FOREIGN INVESTMENT AND TRANSITION IN CENTRAL/EASTERN EUROPE ALONG THE PHASE CURVE

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Abstract
An empirical neoclassical growth model reveals that foreign investment incrementally contributed to the economic transition of 27 countries in Central and Eastern Europe during the transition period 1989 to 2003. The model departs from the theoretical and applied growth literatures by estimating the phase equation of a partial adjustment model of growth that implicitly includes foreign investment. The pooled estimate reveals an early phase of economic growth that will take generations, aside from a few positive outliers, to approach the status of the developed countries.
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1. Introduction

Foreign investment plays a role in successful economic growth. The present paper estimates a growth phase equation with pooled data for the 27 Central and Eastern Europe and Newly Independent States (CEENIS) during their transition years 1989 to 2003. Sustained economic growth in the CEENIS region remains a critical international issue, and the widely varying situations in the region provide a unique experiment for analyzing the growth process.

Growth theory generally assumes perfect foreign investment occurs in the steady state while economies in transition seem to be moving toward the steady state. Applications interpret residuals of estimated production or cost functions as evidence of technological improvement associated with foreign investment. The present model is a departure, directly estimating a differential growth phase equation. The underlying theoretical model assumes foreign investment feeds into the capital stock in an explicit partial adjustment mechanism based on Thompson (2007). The model specifies foreign investment as a function of its expected return, estimated in a first stage model. Zhang (2001) presents a similar direct estimate of the recent transition in China finding a positive effect of foreign investment concentrated in the coastal provinces.

2. A brief review of the literature on foreign investment and growth

Barro and Sala-i-Martin (1999) illustrate the typical assumption of applied growth theory that foreign investment shifts technology. Examples include Blomström, Lipsey and Zejan (1992), De Gregorio (1992), and Berthelemey and Demurger (2000). The evidence on technology spillover from foreign ownership based on residuals of production or cost functions is inconclusive. As examples, Aitken, Harrison, and Lipsey (1996) and Campos and Kinoshita (2002) find positive spillovers while Aitken and

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Harrison (1999) do not. In the CEENIS region, Konings (2001) finds foreign investment does not raise firm productivity in Bulgaria, Romania, or Poland.

The present estimation includes non-economic influences that might affect growth, testing several indices of the European Bank of Reconstruction and Development (EBRD, 2004). Other exogenous influences in the literature include local market potential and low production cost (Lankes and Venables,1996), domestic market size, the competitive environment, human capital (Balasubramanyam, Salisu, and Sapsford, 1999), schooling (Lipsey, 2000), political and legal issues (Bevan and Estrin, 2000), institutions (Rodrik, Subramanian, and Trebbi, 2004), investment uncertainty (Pennings and Altomonte, 2003), and regional integration (Waldkirch, 2003). In the CEENIS region, Clasusing and Dorobantu (2005) show market size and cost differences affect foreign direct investment while announcements of EU accession stimulate growth. The present estimate does not include thes other exogenous variables but they can be included in this framework.

The present methodology applies to economies experiencing economic growth rather than those in or near the steady state. Campos and Coricelli (2003) survey the inconclusive literature on foreign investment and growth suggesting pooled data in models beyond the standard framework. The present empirical results confirm the positive influence of foreign investment in pooled data uncovered by Gopinath and Chen (2003).

3. Foreign investment in a partial adjustment model

The neoclassical production function with constant returns and diminishing marginal productivity is the foundation for the growth model of Solow (1956) and Swan (1956). The per capita production function is $y = y(k)$ where y is income per capita (worker) $y \equiv Y/L$, $Y \equiv$ gross domestic product, and k is the capital/labor ratio $k \equiv K/L$.

Given the potential of foreign investment to add directly to the capital stock, capital K in a host country is composed of domestic and foreign capital, $K = K_D + K_F$. In a source country, foreign capital K_F would be negative. The capital stock then changes according to

$$K^{\bullet} = K_D^{\bullet} + K_F^{\bullet}, \tag{1}$$

where dots $^{\bullet}$ represent a time derivatives d/dt. Domestic capital K_D grows due to domestic saving that depends on per capita income,

$$K_D^{\bullet} = S(y). \tag{2}$$

Capital is paid its marginal product and the first derivative of the production function $y_k \equiv dy/dk$ equals the return to homogeneous domestic and foreign capital. The expected return to capital r^e would be relevant for investment decisions and the model estimates r^e as the marginal product y_k. Foreign investment is assumed to be a positive function of the difference between r^e and the exogenous world interest rate r^*, as well as the exogenous vector of transition progress indices ω,

$$K_F^{\bullet} = \Phi(r^e - r^*, \omega). \tag{3}$$

The opportunity cost of foreign investment is the exogenous international expected return r^* in these small open economies. If $r^e = r^*$ there is no foreign investment, $\Phi = 0$. Transition progress indices would increase the slope of the investment function.

The partial adjustment model of foreign investment is from Thompson (2007). The estimation assumes a partial adjustment process with the economies in transition short of the steady state. Where K_F* represents the optimal foreign capital stock, foreign investment adjusts each period according to $\alpha(K_F^* - K_F)$ where $0 < \alpha < 1$. This model of imperfect capital mobility seems appropriate for economies in transition because as Lucas (1990) suggests larger differences between capital/labor ratios might make foreign investment more difficult.

Combining domestic and foreign investment, the capital stock evolves according to

$$K^{\bullet} = S(y) + \Phi(r_e, \omega) \tag{4}$$

assuming constant r*. The capital/labor ratio k adjusts according to $k^{\bullet} = (K^{\bullet}L - L^{\bullet}K)/L^2$ and from (3) and (4) the phase curve is

$$k^{\bullet} = \sigma(y) + \varphi(r_e, \omega) - (n + \delta)k \tag{5}$$

where $\sigma(y)$ is the per capita saving function, $\varphi(r_e, \omega)$ is the per capita foreign investment function, $n \equiv L^{\bullet}/L$ is the constant exogenous growth rate of labor, and δ the depreciation rate.

Sufficient conditions for a concave phase curve and steady state stability are a neoclassical production function and an increasing concave effect of r^e on φ. Necessary conditions are much weaker. Foreign investment is added to the neoclassical saving curve σy and the $\sigma y + \theta$ curve, diminishing as r^e falls.

The phase curve without foreign investment approaches the steady state k^A. The phase curve with positive foreign investment would have a higher steady state k^S and lies everywhere above the phase curve without foreign investment. The present model avoids the startup problem of neoclassical growth theory where $k = 0$ with $k^{\bullet} > 0$ due to foreign investment. Countries with higher labor growth rate n or more responsive foreign investment function φ would tend to be a steady state foreign investment source.

4. Specification of growth along the phase curve

The empirical model is a specification of phase equation (5) in a first order differential equation in k familiar from neoclassical growth theory with the explicit separation of foreign investment. Per capita income y is a function of k. Saving in (5) can be written $\sigma(y(k))$. The general form of (5) is then $k^{\bullet} = f(k; r^e, \omega, n)$ with exogenous variables r^e, ω, and n.

The estimated phase equation is

$$k_{it}^{\bullet} = \alpha_0 + \alpha_1 k_{it} + \alpha_2 k_{it}^2 + \alpha_3 r^e_{it} + \alpha_4 n_{it} + \alpha_5 \omega_{it} + \alpha_6 d_t + a_i + \varepsilon_{it}, \tag{6}$$

where subscripts i refer to country and t to year. The quadratic term is included to allow a concave phase line. The vector d_t is a dummy variable for time and the latent unobservable element a_i captures time constant effects on $k^{\bullet}$.

Saving and foreign investment do not enter directly into (6) but saving would affect capital accumulation through the saving function $\sigma(y(k))$. A change in the independent expected return to capital r^e shifts phase curve (6). The estimation includes transition progress indices in the vector ω to determine whether they affect the phase curve.

Economic properties imply a concave phase curve of $k^\bullet$ in k and there are other requirements for a stable steady state. At low levels, an increase in k would raise $k^\bullet$. With concavity, the slope of the phase curve $\alpha_1 + 2\alpha_2 k$ is negative beyond $k = -\alpha_1/2\alpha_2$. From (5) the slope of the phase curve is $\delta k^\bullet/\delta k = \sigma_y y_k - n$ estimated as $\delta k^\bullet/\delta k = \alpha_1 + 2\alpha_2 k$ in (6) leading to derivation of the marginal propensity to save σ_y.

An increase in the expected return to capital r^e would increase foreign investment $\varphi(r^e, \omega)$ and $k^\bullet$ given the positive coefficient α_3 in (6). The estimated r^e is independent of k. A negative coefficient α_4 would indicate that a higher labor growth rate implies a lower phase curve. The α_5 coefficients would isolate any effects of the transition indices in vector ω.

5. Data and Preliminary Estimation

Data cover the transition years 1989 to 2003. Economic and workforce data are from the *World Development Indicators* series compiled by the World Bank. Economic variables are in 1995 US dollars. Transition progress indices are from the *Transition Reports* of the European Bank of Reconstruction and Development (EBRD, 2004). Countries that gained independence from the former Yugoslavia and USSR are included from the first year of World Bank data.

Derivation of the capital/labor ratio requires an estimate of the capital stock. One technique is to build K_{it} by setting K_{i1} equal to gross fixed capital formation I_{i1} in the first year of the data 1983 with each subsequent K_{it} calculated as $K_{i,t-1} + I_{it}$. An alternative is to begin the capital accumulation process based on a preliminary K_{i1} from a standard capital/GDP ratio. Estimates of (6) with either technique are nearly identical and the present specification builds the capital stock series for the 14 years starting with the first year's investment. Summary statistics are in Table 1 in the Annex.

There are high degrees of variation. The average k is \$7,720 ranging up to \$55,149 for Slovenia in 2003. For comparison, k in the developed countries is at least \$80,000 in the derivations of Jones and Hall (1999). The standard deviation of k is larger than its mean.

The dependent variable $k^\bullet$ has mean \$1,040 with a slightly larger standard deviation. The smallest $k^\bullet$ is \$19 for Tajikistan in 1991 and the largest \$6,151 for Slovenia in 2003.

The expected return to capital r^e is the first derivative of the production function, $r^e = f_k = dy/dk = y^\bullet/k^\bullet$. To derive an independent r^e consider $k^\bullet$ a function of y given the dependent variable $k^\bullet$ in phase equation (6). That is, $r^e = y^\bullet/k_p^\bullet$ where the predicted $k_p^\bullet$ comes from the pooled regression $k^\bullet = b_0 + b_1 y$ making r^e a function of $y^\bullet$ and y. Estimated parameters and t-statistics are $k^\bullet = -.205\ (-4.02) + .269y\ (38.4)$ with an R^2 of 0.94 and no indication of autocorrelation or other statistical problems in the pooled data. Higher y is associated with higher $k_p^\bullet$ suggesting an early period of accelerating growth in the sample. Using these estimated parameters, the expected return to capital in Table 1 is derived as $r^e = y^\bullet/k_p^\bullet = y^\bullet/(-.205 + .269y)$.

The high variation in the estimated r^e reflects volatile transition. The largest r^e is 21% for Bosnia & Herzegovina in 1996 coincidental with a large labor force increase. The negative mean of r^e is due to a few instances of large declines in K and $y^{\bullet}$. Figure 1 shows the evolution of r^e over time. Negative outliers during the early transition disappear by the last year of complete data in 2002.
* Figure 1 *

The average labor force growth rate $n \equiv L^{\bullet}/L$ is 0.26% with high variation and instances of large decline due to emigration and war. The largest single labor force decline is -30.3% for Serbia & Montenegro in 2002 but the mean rises to only 0.35% without this outlier. The largest population growth rates are 3.7% for both Tajikistan in 1991 and Bosnia & Herzegovina in 1999. The decreases in the labor force for about 40% of the observations reflects the tumultuous transition period. Bulgaria suffered a loss of labor every year, and Latvia and Estonia every year but one.

Income per worker y has a mean of $4,680 and a standard deviation almost as large with values ranging from $520 for Tajikistan in 1997 to $25,300 for Slovenia in 2003. Slovenia contributes most to the high standard deviation with only Hungary approaching Slovenia in per capita income at about half its level.

Table 2, in the Annex, lists the CEENIS countries with per capita incomes y, capital labor ratios k, and growth rates of capital labor ratios $k^{\bullet}$ for the last year of complete data in 2002. Lucas makes the point that the striking differences in capital labor ratios suggest differences in foreign investment potential.

Variations of the transition indices are high with standard deviations averaging 40% of means. All countries begin with a transition progress index of 1 in 1989 except Hungary with 1.33 and by 2002 all indices indicate progress with more progress for the new EU members. Those in line for EU accession had high transition progress indices, 3.85 for Hungary in 2002 for instance.

The competition policy index remains relatively low. On a scale of 1 to 4.33 only the Czech Republic, Hungary, Lithuania, Poland, and the Slovak Republic reach 3 by 2003. There is progress for privatization with final averages of 3.07 for small scale and 2.36 for large scale privatization. The Czech Republic, Slovak Republic, Hungary, and Estonia rank 4.33 in small scale and 4 in large scale privatization as early as 1996. The other high performers are in Central Europe and the Baltic.

Infrastructure reform indices for roads and telecommunication show much slower progress with final means of 1.77 and 1.96. The highest index for roads is 3.33 for Hungary by 1995, Poland by 1999, the Czech Republic, Estonia, and Hungary by 1998, and Poland by 2000.

The average value of banking reform is 2.10 with only Hungary reaching 4 in 1997. Belarus, Uzbekistan, and Tajikistan make the least progress, rising to only 1.67 by 2003.

5. Phase equation estimation and interpretation

The choice of method to estimate phase equation (6) depends on whether the unobservable time constant effects a_i are outcomes of a random variable uncorrelated with the explanatory variables or fixed parameters to estimate. The countries are not a random draw from a large population and it is appropriate to assume a_i in (6) has no distribution, implying a fixed effect model.

Estimation results are in Table 3 in the Annex. Model A includes only economic variables, B adds the index of overall transition progress, and C includes the separate indices. Year dummies are consistently significant.

The Hausman test of whether the fixed effects model is more appropriate utilizes the consistency of fixed effects and inconsistency of random effects with correlation between a_i and the explanatory variables. Significant differences would be evidence against the random effects model (Woodridge, 2002). Hausman tests reject the null hypothesis of no differences in coefficients, suggesting the fixed effects model is appropriate.

The transition progress index is insignificant in model B and individual indices in model C are insignificant except competition policy. Correlation among indices in C would weaken their impact but there in no apparent problem with multicolinearity. The indices add some information to the model making the constants in models B and C insignificant but overall do not shift the estimated phase curve to any extent. A country increasing its competition policy index from 2 to 3 in model C on the scale from 1 to 4.33 would increase $k^{\bullet}$ by only \$119 or 1.5% of its mean.

Results support the present growth model with these transition countries in an early phase of economic growth on the upward sloping portion of their phase curve. Figure 2 illustrates the estimated phase curve in model A evaluated at the means of variables and the median r^e. The equation of the phase curve is $k^{\bullet} = 0.390 + 0.069k - 0.0005k^2$ with the derived constant embedding the other variables. Phase curves for Models B and C are nearly identical. The concave phase curve has a maximum at k = 69 where $k^{\bullet} = 2.85$ and a steady state where k = 145. The sample mean $k^{\bullet}$ is 0.89 or \$890 using means of variables and the median r^e. Observations for each country in the final year of complete data 2002 are included.

* Figure 2 *

Capital/labor ratios of developed countries are above 80 placing them on the downward sloping portion of the estimated phase curve. The average country in the sample would take decades to reach the present levels of developed countries. Solving a difference form of the estimated phase equation, more than four decades will be required for the average country to reach this developed country status. This time horizon is consistent with the capital accumulation process of Hungary estimated by Darvas and Simon (2000).

The positive outlier Slovenia is growing much faster. Hungary, Croatia, the Czech Republic, the Slovak Republic, and Estonia are growing faster than average as show in Table 2. The cluster of countries below the mean capital/labor k ratio in Figure 2 are Albania, Armenia, Azerbaijan, Bosnia & Herzegovina, Georgia, Kyrgyz Republic, Moldova, Serbia & Montenegro, Tajikistan, Turkmenistan, and Uzbekistan. For these countries, the model predicts growth to developed country status will require generations.

The estimated model gauges the potential impact of foreign investment due to an increase in the expected return to capital r^e. Doubling r^e from its 2002 mean of 0.277 to 0.554 would stimulate $k^{\bullet}$ by an estimated 0.071 x 0.277 = 0.02 = 2%. Such a modest increase due to a doubling of the expected return to capital suggests there will be no dramatic shifts due to foreign investment. As further evidence, the level of foreign investment is insignificant as an exogenous variable in estimates of a phase equation, as are real interest rates and local stock market returns. The sober economic lesson is that growth in the region will be gradual with an incremental stimulus from foreign investment.

Lower labor growth raises the phase curve in Figure 2 increasing $k^{\bullet}$ but the effect is small. A marginal decrease in labor growth leads to an estimated \$15 increase in $k^{\bullet}$ and the elasticity of $k^{\bullet}$ with respect to n evaluated at the sample mean is only -0.015 x (0.26/1.04) = -.004. A 50% reduction in labor growth rate would lead to an increment of only 0.2% in $k^{\bullet}$.

The fixed effect model allows estimation of country specific effects. Countries with larger than average unobserved non-stochastic effects are the Czech Republic, Hungary, Slovak Republic, and Slovenia. These positive outliers in Figure 3 enjoy advantages due to their location in Central Europe and their relatively advanced institutions as suggested by Rodrik, Subramanian, and Trebbi (2004). The Russian Federation and Estonia have fixed effects about average for the sample, while the majority of the sample countries suffer idiosyncratic growth handicaps.

6. Conclusion

The present model of foreign investment and growth provides a novel framework and leads to the conclusion that the economies in Central and Eastern Europe, aside from positive outliers, are in an early phase of economic growth. The average CEENIS country is a few decades at least away from reaching developed country status, and a cluster of lagging economies farther away than that. There is substantial variation in their positions along the estimated growth phase curve with a few leaders but most lagging behind with idiosyncratic growth handicaps. Foreign investment offers no quick fix for the average economy in the region but economic growth by nature is a slow process of capital accumulation.

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Table 1. Summary Statistics

Variable	Statistics	Mean	SD	Min	Max	Type	# Obs
k [a]	overall	$7.72	8.40	0.09	55.1	N	362
	between		6.63	1.40	27.0	n	27
	within		5.51	-16.0	35.9	T-bar	13
$k^{\bullet}$ [a]	overall	$1.04	1.06	0.02	6.15	N	335
	between		1.09	0.10	5.19	N	27
	within		0.31	-0.61	2.21	T-bar	12
r_e	overall	-0.041	0.057	-0.39	0.21	N	335
(median = .126)	between		0.02	-0.05	0.06	n	27
	within		0.05	-0.35	0.15	T-bar	12
n	overall	0.26%	2.04	-30.3	3.73	N[b]	335
	between		1.60	-5.70	2.60	n[c]	27
	within		1.60	-24.3	6.52	T-bar[d]	12
y [a]	overall	$4.68	4.17	0.52	25.3	N	362
	between		4.37	0.88	21.3	n	27
	within		0.85	0.87	8.74	T-bar	13
Transition progress	overall	2.37	0.80	1.00	3.85	N	355
	between		0.50	1.39	3.22	n	27
	within		0.64	0.27	3.26	T-bar	13
Competition policy	overall	1.85	0.67	1.00	3.00	N	355
	between		0.48	1.00	2.79	n	27
	within		0.50	0.24	2.73	T-bar	13
Small scale privatization	overall	3.07	1.15	1.00	4.33	N	355
	between		0.65	1.81	4.24	n	27
	within		0.96	0.20	4.59	T-bar	13
Large scale privatization	overall	2.36	0.99	1.00	4.00	N	355
	between		0.58	1.14	3.31	n	27
	within		0.83	0.05	3.60	T-bar	13
Enterprise reform	overall	1.92	0.74	1	3.33	N	355
	between		0.51	1.10	2.85	n	27
	within		0.55	0.15	2.75	T-bar	13
Road system reform	overall	1.77	0.69	1.00	3.33	N	355

Variable	Statistics	Mean	SD	Min	Max	Type	# Obs
	between		0.52	1.00	3.07	n	27
	within		0.47	0.18	2.84	T-bar	13
Telecom reform	overall	1.96	0.96	1.00	4.00	N	355
	between		0.57	1.00	3.07	n	27
	within		0.78	-0.10	3.70	T-bar	13
Banking reform	overall	2.10	0.88	1.00	4.00	N	355
	between		0.60	1.00	3.15	n	27
	within		0.66	0.10	3.33	T-bar	13

[a] $000 1995 equivalents [b] Total observations [c] Number of countries [d] Average years

Table 2. CEENIS countries in 2002

	k	$k^{\bullet}$	y
Slovenia	49.0	5.94	24.7
Czech Republic	34.0	2.80	10.2
Hungary	32.9	2.83	12.0
Slovak Republic	32.0	2.29	8.53
Estonia	26.0	2.21	7.69
Croatia	24.4	2.80	11.6
Poland	18.5	1.63	8.84
Russian Federation	18.4	1.09	6.08
Latvia	17.1	1.50	5.50
Lithuania	14.9	1.21	5.73
Macedonia, FYR	11.3	0.83	5.19
Belarus	11.2	0.83	3.94
Bulgaria	8.63	0.67	3.38
Romania	8.15	0.78	3.36
Ukraine	7.78	0.43	2.01
Kazakhstan	7.71	0.92	3.90
Bosnia and Herzegovina	5.19	0.64	3.58
Uzbekistan	4.64	0.21	1.59
Georgia	3.43	0.33	1.54
Albania	3.36	0.46	2.24
Armenia	3.26	0.28	1.48
Azerbaijan	3.17	0.42	1.40
Kyrgyz Republic	3.11	0.11	1.04
Serbia & Montenegro	3.01	1.16	3.80
Turkmenistan	2.86	0.47	2.06
Moldova	2.29	0.13	0.82
Tajikistan	1.93	0.03	0.67

Table 3. Fixed Effects Model Estimates

	Model A	Model B	Model C
Constant	0.385***	0.167	0.279
	(3.77)	(0.78)	(1.34)
k	0.069***	0.067***	0.066***
	(6.83)	(6.68)	(5.88)
k^2	-0.0005***	-0.0005**	-0.0005**
	(-2.61)	(-2.48)	(-2.34)
r_e	0.071**	0.064*	0.073**
	(2.18)	(1.94)	(2.21)
n	-0.015*	-0.014*	-0.015*
	(-1.93)	(-1.78)	(-1.93)
Transition progress		0.077	
		(1.15)	
Competition policy			0.119**
			(2.42)
Small scale privatization			-0.022
			(-0.53)
Large scale privatization			0.048
			(1.22)
Enterprise reform			-0.067
			(1.19)
Road system reform			-0.060
			(-1.34)
Telecom reform			-0.021
			(-0.67)
Banking reform			0.057
			(1.21)
Observations	308	308	308
Number of countries	27	27	27
R-squared	0.75	0.71	0.75
Hausman test	67	189	341

(t statistics) *10% **5% ***1%

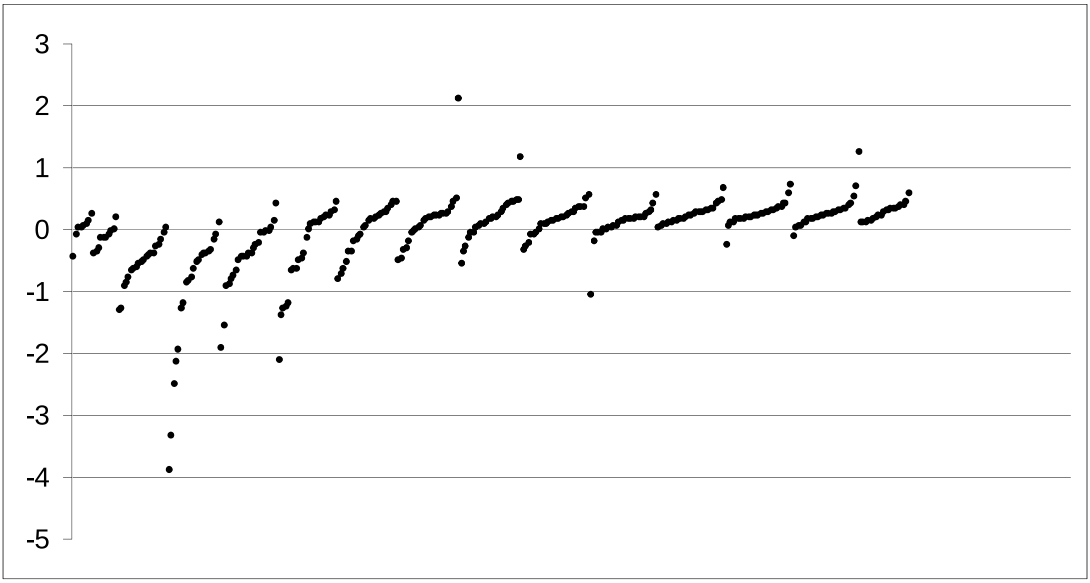

Figure 1. Trend of Estimated r^e

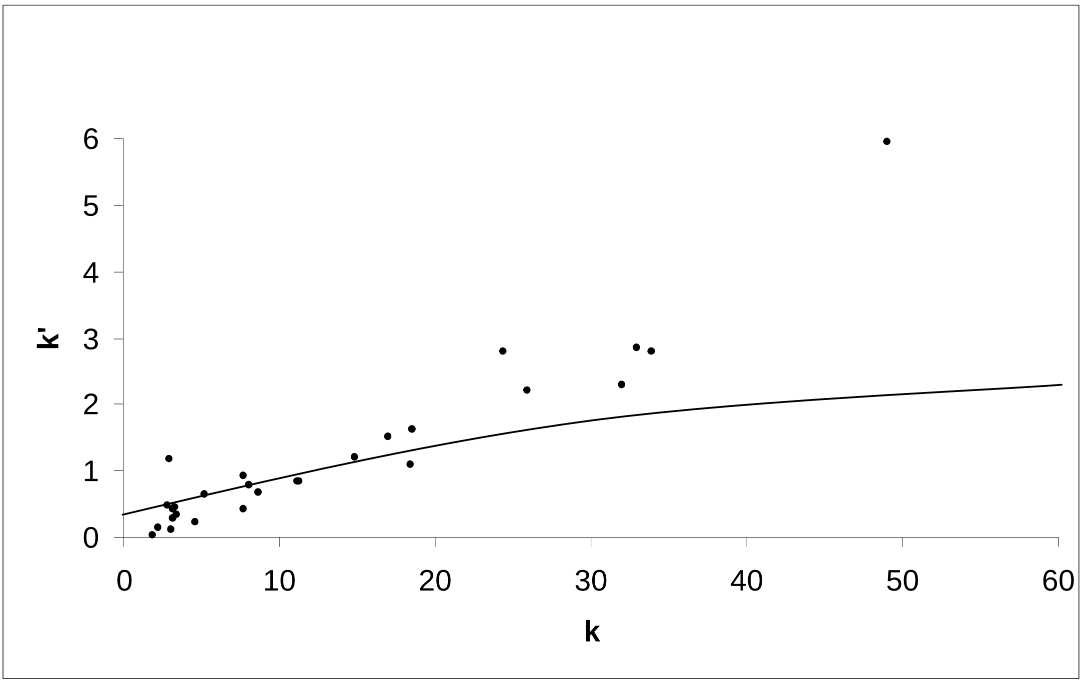

Figure 2. Estimated phase curve with 2002 observations