs. Under both approaches, the coefficient on the fitted trade share is statistically significant.[16] Indeed the point estimate for the effect of openness is higher than it was in the OLS estimates. For every one per cent increase in trade as a share of GDP, income per capita is higher by an estimated .26 per cent. The predicted effect of going from a closed economy to one where imports and

[16] The point estimates and significance levels are higher in Table 2b, which uses Tobit in the regression to construct the openness instrumental variable.

exports sum to 200 per cent of GDP (not as high as Hong Kong and Singapore), is to raise GDP by about 50 per cent.[17]

These results indicate that simultaneity is not as bad a problem in appraising the effect of openness on growth as many have thought. A Hausman specification test fails to reject the hypothesis that the OLS and Instrumental Variables estimates are similar. To the extent that simultaneity is present, it seems to produce the opposite effect on the estimate from what has previously been feared.

Implications for Trade-Led Growth Among Ten East Asian Countries

The next step is to examine individual East Asian countries (particularly those with positive TFP growth residuals), and so see how much of their growth can be explained by the estimated effect of the fitted trade share, $\beta (T^{\wedge}/Y)_i$. We expressed the dependent variable (1985 GDP per capita) and the explanatory variables as deviations from the world average. The explanatory variables, again, are: each country's openness, investment, population growth, schooling, and initial (1960) income per capita. Then we plugged these values into the estimated growth equation (the IV estimates) to see the role played by each factor in explaining growth. The results are reported in Tables 3 and 3a. We see that openness explained a large amount of growth for Hong Kong and Singapore, and positive (though smaller) amounts also

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[17] We noted earlier an argument that one should condition on country size, as measured by area and population, when observing the effects of openness on growth. In tests of this sort, the standard error of the coefficient on openness is increased, so that its t-statistic falls to 1.7, though the point estimate is little affected. (When initial income per capita is excluded from the equation, openness remains statistically significant at the 95 per cent level even when conditioning on country size.) These results are reported in Frankel and Romer (1994), Table 5.

for Korea, Malaysia, Taiwan, and the Philippines. (In the last case, the results presumably mean that lower-than-average openness partly explains the lower-than-average growth.) Low openness detracted from the growth accomplished by China, Indonesia, Japan and Thailand. Of the other variables, investment and schooling are the dominant determinants in most of the countries. (The Philippines is an exception.) All have a large positive unexplained component, except for China where catch-up from a low initial GDP explains most of the growth, and Singapore. As in the Young (1992) results, the residual for Singapore is very small (actually substantially negative); in our case, however, openness, not factor accumulation, is the dominant explanation, apparently accounting for more of the growth miracle than investment and schooling combined.

If openness was an important contributor to growth in many of these countries, was this the result of the accidents of geography and history, or might it have been the outcome of deliberate policies? Table 4 further breaks down the openness effect from Table 3b. We see that for Korea, the Philippines, and Thailand, the beneficial effect of openness cannot be attributed to policies: only the contribution of fitted openness to growth was positive, not the contribution of residual openness, which was negative. [In the case of the Philippines, the right way to describe the results seems to be that, although low openness contributed to low growth, this was the fault of a relatively remote location, as indicated in Table 4b, more than of bad policies.] For Hong Kong the two sources of openness had approximately equal effects on growth. For Malaysia and Singapore, residual openness had the greater effect on growth, while for Taiwan fitted openness had the greater effect.

To summarize the results briefly, many of the explanations offered for East Asian growth indeed appear to play an important role: simple catch-up (particularly China and Indonesia), investment and education (especially Japan, Korea, Malaysia, Singapore, and Taiwan), and an unknown residual (especially the Philippines, where growth was much lower than one would predict). Openness plays a substantial role in many countries, especially Hong Kong and Singapore.

Our results are highly preliminary. Several extensions are desirable. In the results reported here, we do not constrain the coefficients c, g, and h to be the same for country i and country j, e.g., $g_1 = g_2$, even though the dependent variable is the sum of both directions of trade. Eventually we will estimate a gravity equation for *imports separately from exports*; at that time it will be appropriate to allow the coefficients on domestic and foreign variables to differ. Among other advantages, such an equation might allow us to distinguish whether the spillover effects on neighbors' growth come via imports or exports, as traditionally assumed, or imports, as might be implied by some recent theory such as Grossman-Helpman (1991a, 1991b).[18] Another possible extension for future research would be to attempt explicit tests that distinguish the importance of rapid growth among close trading partners from other determinants of trade.

Our provisional conclusion, however, is that the role played by openness in promoting East Asian growth turns out to stand up well to the simultaneity charges that have been leveled against it.

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[18] Coe and Helpman (1993) test the theory, and find that TFP is affected not only by domestic R & D, but also by R & D of those countries from whom the domestic country imports a lot.

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TABLE 1

country or group	GDP per capita, 1960	GDP per capita, 1985	GDP per worker, 1960	GDP per worker, 1985	trade share, 1985 in %
China	619.00	1811.00	1195.28	3107.00	24.93
Hong Kong	2222.00	10653.00	4127.29	16529.00	209.48
Indonesia	621.00	1626.00	1594.73	4267.00	42.65
Japan	2976.00	12004.00	5035.55	19191.00	25.54
S. Korea	883.00	4267.00	2639.27	10484.00	67.85
Malaysia	1381.00	4073.00	3995.71	10273.00	104.68
Philippines	1112.00	1521.00	2915.65	4174.00	45.85
Singapore	1653.00	8153.00	4992.79	17021.00	318.02
Taiwan	1359.00	5786.00	3647.27	13488.00	94.62
Thailand	923.00	2422.00	1844.01	4672.00	51.20
East Asia	1374.90	5231.60	3198.75	10320.60	98.48
South America	2409.83	3132.33	7297.47	9248.83	48.03
Central America	2078.38	3711.95	6360.31	10009.26	88.19
Africa	860.02	1271.42	2013.79	3407.74	68.03
OECD	5695.79	11343.13	13584.62	24348.42	73.43
non-OECD	1377.16	2542.88	3063.24	6609.40	61.54
world	2233.75	4357.78	5757.71	10505.15	73.29

Table 2a: Determination of Real GDP per capita in 1985

	OLS	IV (pure geography)	IV (gravity)
Const	2.66**	2.54*	2.50*
	(.792)	(.807)	(.813)
$Openness_{85}$	.00141†	.00228†	.00255*
	(.00072)	(.00116)	(.00119)
Inv_{Av}	.266**	.250**	.245**
	(.058)	(.060)	(.061)
Pop Gr_{Av}	-207	-.233	-.241
	(.262)	(.265)	(.267)
$School_{Av}$	.308**	.304**	.302**
	(.057)	(.058)	(.058)
GDP/pop_{60}	.693**	.696**	.698**
	(.050)	(.050)	(.051)
No. obs.	100	100	100
s.e.r.	.287	.290	.291
R^2	.934	.933	.933
adj. R^2	.931	.930	.929

(standard errors reported in parentheses.)

† significantly greater than zero at 90% level
* significantly greater than zero at 95% level
** significantly greater than zero at 99% level

Note: In the second column, the pure geography approach, the instrumental variable for the domestic country's openness is the fitted value based on the following variables: the populations and land areas of it and its trading partners, the distance between them, and dummy variables for common borders and landlockedness. They do not include any measure of trading partners' GDPs. In the third column, the gravity approach, partners' factor accumulations (investment, population growth, and schooling) are substituted for their incomes, as instrumental variables for openness. For both instrumental variables regressions, the fitted values for trade are estimated by dropping zero-valued observations from the log-linear regression, but constructing fitted values for these observations just like the others.

Table 2b:
Determination of Real GDP per capita in 1985 (Tobit for IV)

	IV (pure geography)	IV (gravity)
Const	2.20*	2.139*
	(.910)	(.946)
$Openness_{85}$	.00469*	.00522*
	(.00200)	(.00225)
Inv_{Av}	.206**	.197**
	(.072)	(.076)
Pop Gr_{Av}	-.305	-.320
	(.293)	(.304)
$School_{Av}$	.291**	.280**
	(.064)	(.066)
GDP/pop_{60}	.706**	.708**
	(.056)	(.057)
No. obs.	100	100
s.e.r.	.317	.327
R^2	.921	.916
adj. R^2	.916	.911

(standard errors reported in parentheses.)

* significantly greater than zero at 95% level
** significantly greater than zero at 99% level

Note: In the first column, the pure geography approach, the instrumental variable for the domestic country's openness is the fitted value based on the following variables: populations and land areas of it and its trading partners, the distance between them, and dummy variables for common borders and landlockedness. They do not include any measure of trading partners' GDPs. In the second column, the gravity approach, partners' factor accumulations (investment, population growth, and schooling) are substituted for their incomes, as instrumental variables for openness. In both columns, the fitted values for trade are estimated by Tobit, as one way of dealing with zero values.

TABLE 3 (USING IV)

country	growth residual	contribution of openness	contribution of investment	contribution of pop. growth	contribution of schooling	contribution of 1960 GDP
China	0.45180	-0.092600	0.018343	-0.016562	0.16593	0.33480
Hong Kong	0.88402	0.37740	0.11475	-0.033773	0.22869	-0.040037
Indonesia	0.48073	-0.047472	0.027645	-0.0049350	-0.033364	0.24759
Japan	0.83444	-0.091046	0.23016	0.028028	0.32607	-0.10020
S. Korea	0.87589	0.016705	0.12130	-0.025806	0.28959	0.095206
Malaysia	0.44082	0.11050	0.12853	-0.036732	0.18507	-0.030236
Philippines	-0.14469	-0.039323	0.030784	-0.017185	0.28492	0.065082
Singapore	0.72298	0.65382	0.20450	-0.047042	0.26013	-0.097621
Taiwan	0.80435	0.084861	0.13281	-0.028790	0.30072	-0.0026363
Thailand	0.42617	-0.025698	0.066855	-0.027152	0.017469	0.20366

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TABLE 3b (USING IV)

country	percent of growth due to openness	percent due to investment	percent due to pop. growth	percent due to schooling	percent due to 1960 GDP	percent due to unexplained factors
China	-0.20496	0.040600	-0.036657	0.36727	0.74104	0.092704
Hong Kong	0.42691	0.12980	-0.038204	0.25870	-0.045290	0.26809
Indonesia	-0.098749	0.057506	-0.010266	-0.069402	0.51503	0.60588
Japan	-0.10911	0.27585	0.033589	0.39076	-0.12008	0.52899
S. Korea	0.019073	0.13849	-0.029463	0.33063	0.10870	0.43257
Malaysia	0.25067	0.29157	-0.083325	0.41982	-0.068591	0.18985
Philippines	0.27177	-0.21275	0.11877	-1.96916	-0.44980	3.24118
Singapore	0.90434	0.28296	-0.065067	0.35980	-0.13503	-0.34691
Taiwan	0.10553	0.16511	-0.035793	0.37387	-0.0032801	0.39456
Thailand	-0.060299	0.15687	-0.063712	0.040990	0.47789	0.44826

TABLE 4 (USING IV)
[REVISED]

country	actual 1965 trade share	fitted trade share	contribution of fitted openness	contribution of residual openness	percent of growth due to fitted openness	percent due to residual openness
China	24.93000	44.78735	-0.042029	-0.050571	-0.093024	-0.11193
Hong Kong	209.48000	96.64214	0.090030	0.28737	0.10184	0.32507
Indonesia	42.65000	45.25818	-0.040830	-0.0066423	-0.084932	-0.013817
Japan	25.54000	54.76419	-0.016621	-0.074426	-0.019918	-0.089192
S. Korea	67.85000	71.50314	0.026009	-0.0093035	0.029694	-0.010622
Malaysia	104.68000	57.69717	-0.0091512	0.11965	-0.020759	0.27143
Philippines	45.85000	56.49353	-0.012216	-0.027106	0.084432	0.18734
Singapore	318.01999	102.53243	0.10503	0.54878	0.14528	0.75906
Taiwan	94.62000	68.53370	0.018446	0.066434	0.022933	0.082594
Thailand	51.20000	50.16552	-0.028332	0.0026345	-0.066481	0.0061819

TABLE 4b

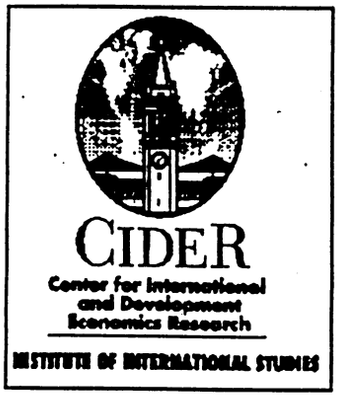
WEIGHTED AVERAGE OF TRADING PARTNERS' DATA

country or group	total GDP, 1985	pop., 1985	GDP per capita, 1985	number of workers, 1985	GDP per worker, 1985	distance	adjacency	area
China	1.13D+12	8.80D+07	11442.71	4.81D+07	20846.91	5107.31	0.22	7.34D+5
Hong Kong	1.66D+12	3.58D+08	9291.82	1.98D+08	18465.80	5860.25	0.25	1.87D+6
Indonesia	1.58D+12	1.20D+08	11998.31	6.63D+08	22518.42	8140.44	0.01	9.43D+5
Japan	1.78D+12	2.06D+08	10741.20	1.06D+08	22492.84	7891.65	0.00	2.06D+6
S. Korea	1.82D+12	1.33D+08	12356.06	6.74D+08	24261.15	6979.48	0.00	1.54D+6
Malaysia	9.04D+11	8.73D+07	9688.43	4.66D+07	19159.71	5391.44	0.35	6.61D+5
Phil.	1.83D+12	1.66D+08	11765.10	8.82D+08	23269.44	7729.25	0.00	1.58D+6
Singapore	1.16D+12	1.36D+08	8394.65	6.94D+08	18348.47	6429.71	0.20	1.08D+6
Taiwan	2.13D+12	1.43D+08	13053.85	7.27D+08	25726.83	8195.31	0.00	1.85D+6
Thailand	1.17D+12	1.36D+08	10286.80	7.46D+08	20589.42	6490.26	0.08	9.49D+5
East Asia	1.52D+12	1.57D+08	10959.73	8.37D+08	21559.82	6821.52	0.11	1.32D+6
South America	1.43D+12	1.23D+08	10142.56	5.89D+08	21955.36	7788.96	0.20	1.68D+6
Central America	3.09D+12	1.94D+08	14920.72	9.58D+08	30626.47	4516.67	0.74	2.76D+6
Africa	1.03D+12	9.21D+07	11309.49	4.47D+07	24398.16	5873.54	0.01	7.80D+5
OECD	9.79D+11	8.68D+07	11463.40	4.23D+07	24336.66	3753.55	0.26	7.98D+5
non-OECD	1.29D+12	1.19D+08	10857.83	5.98D+08	22791.70	6359.72	0.13	1.17D+6
world	1.17D+12	1.06D+08	11089.97	5.31D+08	23383.94	5360.69	0.18	1.03D+6

Appendix

100-country-sample

1	Algeria
2	Angola
3	Benin
4	Botswana
5	Burkina Faso
6	Burundi
7	Cameroon
8	Central African Republic
9	Chad
10	Congo
11	Egypt
12	Ethiopia
13	Ghana
14	Ivory Coast
15	Kenya
16	Liberia
17	Madagascar
18	Malawi
19	Mali
20	Mauritania
21	Mauritius
22	Morocco
23	Mozambique
24	Niger
25	Nigeria
26	Rwanda
27	Senegal
28	Sierra Leone
29	Somalia
30	South Africa
31	Sudan
32	Tanzania
33	Togo
34	Tunisia
35	Uganda
36	Zaire
37	Zambia
38	Zimbabwe
39	Canada
40	Costa Rica
41	Dominican Republic
42	El Salvador
43	Guatemala
44	Haiti
45	Honduras
46	Jamaica
47	Mexico
48	Nicaragua
49	Panama
50	Trinidad & Tobago
51	USA
52	Argentina
53	Bolivia
54	Brazil
55	Chile
56	Colombia
57	Ecuador
58	Paraguay
59	Peru
60	Uruguay
61	Venezuela
62	Bangladesh
63	Hong Kong
64	India
65	Indonesia
66	Israel
67	Japan
68	Jordan
69	South Korea
70	Malaysia
71	Myanmar
72	Nepal
73	Pakistan
74	Philippines
75	Singapore
76	Sri Lanka
77	Syria
78	Thailand
79	Austria
80	Belgium
81	Denmark
82	Finland
83	France
84	West Germany
85	Greece
86	Ireland
87	Italy
88	Netherlands
89	Norway
90	Portugal
91	Spain
92	Sweden
93	Switzerland
94	Turkey
95	UK
96	Australia
97	New Zealand
98	Papua New Guinea
99	China
100	Taiwan



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