EXPORT INSTABILITY AND GROWTH

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ABSTRACT

The impact of export receipts instability on growth is investigated by empirical methods. An instability index that varies over time and across countries is estimated by employing a model of autoregressive conditional heteroscedasticity. The data base includes annual data for twenty-six developing countries over the 1963-82 period.

Our primary result is that there is a negative effect of real export instability on the growth of developing countries. This impact is through reduced ex-post efficiency of investment, rather than through the level of investment. Country differences are demonstrated to be important for the magnitude of the impact. Instability is found to be more detrimental after the first oil shock in comparison to the previous period.

EXPORT INSTABILITY AND GROWTH

I. INTRODUCTION

In the past two decades, many development economists and policymakers have been concerned about the negative effect that instability in real export receipts may have on the growth of developing countries. Continuous "north-south" dialogue over internationally coordinated stabilization measures or design of financial compensation schemes highlight the importance of the issue.[1] Yet, despite the importance of the question and the sustained interest in it, the picture that emerges is still unclear.

Two fairly distinct schools of thought have emerged. (See Adams and Behrman (1982), McCormick (1980), Krueger (1984) and Wilson (1983) for reviews of the literature.) The first view emphasizes the negative impact of export instability on growth (see Nurkse (1958)). The most likely explanation of the negative correlation between export volatility and growth relies on the lack of perfect insurance markets. Specifically, in the absence of ability to smooth out fluctuations of export receipts, developing economies would face occasional difficulties importing intermediate and capital goods that are highly needed for production. In such economies, risk-averse private investors are likely to reduce their investment, or the ex-post efficiency of the existing investment is likely to be reduced.[2] A number of empirical studies have confirmed the existence of a negative relationship between instability and growth (see Glezakos (1973) and Voivodas (1974)).

The second view argues that export instability may encourage growth. The argument is that with risk averse individuals, uncertainty about future income will have a positive impact on savings by increasing the precautionary demand for savings. This in turn will ultimately lead to higher investment and higher growth. Empirical studies have also questioned the existence of a negative relationship between export instability and growth, and some have provided support for a positive link (see McBean (1966), Knudsen and Parnes (1975) and Yotopoulus and Nugent (1976)).

All previous empirical studies have used a cross-country approach alone, though they differ in the construction of the index. For example, McBean (1966) measured instability as the average annual percentage deviations in the dollar value of exports from a five-year moving average of export values. Kenen and Voivodas (1972) employ a first-order autoregressive model for export proceeds, with the standard error of the export equation being the measure of instability. The instability index of Glezakos (1973) is the arithmetic mean of the absolute values of the yearly changes in a time series corrected for a linear time trend. Knudsen and Parnes (1975) distinguish between export instability and domestic (defined as the instability of GNP less exports) instability. Moran (1983) considers price and quantity indices as well as export receipts indices. For each type of fluctuation considered, alternative definitions of cross-sectional export instability are used that differ in the way the trend is calculated.

A major drawback of all the studies reviewed above is that their cross-section approach holds the instability index constant over decades. Inspection of the export receipts data, however, indicates that export receipts are stable in some periods and very volatile in other periods (see Appendix Figure 1).

In contrast to existing studies we use an instability index that varies over time as well as across countries. To measure the movement of a single country's export receipts variance over time, we use a model of autoregressive conditional heteroscedasticity due to Engle (1982). We then investigate the impact of instability on GNP growth and on investment by employing annual data for twenty-six developing countries over the period 1963-82. The importance of cross-country differences (measured by openness and the compositionof exports), for the impact of instability on growth is also investigated. In addition to employing least squares estimation methods, we use Bayesian methods as a solution to the problems of measurement in the explanatory variables. Our estimates lead us to conclude that there is a negative effect which is sufficiently large for export instability to be a serious problem for developing countries.

Our methodology is presented in Section II. The results are presented in Section III. Section IV presents a discussion of these results and some policy implications.

II. METHODOLOGY

1. General Approach

To analyze the impact of export instability on growth we first create an instability index that varies over time for each country. We then investigate the impact of instability on growth by pooling across countries and over time. Two sets of regressions are estimated. First, we employ the country specific instability indices in an otherwise neoclassical growth equation to estimate the impact that instability has on the ex-post efficiency of investment. Second, we estimate an investment equation with instability as an explanatory variable. In addition to estimating each equation with the constraint that the effect of instability is the same across every country and year, we allow the effect to vary over time and across countries. Countries are differentiated by the commodity composition of their exports, and by the openness of their economies defined as the real export to real GNP ratio. The empirical specification of all those equations are discussed next.

2. An Index of Export Volatility

The movement of the variance of real export receipts over time is captured by the following model:

(1) $$e_{it} = \xi_{it} + u_{it}$$

(2) $$u_{it} | u_{it-1} \sim N(0, v_{it})$$

(3) $$v_{it} = \alpha_0 + \alpha_1 u_{it-1}^2 + \ldots + \alpha_k u_{it-k}^2 + \mu_{it}$$

where

e_{it} = real export earnings for country i at time t,

ξ_{it} = the trend value of real exports,

u_{it} = error term with mean zero and conditional variance v_{it},

μ_{it} = i.i.d. normal error term.

In equation (3) v_{it} is described as a linear combination of the lagged squared prediction errors of e_{it}. This is the Autoregressive Conditional Heteroscedasticity (ARCH) process developed by Engle (1982). The economic interpretation of the ARCH model is that if there have been large prediction errors in the recent past, then the forecast error variance is larger than if the recent past has conformed closely to expectations.

There are two econometric issues involved in implementing the procedure described. First, the specification of the trend value of exports, ξ_{it}, is a crucial step, for which there is no unique method. We have employed some alternative specifications but for concreteness, here we specify the trend level of exports as depending log-linearly on lagged exports, an index of industrial production in the developed countries, and a time trend:

$$(1') \qquad \log(e_{it}) = \beta_0 + \beta_1 \log(e_{it-1}) + \beta_2 Q^I_{t-1} + \beta_3 T + u_{it},$$

where

T = time trend,

Q^I_t = an index of industrial production in developed countries.

Second, we need to specify the order of the ARCH process. We assume that the variance of real export receipts follows a first order ARCH process because it seems reasonable to believe that events of the two prior years should have a relatively small impact on the uncertainty associated with a forecast for next year. Furthermore, only a small number of observations are available, which makes it difficult to estimate a higher order process. Accordingly, the instability index is

$$(3') \qquad v_{it} = \alpha_0 + \alpha_1 u^2_{it-1} + \mu_{it}.$$

3. Instability and Growth

Export instability may affect the growth process through a direct impact on investment levels and/or through the efficiency of the already existing capital stock. Accordingly a growth equation as well as an investment equation are estimated.

We assume a Cobb-Douglas form of a neoclassical growth model. This model can be interpreted as our null hypothesis, and we are interested in testing whether instability adds explanatory power to this growth model. Consequently, the equation that we estimate is

$$(4) \qquad Q^G_{it} = b_0 + b_1 L^G_{it} + b_2 K^G_{it} + \gamma v_{it} + \epsilon_{it},$$

where

Q^G_{it} = real GNP growth for country i at time t,

L^G_{it} = labor force growth,

K^G_{it} = growth of the capital stock,

ϵ_{it} = white noise error.

The investment equation is specified in equation (5)

$$K^G_{it} = a_0 + a_1 K^G_{it-1} + \omega v_{it} + \epsilon_{it} \tag{5}$$

In equations (4) and (5), the parameters of primary interest to us are constrained to be the same across countries. There is no reason, however, to assume that the impact should be the same for all countries over different periods of time. Accordingly, to allow for cross-country variation in the effect of instability, we interact the instability index with variables measuring country differences. In particular, instability is interacted with the real export to real GNP ratio, which is intended to allow the effect of instability to vary according to the degree of openness of the country. We also enter instability interacted with three measures of the commodity composition of exports: the percentage of total exports which is in (i) agriculture and raw materials, (ii) manufacturing, and (iii) chemicals and machinery. The possibility that the effect of instability may vary over time is also investigated by employing dummy variables.

4. Estimation

The ARCH model of equation (3') is estimated by a two-step least-squares procedure with equation (1').[3] The growth and investment equations in (4) and (5) are first estimated by ordinary least squares.[4] There is no doubt, however, that all of the variables used in this study are measured with a considerable amount of error. Klepper and Leamer (1984) have shown that when all variables in a regression are measured with error, the set of maximum likelihood estimates may be unbounded. A solution to this problem is to use inexact prior information that may be available, and perform a

Bayesian analysis. The Bayesian estimates can then be examined for sensitivity to reasonable changes in the form of the prior information, and we can see if the resulting set of estimates is informative.

We introduce prior information into the data analysis by assuming that our opinions about the parameters of equation (4) can be well-approximated by a multivariate normal distribution. The mixing of this information with the likelihood function of equation (4) produces a multivariate student posterior distribution, whose mean will be taken as the estimate of the parameter vector. We then examine the set of posterior means generated by varying the prior information. For this purpose we consider all prior covariance matrices Ω that satisfy

$$\delta^{-1}\Omega_0 \leq \Omega \leq \delta\Omega_0,$$

where Ω_0 is the prior covariance matrix discussed below, and where δ is an arbitrary number. This type of sensitivity analysis shows how the posterior mean varies as the prior covariance matrix is contracted or inflated, expressing greater or lesser confidence in the choice of prior mean (For further details, see Leamer and Leonard (1983) and Leamer (1982)).

Our prior information for the growth equation takes the form of a weak commitment to constant returns to scale, a belief that capital accumulation is relatively more important to growth than is labor force growth, and a cautious belief that high export instability may noticeably reduce growth. This is formalized in the following way:

1. $b_1 + b_2 = 1$, $\sigma_1 = .25$.

This prior restriction says that the sum of the coefficients on labor and capital is probably about 1, and our 95% prior confidence interval for returns to scale is (.5, 1.5).

2. $b_2 = .75$, $\sigma_2 = .25$.

In conjunction with restriction 1, this expresses the belief that capital is about three times as important as labor in the growth process, and the prior standard error expresses the near-certainty that its effect is positive.

3. $\gamma = -1.5$, $\sigma_3 = 1.5$.

This restriction indicates that we expect the impact of instability to be sizeable. Specifically, for our data set which will be discussed further later, this restriction means that a one standard deviation increase in instability will decrease growth by about one-quarter of a standard deviation, or by about 2 percentage points. Our vagueness about this view is expressed by a willingness to bet at only about 2 to 1 odds that the true parameter is negative, that is, our prior 67% confidence interval is (0,-3). In the regressions where we enter instability interacted with other variables, our prior is on the sum of the instability coefficients, and has the same mean and standard deviation as above.

We were not able to formulate a prior distribution for the investment model, so we only report the least squares estimates for the investment equation.

III. RESULTS

In this section we present three sets of results. The first concerns the instability index as defined in equations (1′) and (3′); the second is the estimate of the GNP growth model specified in (4); and finally the capital stock growth model as in (5). Equations (1′) and (3′) are estimated employing annual data for twenty-six developing countries over the period 1950-84.[5] Because we have only twenty years of capital stock data, however, equations (4) and (5) are estimated for the 1963-82 period.

Data sources and variable construction are described in detail in the Appendix, as are some simple descriptive statistics and sample correlations.

1. Instability Index

The motivation for using an ARCH model to describe the variability of real export receipts is the observation that exports grow smoothly and predictably in some periods, and quite erratically in other periods. Figure 1 is an example of this for two of the countries in our sample, Chile and India.

The parameter estimates for the detrending equations are in Table A-1, and the parameter estimates and standard errors for the ARCH processes are in Table A-2. Our estimates of the ARCH processes indicate that the ARCH effect, α_1 is typically positive (65% of the parameter estimates), although nearly half of these are not statistically significantly different from zero. Furthermore, almost none of the negative α_1 parameters are estimated statistically significantly. The lack of evidence for a statistically significant ARCH effect in nearly two-thirds of our estimates could be a concern if our primary purpose were to make inferences about the ARCH process. Instead our purpose is to construct a generally defensible measure of export instability.[6] These estimate indicate that the overall mean for the instability index v is .016, and its standard error is .009. The estimated v for Chile and India are shown in Figure 1.)

2. Instability and GNP Growth

In investigating the impact of export instability on GNP growth, equation (4) and its alternative specifications are employed. These specifications differ in the way the instability index enters the equation. Specifically, to allow for cross-country variations, the instability index is interacted with real export to real GNP ratios for countries as well as with variables that measure the export composition of countries. Furthermore, we allow the effect to differ over time, employing dummy variables for subperiods of our data. Table 1 presents the ordinary least squares estimates as well as the Bayesian estimates for all specifications.

When the impact of instability on growth is constrained to be the same over time and across countries, the coefficient on v indicates that a one standard deviation increase in instability would cause GNP growth to fall from its mean of 4.5% per year to about 3.7% per year.[7] While this effect is smaller than our prior mean by about half, it is still substantial, amounting to a difference in GNP of about 17% when compounded over twenty years.

Next, we allow the effect of instability to differ across countries. First, we find that the degree of openness of the economy, measured by the real exports to real GNP ratio, has a dramatic effect on the impact of instability on growth. The effect evaluated at the mean of the sample is almost twice as big as the effect estimated when openness is not taken into account. Second, we consider the composition of exports. The overall effect of instability is negative, but the biggest negative impact is on countries whose exports are relatively heavily concentrated in the most capital intensive sectors, which are chemicals and machinery.[8] This result provides some support for the hypothesis that the negative effect of instability works through reducing the ex-post productivity of the capital stock. The argument is that imperfections in the international credit markets preclude perfect insurance for fluctuations in the developing economies, and in particular fluctuations in foreign exchange earnings. Furthermore, developing countries that are producers of more capital intensive goods rely on large amounts of imported capital and intermediate goods, whereas

TABLE 1

The Impact of Instability On Growth: Equation (4)

(Numbers in parentheses are standard errors.)

		Least Squares		Bayesian Estimates	
Summary*	Variable**	Estimate	Beta***	Non-skeptical Prior: $\gamma=-1.5$	Skeptical Prior: $\gamma=0$
		Specification 1			
	CONST	.017		.0135	.0125
$R^2 = .166$		(.0084)			
	K^G	.633	.400	.649	.649
DL1 = .781		(.065)		(.062)	(.062)
	L^G	.030	.005	.171	.171
DL2 = .784		(.225)		(.171)	(.171)
	v	-.634	-.080	-.674	-.606
		(.326)		(.319)	(.319)
		Specification 2			
	CONST	.015		.011	.011
$R^2 = .180$		(.007)			
	K^G	.639	.404	.651	.651
DL1 = .709		(.065)		(.062)	(.062)
	L^G	.137	.025	.216	.206
DL2 = .456		(.226)		(.171)	(.171)
	v	-.191	-.019	-.188	-.221
		(.366)		(.363)	(.363)
	v(e/RGNP)	-3.550	-.132	-2.780	-2.210
		(1.250)		(1.02)	(1.02)

Table 1 (cont.)

Summary*	Variable**	Estimate	Beta***	Non-skeptical Prior: γ=-1.5	Skeptical Prior: γ=0
		Specification 3			
	CONST	.012		.008	.607
R^2 = .182		(.009)			
	K^G	.639	.404	.658	.663
DL1 = .753		(.067)		(.063)	(.063)
	L^G	.189	.035	.251	.244
DL2 = .514		(.234)		(.174)	(.174)
	v	-1.380	-.186	-1.620	-1.690
		(.946)		(.524)	(.524)
	v(AGRAW)	1.320	.131	1.530	1.650
		(.653)		(.610)	(.610)
	v(MANUF)	1.810	.093	1.890	1.880
		(1.05)		(1.03)	(1.030)
	v(CAPIT)	-5.370	-.096	-3.87	-2.80
		(2.690)		(1.65)	(1.65)
		Specification 4			
	CONST	.017		.0129	.119
R^2 = .190		(.008)			
	K^G	.606	.383	.623	.624
DL1 = .787		(.065)		(.062)	(.062)
	L^G	.061	.011	.197	.196
DL2 = .775		(.222)		(.169)	(.169)
	v	.018	.002	.005	.094
		(.364)		(.361)	(.361)
	v(POST73)	-1.210	-.176	-1.210	-1.180
		(.318)		(.316)	(.316)

Table 1 (cont.)

Summary*	Variable**	Estimate	Beta***	Non-skeptical Prior: γ=-1.5	Skeptical Prior: γ=0
		Specification 5			
	CONST	.014		.0101	
R^2 = .196		(.009)			
	K^G	.608	.384	.626	.630
DL1 = .849		(.067)		(.0639)	(.064)
	L^G	.180	.033	.264	.297
DL2 = .665		(.232)		(.174)	(.174)
	v	-.622	-.078	-.720	-.770
		(.618)		(.609)	(.605)
	v(AGRAW)	.711	.071	.854	.951
		(.682)		(.649)	(.649)
	v(MANUF)	1.660	.085	1.760	1.750
		(1.040)		(1.020)	(1.020)
	v(CAPIT)	-3.360	-.060	-2.650	-1.960
		(2.760)		(1.700)	(1.700)
	v(POST73)	-1.030	-.150	-1.030	-1.060
		(.397)		(.393)	(.393)

*DL1 is the ratio of the likelihood value evaluated at the posterior mean to the maximum likelihood value for the nonskeptical prior. DL2 is defined similarly for the skeptical prior.

**Post73 is a dummy variable that is one for years after 1973. (e/RGNP) is the real exports to real GNP ratio. AGRAW, MANUF and CAPIT are variables that measure the percentage of exports of a country that falls into agriculture and raw materials, manufacturing and capital intensive goods. These variables are more precisely defined in the Appendix.

***Beta coefficients are a scaling of the least squares estimates that measure how many standard deviations the dependent variables moves when there is one standard deviation increase in the dependent variable.

agricultural production generally requires fewer imported inputs. Consequently, the limited ability to smooth fluctuations will have a more negative effect on countries that need higher levels of imports for production. In other words, the limited ability to import intermediate goods seems to reduce the ex-post efficiency of investment.

Allowing the effect to differ in the first and second half of the sample, we find that instability has essentially no effect from 1963 to 1973, but from 1974 to 1982 the effect is negative and quite large, with a one-standard deviation increase in v lowering growth by about 1.2 percentage points. A possible explanation for the time effect is that the average level of instability has increased over time. However, that is not the case; in fact, the mean of v is about 9% lower in the second half of the sample.[9] Second, it is possible that the time dummy and the percent of exports in chemicals and machinery are measuring the same effect because the countries in our sample have diversified their exports away from agriculture over time.[10] To check this, we include the time variable in a regression with the export composition variables; the results support this interpretation somewhat (the correlation between the coefficients on time and the capital intensive exports variable is -0.25), but the time variable still has a large effect.

Table 2 presents the results of a Bayesian sensitivity analysis, where the extreme bounds are calculated using $\delta = 2$; that is, the bounds on the prior covariance matrix are 1/2 and 2 times the covariance matrix described above. This allows prior information to be very dogmatic or quite diffuse. For the non-skeptical prior, each regression leads to the same conclusion. The overall effect of instability on growth is negative as shown by the negative extreme bounds on γ. For the more skeptical prior, all but the

TABLE 2

The Impact of Instability On Growth:

Sensitivity Analysis

Extreme Bounds, $\delta = 2$

Specification*	Non-skeptical Prior		Skeptical Prior	
	Max	Min	Max	Min
1	-.604	-.813	-.486	-.676
2	-2.040	-3.640	-1.040	-3.420
3	-1.280	-3.190	-.035	-2.430
4	-1.120	-1.330	-.932	-1.220
5	-.830	-2.920	.031	-1.920

*These specifications correspond to the ones employed in Table 1.

last regression reported has bounds which are negative. In the last regression, the upper bound on the effect of instability is positive but very small. The results of this sensitivity analysis suggests that we can be sure of the sign of the effect of instability on growth, but that it is difficult to pin down a precise magnitude.

To summarize, the results presented in Tables 1 and 2 point out that country differences are important in examining the impact of export instability on growth. First, instability hurts countries with large real exports to real GNP ratios. Second, the countries with a large share of exports in capital intensive industries are affected more negatively than countries which concentrate their exports in agriculture and manufacturing goods. Finally, most of the negative effect of instability on growth is apparent only in the latter half of our sample period.

3. Instability and Investment

Table 3 presents the parameter estimates and the standard errors of equation (5). When country differences are neglected, the coefficient on v indicates that a one standard deviation increase in instability would cause capital growth to fall from its mean of 6.4% per year to about 6.24% per year. This effect is quite small, and the large standard error indicates that we cannot be sure of the sign of the effect.

In contrast to the results of the growth regressions, the openness of the economy has essentially no effect on the impact of instability. The regressions including variables on export composition give somewhat different results than the growth regressions do. For the present equations both the percentage of exports in agriculture and in highly capital intensive sectors contribute to a negative effect of volatility. However, the net effect at the mean of the sample is quite small, although negative. As with the results

TABLE 3

Impact of Instability On Investment: Equation (5)

(Numbers in parentheses are standard errors.)

Specification 1

Variable	OLS Estimate	Beta
CONSTANT	.015	
	(.003)	
Lagged K^G	.757	.736
	(.032)	
v	-.141	-.028
	(.157)	

$R^2 = 0.541$

Specification 2

Variable	OLS Estimate	Beta
CONSTANT	.015	
	(.003)	
Lagged K^G	.755	.734
	(.032)	
v	.048	.00958
	(.176)	
v(POST73)	-.345	-.0795
	(.153)	

$R^2 = .546$

Specification 3

Variable	OLS Estimate	Beta
CONSTANT	.015	
	(.003)	
Lagged K^G	.757	.736
	(0.322)	-.0283
v	-.142	-.0283
	(.177)	
v(RGXP/RGNP)	-.005	-.00269
	(.602)	

$R^2 = .941$

Specification 4

Variable	OLS Estimate	Beta
CONSTANT	.019	
	(.004)	
Lagged K^G	.737	.717
	(.033)	
v	.199	.040
	(.299)	
v(AGRAW)	-.535	-.084
	(.312)	
v(MANUF)	.186	.015
	(.478)	
v(CAPIT)	-2.837	-.082
	(1.245)	

$R^2 = .548$

Specification 5

Variable	OLS Estimate	Beta
CONSTANT	.019	
	(.004)	
Lagged K^G	.729	.709
	(.033)	
v	.533	.106
	(.293)	
v(AGRAW)	-.757	-.119
	(.324)	
v(MANUF)	.124	.010
	(.476)	
v(CAPIT)	-2.040	-.059
	(1.280)	
v(POST73)	-.406	-.094
	(.170)	

$R^2 = .543$

for the growth model, the effect is much larger in the second half of the sample, with a one standard deviation increase in instability reducing capital growth from 6.4% per year to about 6% per year.

Overall, the effect of instability on the growth of the capital stock is much smaller and more ambiguous than its effect on growth. This lends support to the interpretation that the effect of instability operates through reducing the efficiency of the already existing capital stock, by making the supply of intermediate inputs erratic, with only a small effect on the level of investment.

IV CONCLUSION

In this study, we constructed a measure of export instability that varies over time for each country, in contrast to the solely cross section approach of the existing studies. This approach is an improvement on existing studies because exports data are predictable and stable in some periods and very volatile in other periods.

We analyzed the response of capital stock growth and GNP growth to instability. Our primary result is that there is a negative effect of real export instability on the growth of developing countries. This impact appears to be through reduced ex-post efficiency of investment, rather than through the level of investment. Furthermore, we demonstrated that country differences are important. Specifically, openness and the export composition of countries affect the magnitude of the negative impact.

Overall, although measurement error and ambiguity in the choice of econometric specification make a precise estimate of the magnitude impossible, our results suggest that the negative effect of instability on growth is large enough to be a source of concern for policymakers.

There are two possible policy responses to the conclusion that export instability negatively affects growth. The first approach is to improve financing for the developing countries. The development of such schemes, perhaps in the context of existing international institutions, is therefore an important policy issue. The second is to try to reduce the magnitude of instability. This approach would require a through understanding of the causes of instability. A number of existing studies have investigated the sources of instability by focusing on export structure of developing countries.[11] Other sources, such as the exchange rate policies of governments, could also be investigated. Although important, this latter issue is beyond the scope of the present study.

ENDNOTES

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[1]See, for example, U.N. (1979). A number of stabilization programs have been discussed. For example, compensatory financing schemes are designed to allow developing countries to maintain a constant level of imports. Buffer stock programs, on the other hand, attempt to regulate prices. For a review of the literature on stabilization policies see McCormick (1980).

[2]Another cause of a negative impact is that unstable receipts may cause instability in foreign exchange reserves, forcing countries to hold very large reserves. The opportunity cost of these reserves may be substantial.

[3]Joint estimation by maximum likelihood is a more efficient procedure, but Engle (1982) shows that the efficiency gain from maximum likelihood is small unless the α_1 coefficient is near unity. We experimented with maximum likelihood estimation and found that it made no appreciable difference in the estimated conditional variances. In cases where the estimated α_1 coefficient is negative we set the instability index equal to the unconditional variance of the residuals from the detrending equation.

[4]With this method γ and ω are estimated consistently although the standard errors on γ and ω are biased downward. Because the v_{it} series is generated from a regression model, the estimated covariance matrices of models (4) and (5) are incorrect. Pagan (1984) gives results for the correct computation of the covariance matrices.

[5]The countries are: Greece, Portugal, Turkey, Brazil, Chile, Colombia, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Panama, Peru, Uruguay, Jamaica, Cyprus, Egypt, Burma, India, South Korea, Malaysia, Pakistan, Philippines, Thailand, Nigeria, and South Africa.

[6]We also estimated a version of equation (1) in first differences, and ran all the regressions reported in the paper using the resulting v series. Somewhat surprisingly, since the two v series have a correlation of only about .67, the results of the regression analysis were very similar. In the interests of brevity, we therefore only report the results using the v series generated by equation (1′) in the paper. Complete results using the other v series are available from the authors.

[7]We also examined the data for outliers, in the sense of observations that make a disproportionately large impact on the estimate of the parameter of interest γ. To identify outliers, we looked at the measure DFBETAS, as described in Krasker, Kuh, and Welsch (1983); observations with a large value of DFBETAS are observations that are influential. Three countries, Brazil, Chile, and Nigeria, each had a large number of influential observations, but running the OLS regressions without these countries changed the estimate of γ by less than ten percent or so.

[8]We considered one other way of defining export composition, by splitting up the manufacturing category into labor and capital intensive sectors, and adding the capital intensive sector to the category of chemicals and machinery. While this changed the results somewhat, it did not alter the main inference, that is, that the effect of instability is most negative when the concentration in capital intensive production is largest. The complete results are available from the authors on request.

[9]Since the second half of our sample corresponds to the post- first oil shock period we also explored the impact of having oil exports in our sample in two steps: 1) In estimating the detrending equation (1′) we employed dummy variables for Egypt, Nigeria and Mexico, which are the oil exporters in our sample. The instability index obtained in this manner is very highly correlated (.96) with the instability index reported in the text. 2) In estimating the growth equation (5) we employed a dummy variable that is one for oil exporters and zero otherwise, and interacted this dummy variable with the instability index. This specification yields the parameter estimate (standard error) of the instability index as -0.45 (0.34) and the parameter estimate (standard error) of the interaction term -1.04 (0.60).

[10]Diversification could reduce export earnings instability if earnings from manufactures are more stable than earnings from primary products. Existing evidence indicates that "diversification has taken place but has not been accompanied by relatively greater stability in manufactures and favorable changes in covariances" (Love, 1983). Furthermore, decreased instability by itself is not sufficient to provide evidence on the impact of instability.

[11]See McCormick (1980) for a review of this literature.

APPENDIX

Variable Definition and Data Sources

IFS stands for International Financial Statistics, which is the data base assembled by the International Monetary Fund.

Exports (e): Nominal exports in U.S. dollars, deflated by U.S. wholesale price index, both from IFS.

Industrial Production (Q^I): Index of industrial production of the developed countries, from IFS.

Real GNP (Q): Nominal GNP in domestic currency is deflated by the consumer price index of the country, both from IFS.

Labor Force Growth (L^G): Number of people in the labor force is calculated by using the population series from the IFS multiplied by the percentage of the population which is economically active, from the International Labor Organization's Labor Force Projections. The ILO's data is only every five years, so we fill in the missing years by interpolating linearly.

Growth of Capital Stock (K^G): Capital stock in U.S. dollars is discounted real investment flows, assuming a 15 year useful life. The series was kindly provided to us by Edward Leamer, and the construction of the capital stock series is discussed in detail in Appendix B of Leamer (1984).

Export Composition Our classification scheme for export structure is based on the classification scheme developed in Leamer (1984, pp. 62-63) that employs SITC categories. Our AGRAW variable includes his categories 2-6, our MANUFPCT includes his categories 7 and 8, and our CAPIT includes his categories 9 and 10. The data was also provided to us by Edward Leamer.

Openness is defined the ratio of real exports to real GNP.

All data are available from the authors on request.

Sample Characteristics

VARIABLE	MEAN	STANDARD DEVIATION
growth rate of real GNP (Q^G)	0.045	0.075
growth rate of the labor force (L^G)	0.021	0.013
growth rate of the capital stock (K^G)	0.063	0.045
real exports (e)	34.498	44.109
Estimated Conditional Variance (v)	0.016	0.009

Pearson Correlation Coefficients, 500 observations

Q^G	1.000								
K^G	0.400	1.000							
L^G	0.033	0.068	1.000						
v	-0.078	0.005	0.003	1.000					
POST73	-0.194	-0.141	0.053	0.074	1.000				
e/RGNP	-0.107	-0.022	0.185	0.055	0.249	1.000			
AGRAW	0.053	-0.126	0.010	-0.099	-0.392	-0.059	1.000		
MANUF	0.006	0.049	-0.259	-0.111	0.218	-0.104	-0.659	1.000	
CAPIT	-0.123	-0.113	0.115	-0.201	0.316	0.139	-0.455	0.329	1.000

Table A.1 - Detrending Equation (1')

Country	β_o	β_1	β_2	β_3
Greece	43.096	0.766**	0.016**	-0.022
Portugal	47.175*	0.434**	0.023**	-0.024*
Turkey	11.555	0.788**	0.008	-0.006
Brazil	67.775**	0.842**	0.018**	-0.035**
Chile	71.692*	0.231	0.026**	-0.036
Colombia	61.413	0.781**	0.015*	-0.031*
Dominican Republic	62.658	0.668**	0.017*	-0.032
El Salvador	37.948	0.792**	0.010	-0.019
Guatemala	46.046	0.642**	0.016*	-0.024
Honduras	43.331	0.467**	0.019*	-0.022
Mexico	49.333	1.013**	0.011*	-0.025
Panama	-8.760	0.942**	-0.002	0.005
Peru	14.931	0.715**	0.008	-0.007
Uruguay	48.870	0.709**	0.013	-0.025
Jamaica	37.758	0.951**	0.006	-0.019
Cyprus	28.451	0.455**	0.016*	-0.015
Egypt	17.064	0.425**	0.009	-0.008
Burma	70.318	0.857**	0.012	-0.036
India	7.746	0.654**	0.006	-0.003
South Korea	42.186	0.656**	0.040**	-0.022
Malaysia	30.200	0.726**	0.013	-0.015
Pakistan	42.664	0.717**	0.012	-0.022
Philippines	25.822	0.404**	0.017**	-0.013
Thailand	40.402	0.735**	0.016**	-0.021
Nigeria	161.791**	0.790**	0.040**	-0.083**
South Africa	49.086	0.691**	0.015**	-0.024

* Significant at 5% confidence level

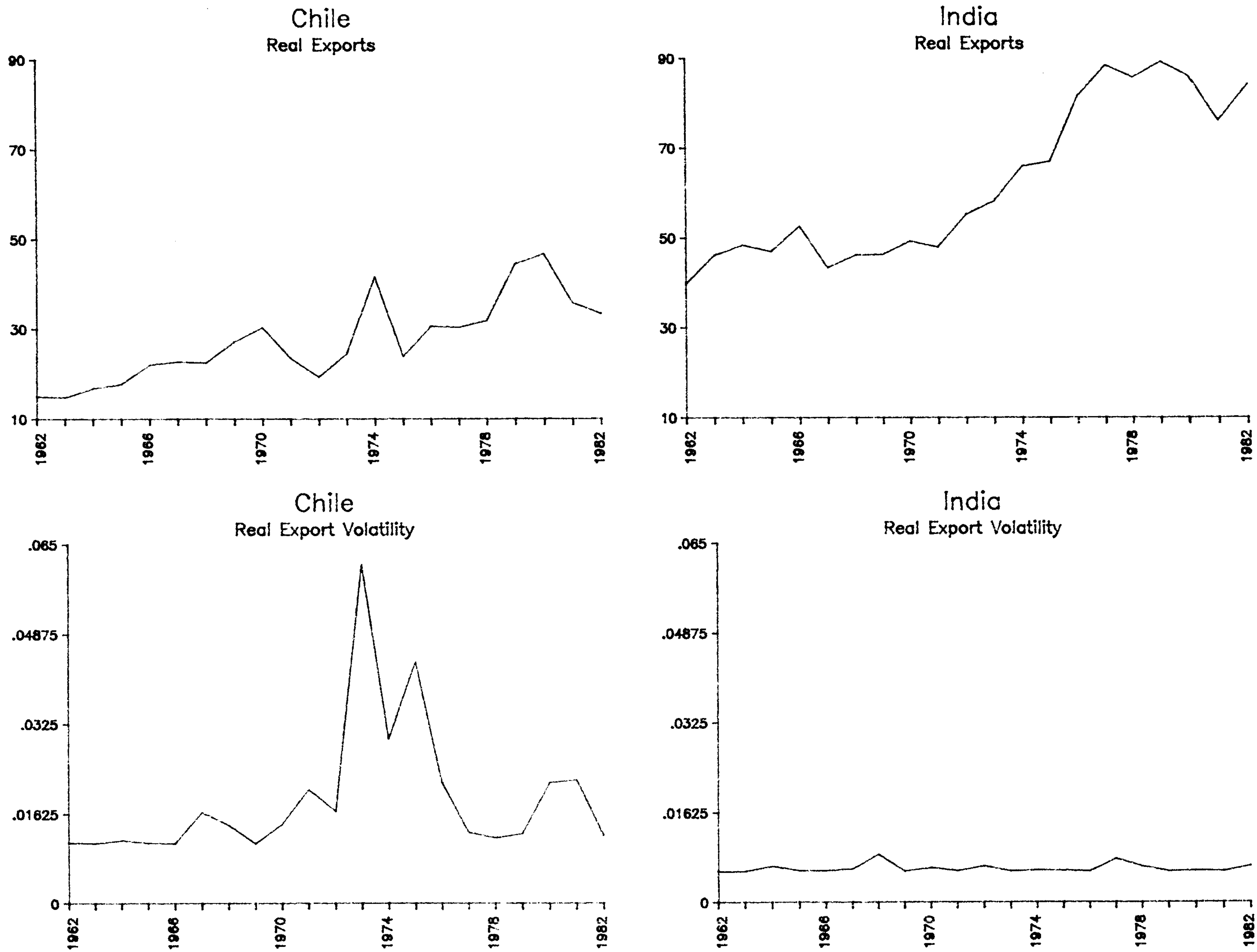
** Significant at 1% confidence level

Table A.2 - ARCH Regressions: Equation (5')

(standard errors in parentheses)

	(1")			(1")	
Country	Constant	α_1		Constant	α_1
Greece	0.009 (0.003)	-0.107 (0.173)	Uruguay	0.028 (0.008)	-0.098 (0.178)
Portugal	0.005 (0.002)	0.131 (0.180)	Jamaica	0.012 (0.004)	0.139 (0.174)
Turkey	0.018 (0.006)	0.158 (0.177)	Cyprus	0.010 (0.005)	0.221 (0.175)
Brazil	0.004 (0.002)	0.335 (0.158)	Egypt	0.007 (0.003)	0.141 (0.165)
Chile	0.011 (0.005)	0.380 (0.167)	Burma	0.026 (0.008)	-0.076 (0.180)
Colombia	0.013 (0.004)	-0.042 (0.179)	India	0.006 (0.002)	0.078 (0.123)
Dom. Rep.	0.030 (0.009)	-0.150 (0.178)	South Korea	0.019 (0.008)	0.271 (0.130)
El Salvador	0.012 (0.005)	0.322 (0.169)	Malaysia	0.016 (0.005)	0.086 (0.165)
Guatemala	0.013 (0.006)	0.012 (0.181)	Pakistan	0.017 (0.008)	0.185 (0.144)
Honduras	0.008 (0.003)	0.373 (0.165)	Philippines	0.009 (0.003)	0.151 (0.177)
Mexico	0.010 (0.003)	-0.135 (0.178)	Thailand	0.009 (0.003)	0.069 (0.180)
Panama	0.022 (0.007)	-0.066 (0.179)	Nigeria	0.040 (0.012)	-0.074 (0.179)
Peru	0.026 (0.007)	-0.223 (0.175)	South Africa	0.040 (0.012)	-0.074 (0.179)

Figure 1


Chile
Real Exports
90
70
50
30
10
1962
1966
1970
1974
1978
1982
India
Real Exports
90
70
50
30
10
1962
1966
1970
1974
1978
1982
Chile
Real Export Volatility
.065
.04875
.0325
.01625
0
1962
1966
1970
1974
1978
1982
India
Real Export Volatility
.065
.04875
.0325
.01625
0
1962
1966
1970
1974
1978
1982

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