E C O N O M I C S B U L L E T I N

Big push industrialization: some empirical evidence for East Asia and Eastern Europe

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Abstract

In this paper we examine some testable implications of growth theories based on threshold externalities and complementarities. Specifically, we use industry data for a set of eight emerging economies in East Asia and Eastern Europe to perform general tests of the big push industrialization hypothesis of Murphy, Shleifer, and Vishny (1989). The preliminary results reported here are generally supportive of the theory. They also suggest that government policy may have played a role in moving an economy from a "bad" to a "good" equilibrium.

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1. INTRODUCTION

The focus of the empirical growth literature has been on a linear relationship between growth and a broad set of causal factors, including education, openness, financial sector development or repression, tax rights, natural resource endowments, income distribution, and many more (see Ghosh and Wolf 1998). Yet it has been difficult to identify a list of "essential" factors that are strongly and robustly associated with growth in a broad cross-section of countries, suggesting the presence of non-linearities in the growth process. Such nonlinear links between growth and its determinants have long been noted in the theoretical literature (e.g., Rosenstein-Rodan 1961). They are also intuitively appealing. For example, human capital accumulation is less likely to accelerate growth in a country with relatively high school enrollment rates or in a country ravaged by civil war. Recent work attributes these non-linearities to threshold effects and complementarities among various growth factors (e.g., Murphy, Shleifer, and Vishny 1989, Azariadis and Drazen 1990, Jones and Manuelli 1990, Matsuyama 1991, Rodrik 1996, Ciccone and Matsuyama 1996).

The theoretical literature on non-linearities in growth has arrived at the point where it requires formal empirical validation. While the empirical literature has boomed, it has focused on linear relationships between growth and its causal factors in a cross-sectional setting. The lone exception is Azariadis and Drazen (1990), but the evidence on their own seminal theory of threshold externalities is at best preliminary. Ghosh and Wolf (1998) attempt an ambitious study using classification tree analysis rather than regression analysis. Their message is that non-linearities are prevalent, and may be more pervasive than imagined. However, they do not test any specific hypotheses, and hence it is unclear whether their contribution constructively informs the theoretical literature.

The main objective of this paper is to test some hypotheses that emerge from one strand of the vast literature on non-linearities in the growth process – the theory of "big push" industrialization as proposed by Murphy, Shleifer, and Vishny (1989). These hypotheses require a focus on specific industries in emerging or developing countries over time. Thus, one of our contributions is the study of country-industry data from a different perspective. The remainder of the paper is organized as follows. Section 2 motivates and states the hypotheses implied by the big push theory. Section 3 describes the data and empirical methods, followed by the presentation and analysis of our test results. Concluding observations are made in Section 4.

2. BIG PUSH INDUSTRIALIZATION: THEORY AND TESTABLE HYPOTHESES

Murphy, Shleifer, and Vishny (1989) explore the idea that simultaneous industrialization of many sectors can be self-sustaining and profitable even if no sector can break even when investing alone. Such a big push, which is interpreted as a move from a "bad" (underdevelopment) equilibrium to a "good" (industrialization) equilibrium, is made possible by complementarities between sectors that work through market size effects. The inefficiency of the underdevelopment equilibrium also raises the possibility of a role for government policy in promoting the coordination of investments across sectors.

One model of the big push relies on a wage premium in mass production. Suppose there are n sectors, each consisting of competitive firms that produce with a constant-returns-to-scale (CRS) "cottage production" technology. In addition, each sector has one firm with access to increasing-returns-to-scale (IRS) "mass production" technology, which requires a fixed investment cost (equal to F units of labor) but then yields $a > 1$ units of output per unit of labor. With a wage premium in mass production over cottage production, there are always some values of F that permit multiple equilibria, specifically, a no-industrialization equilibrium with only cottage production and an industrialization equilibrium.[1] For these values of F a big push is possible whereby all sectors coordinate investments and, thus, push the economy into the (Pareto superior) industrialization equilibrium due to positive spillover effects between sectors. These spillover effects occur because a firm that sets up mass production pays a wage premium, thus increasing the size of the market for other producers through the extra wages it pays, even if its own investment is unprofitable. The problem is to bring about a coordination of the mass production technologies through a big push, a problem that may be solved through government policy. In summary, the implications of the wage premium model are two-fold. First, the necessary condition for big-push industrialization is that worker productivity in mass production exceeds wage. Second, ex post, wherever the big push has succeeded the (sufficient) condition $1/(1+v)z < F < z$ must be satisfied (see footnote 1 for details).

Another model of the big push emphasizes the dynamic nature of investment. Dynamically, we can think of the economy as moving from the use of CRS to IRS technologies over time. Mass producers invest in the first period (with little or negative profit) and enjoy the cash flow only in the second and later periods (based on a markup of price over marginal cost as production begins). Again, there is a set of values for F that permits multiple equilibria. Intuitively, the reason is that profits are not an adequate measure of a firm's contribution to the demand for other manufactures. An investing firm reduces period 1 aggregate income and increases period 2 aggregate income, thus raising demand for all manufacturing sectors in period 2. This is what makes it attractive for other firms to invest in period 1. So long as interest rates do not rise by too much to substantially discount future cash flows (e.g., Krugman 1991), investment by one firm makes investment by others desirable by shifting income across periods.

The Murphy-Shleifer-Vishny model then suggests the following testable hypotheses. First, the big push takes the form of simultaneous industrialization in many sectors, each generating future income and making other sectors profitable. Second, a necessary condition for big-push industrialization is the existence of a wage premium in mass production. Third, government policy can bring about the critical mass of investment and set in motion the big push into industrialization.

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[1] In the wage premium model, the marginal product of labor in cottage production is 1. Cottage production wage is set to one as numeraire. Industrialization of any mass producing method requires an investment of F units of labor, but yields a marginal product equal to $a > 1$ units. Due to the competitive fringe, the single firm cannot raise unit price above 1. However, the disutility of work in mass production (v per unit of labor) requires a compensating differential to be paid to workers in mass production, so that $w = 1+v > 1$. The main reason why multiple equilibria exist in this model is that the marginal product in mass production exceeds this compensating differential: $a > 1+v$. Specifically, suppose labor supply equals L and let $z = L - L(1+v)/a$. Then no-industrialization and industrialization equilibria are both possible for $1/(1+v)z < F < z$.

3. EMPIRICAL ANALYSIS AND PRELIMINARY RESULTS

Tests of the big push industrialization hypotheses require production-side data on specific industries and/or countries over time as well as at specific points in time. We use the *UNIDO Industrial Statistics Database* (1998), which focuses on manufacturing industries at the 3-digit level of the ISIC code for a large set of developing and developed countries. Detailed information on variables such as value added, gross output, employment, and wage payments (all expressed in terms of current U.S. dollars) is provided for a maximum span of 34 years (1963-1996). In this paper, we focus on a subset of twelve manufacturing industries[2] for a group of eight emerging economies in East Asia (India, Korea, Malaysia, Philippines, Singapore, Taiwan) and Eastern Europe (former Czechoslovakia, Hungary).

A general test of the big push industrialization hypothesis examines the time-series properties of industry data for countries in our focus group of emerging economies. This approach is based on the fact that the big push takes the form of simultaneous industrialization in many sectors, each generating income and making other sectors profitable and, thus, allowing firms to move from CRS to IRS production technologies over time. Specifically, it is expected that manufacturing industries participating in the big push share a common trend, that is, industry indicators such as value added, gross output, or real wages are likely to be cointegrated as a result of spillover effects between sectors. A visual check of the data suggests that many industries in the emerging countries of East Asia and Eastern Europe have "taken off" together during the latter part of the 1963-1996 sample period.

The cointegration tests are performed on a country-by-country basis, using value added data for our subset of twelve manufacturing industries in the eight emerging economies. Data coverage varies from country to country, ranging from 34 annual observations in India, Korea, Singapore, and Hungary to 24 observations in Taiwan. In light of these data limitations, we test for cointegration among pairs of industries (total manufacturing and one other industry) rather than larger subsets of industries. A crude test of the big push industrialization hypothesis compares the incidence of cointegration in different subperiods, which are chosen to roughly coincide with the "pre" and "post" big-push eras.

The results from Johansen cointegration tests for all eight emerging countries are summarized in Table I.[3] The cointegration models include one lag of each variable and allow for linear trends in both

[2]The industries are: total manufacturing (MFG), industrial chemicals (ICM), other chemicals (OCM), rubber products (RUB), plastic products (PLA), iron and steel (I&S), non-ferrous metals (NFM), fabricated metal products (FAB), machinery except electrical (MCH), electric machinery (ELE), transport equipment (AUT), professional and scientific equipment (PRO).

[3]Detailed country-by-country test results are available upon request.

the variables and the cointegration space to account for trend stationary data.[4] The evidence, which should be taken as suggestive due to the low power of the tests, indicates that a large number of industries "switched" from no cointegration in one subperiod to cointegration in the other. In India, for example, there are five industries that exhibit no common trend with total manufacturing in the first subperiod (1963-79) but then share a common trend in the second subperiod (1980-96); two industries show a transition in the opposite direction. Similar patterns can be observed in Malaysia, Philippines, Singapore, Taiwan, and Hungary. Korea and Czechoslovakia, however, are dominated by "switching" industries that move from cointegration to no cointegration over time. Power considerations aside, this may be related to the choice of subperiods, which were chosen exogenously to divide the full sample roughly in half and, hence, ignore information about the timing of the big push.

Perron (1997) proposes various methods to select break points in time-series data endogenously and provides the asymptotic and finite sample distributions of the corresponding test statistics. These procedures can be used to test for a unit root in the presence of at most one (endogenous) change in the trend function. The "innovational outlier model," for example, allows for both a change in the intercept and the slope at the time of the trend break, T_b, which is selected endogenously as the value that minimizes the *t*-statistic for testing the unit root hypothesis. In Table II, we summarize the test results for the twelve manufacturing industries in our sample of eight emerging economies. Overall, the endogenous trend breaks tend to occur at the midpoint of each country's sample period (as assumed for the cointegration tests in Table I). In many cases, they also coincide with specific events or government policies that have promoted the big push into industrialization. In Malaysia, for example, the endogenous trend breaks are concentrated in the late 1970s and early 1980s, following on the heels of financial reforms in 1978 and the push into industrialization under the Fourth Malaysia Plan in 1981 (World Bank 1993).

4. CONCLUSION

In this paper we conduct some general tests of hypotheses relating to underdevelopment traps in economic growth. Theoretical models attribute the existence of multiple equilibria to threshold externalities and complementarities across sectors, raising the possibility of government policy that can coordinate and stimulate private sector activity so as to move an economy from a "bad" to a "good" equilibrium. We use time-series data for selected industries in a set of eight emerging countries to perform general tests of the big push industrialization hypothesis of Murphy, Shleifer, and Vishny (1989). The preliminary results for East Asia and Eastern Europe reported here are generally supportive of the theory and imply a role for activist government policy in the industrialization process. Future research will extend the analysis to cover a broader set of countries and a variety of industry indicators.

[4]Preliminary tests indicate that most of the series are integrated of order one, that is, they contain a unit root. The unit root test results are available from the authors.

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Table I
Johansen Cointegration Tests for Selected Industry Values Added:
Summary of Results for Eight Emerging Countries
(Annual Data)

Industries ISIC-3	Sample Period	India 1963-96	Korea 1963-96	Malaysia 1968-96	Philippin. 1968-93	Singapore 1963-96	Taiwan 1973-96	Czechosl. 1966-90	Hungary 1963-96
MFG	full	yes	yes	no	yes	no	no	no	no
ICM	sub1	yes	yes	no	no	yes	no	no	no
	sub2	yes	no	yes	no	yes	yes	no	yes
MFG	full	yes	yes	no	no	no	no	no	no
OCM	sub1	no	yes	no	yes	no	no	no	yes
	sub2	yes	no	yes	yes	no	yes	no	yes
MFG	full	yes	no	yes	no	yes	yes	yes	no
RUB	sub1	no	yes	yes	yes	yes	no	yes	no
	sub2	no	no	yes	yes	no	yes	no	yes
MFG	full	yes	yes	yes	yes	yes	no	N/A	yes
PLA	sub1	yes	yes	no	no	yes	no	N/A	yes
	sub2	no	no	yes	no	no	yes	N/A	yes
MFG	full	yes	no	no	yes	yes	no	no	no
I&S	sub1	no	yes	yes	no	no	no	no	no
	sub2	yes	yes	no	no	no	yes	no	yes
MFG	full	no	yes	yes	yes	yes	yes	no	yes
NFM	sub1	yes	yes	no	no	yes	no	yes	no
	sub2	no	no	yes	no	no	yes	no	yes
MFG	full	yes	no	no	yes	yes	yes	no	yes
FAB	sub1	no	yes	no	no	no	yes	yes	no
	sub2	yes	yes	yes	yes	yes	yes	yes	yes
MFG	full	yes	no	yes	yes	no	no	no	no
MCH	sub1	yes	yes	no	no	no	yes	no	no
	sub2	yes	no	yes	yes	no	yes	no	yes
MFG	full	yes	yes	no	no	no	yes	no	no
ELE	sub1	no	yes	no	no	no	yes	no	no
	sub2	yes	yes	no	yes	yes	yes	no	yes
MFG	full	yes	yes	no	yes	no	yes	no	no
AUT	sub1	no	yes	yes	no	no	yes	yes	yes
	sub2	yes	yes	no	yes	yes	yes	yes	yes
MFG	full	no	yes	yes	yes	no	yes	yes	no
PRO	sub1	no	yes	no	yes	no	no	yes	no
	sub2	no	yes	yes	no	yes	yes	no	yes

Notes: Tests are performed with logged values added (in current $) for total manufacturing (MFG) and one other industry. The cointegration models include one lag and allow for linear trends in the variables and the cointegration space. "Yes" indicates that the λ-max and/or trace statistics are significant at the 10% level or higher, suggesting that the variables in questions share a common trend. "No" indicates that the hypothesis of no cointegration cannot be rejected. The two subperiods (sub1, sub2), which are chosen to divide the full sample in half, correspond to 1963-79 and 1980-96 for India, Korea, Singapore, and Hungary, 1968-82 and 1983-96 for Malaysia, 1968-79 and 1980-93 for the Philippines, 1973-84 an 1985-96 for Taiwan, and 1966-78 and 1979-90 for the former Czechoslovakia. Data Source: *UNIDO Industrial Statistics Database* (1998), 3-Digit Level of ISIC Code.

Table II

Unit Root Tests with Endogenous Trend Breaks for Selected Industry Values Added:
Summary of Results for Eight Emerging Countries
(Annual Data)

Industries ISIC-3	Date? Root?	India 1963-96	Korea 1963-96	Malaysia 1968-96	Philippin. 1968-93	Singapore 1963-96	Taiwan 1973-96	Czechosl. 1966-90	Hungary 1963-96
MFG	T_b	1976	1974	1977	1976	1971	1989	1978	1978
	t-signif	no	no	no	no	no	no	1%	5%
ICM	T_b	1989	1980	1981	1980	1984	1986	1978	1977
	t-signif	no	5%	1%	5%	no	10%	1%	1%
OCM	T_b	1982	1974	1975	1977	1971	1981	1982	1978
	t-signif	no	no	5%	no	1%	no	no	5%
RUB	T_b	1992	1989	1988	1983	1980	1990	1986	1976
	t-signif	no	no	no	5%	no	no	5%	no
PLA	T_b	1977	1980	1974	1977	1974	1990	N/A	1978
	t-signif	1%	5%	5%	5%	no	1%	N/A	no
I&S	T_b	1972	1977	1978	1971	1975	1991	1978	1978
	t-signif	no	10%	no	no	no	no	1%	10%
NFM	T_b	1982	1978	1978	1984	1971	1990	1987	1981
	t-signif	10%	5%	1%	1%	1%	1%	1%	no
FAB	T_b	1977	1975	1983	1977	1983	1987	1978	1978
	t-signif	no	10%	no	10%	5%	1%	1%	1%
MCH	T_b	1972	1974	1983	1976	1980	1989	1978	1978
	t-signif	no	no	no	10%	no	no	1%	10%
ELE	T_b	1980	1978	1977	1976	1970	1987	1978	1976
	t-signif	no	5%	no	no	no	no	1%	1%
AUT	T_b	1977	1983	1984	1989	1977	1989	1987	1986
	t-signif	10%	1%	5%	5%	10%	no	1%	10%
PRO	T_b	1977	1976	1974	1980	1963	1990	1974	1976
	t-signif	no	no	no	5%	1%	no	1%	1%

Notes: The unit root tests are performed in an "innovational outlier model," which allows both a change in the intercept and the slope at time T_b. *t*-signif indicates whether the hypothesis of a unit root must be rejected. T_b is selected endogenously as the value that minimizes the *t*-statistic for testing the unit root hypothesis. [See Perron (1997) for details.] The tests are performed with logged values added (in current $) for the following industries: MFG = total manufacturing, ICM = industrial chemicals, OCM = other chemicals, RUB = rubber products, PLA = plastic products, I&S = iron and steel, NFM = non-ferrous metals, FAB = fabricated metal products, MCH = machinery, except electrical, ELE = electric machinery, AUT = transport equipment, PRO = professional and scientific equipment. Data Source: *UNIDO Industrial Statistics Database* (1998), 3-Digit Level of ISIC Code.