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Selective Intervention and Growth: The Case of Korea

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Abstract

This paper attempts to determine whether conditions amenable to successful selective interventions to capture cross-industry externalities are likely to be fulfilled in practice. Three criteria are proposed for good candidates for industrial promotion: that they have strong interindustry links to the rest of the economy, that they lead the rest of the economy in a causal sense, and that they be characterized by a high share of industry-specific innovations in output growth. According to these criteria, likely candidates for successful intervention are identified in the Korean data. It is found that, with one exception, none of the sectors promoted by the heavy and chemical industry (HCI) policy fulfills all three criteria.

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I. INTRODUCTION

Few issues in development economics have been as controversial as the importance of industrial policy in Korea's development. This is a topic of growing importance as economists attempt to distill the "lessons" of the Korean experience for other countries (e.g., Noland and Pack 2003).

For industrial policies to be successful, the market equilibrium must be suboptimal. Governments must be able to identify these opportunities for welfare-enhancing interventions, formulate and implement the appropriate policies, and prevent political market failures from leading the policies astray. In the case of Korea, most conventional static neoclassical analyses have concluded that these conditions were not met, at least in the most interventionist period, that is, the heavy and chemical industry (HCI) drive of 1973–79.

One can think of the evidence brought to bear as falling into two broad categories. The first of these are studies that document the actual interventions undertaken by the Korean government and assess those interventions according to a variety of static welfare criteria. So, for example, Kim (1990) surveys the fiscal, credit, tax, and trade policies undertaken during this period and concludes that the policy was unsuccessful: It had the predictable result of generating excess capacity in favored sectors while starving nonfavored sectors of resources, as well as contributing to inflation and the accumulation of foreign debt. Moreover, "the government [was] reckless in its selection of launch enterprises and in its almost haphazard provision of generous incentives . . . [its] direct, unlimited role in industrial promotion placed it in the position of an implicit, de facto risk partner, thus complicating efforts at market-determined adjustment" (p. 44).

Yoo (1990) covers similar terrain, distinguishing between the less selective efforts at export promotion in the 1960s and the more aggressive industrial promotion efforts of the 1970s. Yoo also directly confronts the argument that the HCI policy was a success inasmuch as the industries favored by the HCI policy became major exporters in the 1980s. He addresses this argument by posing two counterfactuals: What would the Korean economy have looked like in the absence of the policy, and how would the Korean trade structure have looked?

Using reasoning similar to Kim's, Yoo concludes that in macroeconomic terms the Korean economy would have been better off without the HCI policy. But what about industrial upgrading? Yoo compares the Korean experience with other, similarly endowed economies (particularly Taiwan) and concludes that on the basis of upgrading or trade performance the HCI policy was not a success. Indeed, given the high rates of return on capital, the opportunity costs of prematurely promoting a sector could have been enormous. In a subsequent paper (Yoo 1993), he argues that political influences dominate efficiency considerations as an explanation of the actual pattern of selective intervention.

Kwon and Paik (1995) use a computable general equilibrium model calibrated to 1978 to investigate the potential magnitude of these distortions. They conclude that resource misallocation reduced GDP by less than 1 percent if capital is assumed to be immobile and more than 3 percent if it is mobile. The welfare impact they calculate is higher.

Lee (1996) regresses indicators of policy interventions against sectoral total factor productivity (TFP) growth rates and other measures of productivity. He finds little support for the notion that policy interventions promoted productivity growth in the targeted sectors.

Another set of analyses has focused on interindustry linkages and the potentially welfare-enhancing coordination role for the government. Pack and Westphal (1986) argue that, in general, Korea's selective intervention policy has been successful in fostering infant industries without significant losses in efficiency. The key has been to capture latent interindustry pecuniary and nonpecuniary externalities: "The Korean government can be seen as having achieved integrated decision making by acting as a central agent mediating among market agents, forcing and facilitating information interchange and insuring the implementation of decisions reached . . . weighing costs and benefits from a collective standpoint and often intervening to reward cooperative players and punish uncooperative ones" (p. 99).

Okuno-Fujiwara (1988) provides a formal example of this in the form of a model of the interdependence of the two industries. One industry, which produces an intermediate product, is assumed to be oligopolistic due to underlying scale economies and engages in Cournot competition. The other industry, which produces a final product from the intermediate product, is perfectly competitive. In this situation there may be multiple equilibria with one equilibrium Pareto-superior to the others. Industrial policy has a positive role in the form of preplay communication to generate a superior coordinated equilibrium.[1]

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[1] In both this model and that of Pack and Westphal, the same outcome could presumably be attained through organizational integration. Pack and Westphal argue that in the case of Korea this outcome is not feasible: "The externalities may flow in complex and inseparable patterns among (actual and potential) agents covering most if not all of the industrial sector" (p. 99), necessitating government intervention. However, the existence of the giant *chaebol*, spanning the industrial sector, would appear to undermine this argument. If the *chaebol* cannot internalize these externalities, then it is hard to imagine what institution could. Indeed, it is unclear why the government would be any better able to coordinate decisions than the *chaebol*.

The Japanese case does, however, suggest a constructive role for government. In Japan, vertical integration is less complete: The *keiretsu*, networks of affiliated firms, strike a balance between the coordination advantage of full integration, and the maintenance of competition among suppliers. In this more loosely organized system, the government's coordinating role could be larger.

It should also be noted that the Okuno-Fujiwara model is a closed economy model. For the intervention to convey some purely *national* welfare enhancement, there has to be some nontraded aspect of the externality. Otherwise, foreigners have access to the same low-cost inputs, and the pattern of production in the downstream industry is indeterminate without additional assumptions.

Murphy, Shleifer, and Vishny (1989) formalize these notions in terms of Rodenstein-Rodan's idea of the "big push". Once again, there are multiple equilibria due to pecuniary externalities generated by imperfect competition with large fixed costs. They argue that industrial policy that "encourages industrialization in many sectors simultaneously can substantially boost income and welfare even when investment in any one sector appears impossible" (p. 1024).[2]

Each of these papers claim that the possibility exists for welfare-enhancing industrial policies through government coordination activities to capture interindustry externalities, thus promoting growth and industrial development without the standard efficiency losses. The key is the existence of interindustry externalities, which when captured, expand the production set of the economy.

Table 1 presents correlations of changes in real output for 26 Korean manufacturing sectors and the overall index of industrial output for the period 1975:Q1 to 1989:Q4. Changes in output are highly correlated across sectors: In most cases the correlation coefficients are above 0.9, and few are below 0.7. This suggests that selective interventions to encourage output, or coordinated output increases, could indeed be transmitted on an economywide basis. Alternatively, the high correlations could be interpreted as evidence that variations in output are largely due to common macroeconomic shocks.

The likely scope for growth-enhancing interventions would be increased if the industries targeted for intervention met three criteria. The first is that they have strong interindustry linkages to the rest of the economy. Second, they should be leading sectors in a causal sense, so that growth stimulus would be transmitted forward through the economy. One might think of an input supplier industry in the Okuno-Fujiwara model as an example. Finally, variations in output should have a strong industry-specific component; otherwise, variations in output are simply due to macroeconomic shocks, and there is little scope for industry-specific stimulus. The existence of industry-specific variation in output suggests the possibility for industry-specific technical change and/or scope for industry-specific policy interventions to increase output.

This paper analyzes Korean data to explore the potential for growth-enhancing policy interventions and their possible occurrence in the Korean case. This analysis is done by taking sectoral data and putting them through a series of filters to see if any of the industries meet plausible criteria for selective promotion. In the next section the density of the input-output table is analyzed to identify sectors with strong backward and forward linkages. Then, industry times-

[2] Indeed, Auty (1991) provides detailed descriptions of indivisibilities and other entry barriers in the HCI industries. Even after assessing possible pecuniary and nonpecuniary externalities, however, he concludes that from an economywide perspective, resources were misallocated.

series data are analyzed to identify possible "leading" sectors. Lastly, the time-series data are decomposed to identify sectors characterized by a high degree of industry-specific stochastic variation. These statistical analyses do not constitute any kind of test of the previously described theoretical models; rather, they simply indicate whether conditions that would be associated with successful interventions have existed in reality.[3] The possibility that the interventions undertaken in Korea could constitute a case of successful coordinated intervention is then discussed in the concluding section of the paper.

II. INTERINDUSTRY LINKS

A first step in exploring the possibility of welfare-enhancing coordinated interventions is to identify the strength of interindustry linkages. Jones (1976) clarified the appropriate way of measuring backward and forward linkages using an input-output table. The *j*th column sum of the input inverse matrix measures the backward links, indicating the increase in total output of the system required to supply inputs for the initial unit increase in industry *j*. The *i*th row sum of the output inverse matrix measures the forward links, indicating the increase in total output of the system required to utilize the increased output from an initial input from industry *i*. For a given industry, the sum of its backward and forward linkages indicates the total or maximum potential causal links stimulated by an increase in its output.

The measures of backward, forward, and total linkages have been computed for 26 Korean manufacturing industries using the 1986 65-sector input-output table published by the Bank of Korea. Since this study focuses on measuring the potential stimulus to domestic output, linkages have been calculated using the domestic flow matrices. These results are presented in table 2.

Forward links were strongest for paper, basic chemicals, and iron and steel. These sectors also had the highest total linkages. Hence, if one were to target industries on the basis of interindustry linkages, these would be prime candidates. Links were weakest for the tobacco and apparel sectors. Presumably these are sectors a targeting policy would avoid.

Again, this implicitly assumes a closed economy. If the economy is open, then the relevant criterion is not only the degree of forward linkage but also the efficiency of the input industry relative to imported substitutes. Likewise, the relevant criterion for backward links

[3] Of course, it would be desirable to test these models directly, but the necessary firm data do not exist, hence the crude but feasible analysis reported here.

would be whether expansion of the downstream sector induced sufficient expansion of the upstream sector to achieve minimum efficient scale and displace imports.[4]

III. IDENTIFICATION OF LEADING SECTORS

If an economy is at less than full employment, then the targeting of leading sectors could induce an overall expansion of economic activity and put the economy on a permanently higher growth path in growth models where scale economies play an important role. (If the economy is already at full employment, then such targeting would just change the composition of output, and one is back to the neoclassical critique of Kim and Yoo.)

A considerable amount of recent econometric research has focused on the specification and analysis of models in which some or all of the variables may be integrated or possess unit roots. Particular interest has centered on the possibility of cointegration explored by Granger and Engle (1987), where some linear combination of variables exhibit reduced orders of integration. Sims, Stock, and Watson (1990) have shown that the asymptotic distributions of causality tests are sensitive to unit roots and time trends in the series. This underscores the importance of examining the time-series properties of the data prior to model specification and estimation.

Frequently used diagnostic tests include the Stock-Watson (SW) and Dickey-Fuller (DF) tests for a unit root—that is, for a unit root in the series, against the alternative that the series is stationary around a linear time trend (Dickey and Fuller 1979; Stock and Watson 1989); the modified Stock-Watson test (MSW) for a single unit root when there might be a quadratic time trend; and the augmented, or higher order, Stock-Watson and Dickey-Fuller tests for a second unit root—that is, for a unit root in the first difference of the series, against the alternative that the series is stationary in first differences around a linear time trend.

These tests were applied to quarterly data on real output of industrial production and 26 manufacturing industries. For most series the sample period was 1960:Q1–1989:Q4, with some having shorter sample periods due to missing data, the shortest sample being 1975:Q1–1989:Q4. All data were expressed in logs. Examination of autocorrelation and partial autocorrelation functions indicated that all of the series could be represented as AR2 functions, and consequently all of the diagnostic tests were calculated with this correction.

According to the augmented Stock-Watson and Dickey-Fuller tests, the existence of higher-order unit roots could be rejected for all series and for the sake of brevity are not reported. The results from remaining diagnostic tests are reported in table 3. In 14 industries (apparel, leather, footwear, wood products, furniture, basic chemicals, other chemical products, petroleum,

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[4] See Pack (2000) for a further elaboration of this argument.

plastic, iron and steel, nonferrous metals, fabricated metals, industrial machinery, and professional goods, plus industrial production), the existence of a single unit root cannot be rejected. In two cases (rubber and electrical machinery), the test results are ambiguous. In the remaining 10 cases, the existence of a single unit root can be rejected in favor of the alternative that the series are stationary around either linear (SW, DF) or quadratic (MSW) time trends.

To ascertain the degree of the polynomial, the first differences of each series were regressed against a constant, time, and four of its own lags. The t-statistics of these deterministic regressors are reported in the fourth and fifth columns of table 3. In a number of cases (e.g., wood products, furniture), the time-trend coefficient was significant, indicating that the series has a single unit root around a quadratic time trend. In several other cases (e.g., industrial production, apparel, leather), when the time trend is removed from the regression, the constant is significant, indicating that the series could be characterized as having a single unit root with drift.

Having established the univariate characteristics of the data, the next step was to investigate the possibilities of cointegrating relationships between industrial production and the industry series. This investigation was done using the augmented Stock-Watson test (CO), and these results are reported in the final column of table 3. In four cases (basic chemicals, other chemical products, iron and steel, and professional goods), the hypothesis of no cointegrating relationship could be rejected at the 10 percent or greater level.

The information in table 3 was then used in specifying bivariate Sims causality tests on industrial production and sectoral indices. The hypothesis that one variable (Y_1) causes another (Y_2) is tested by running a regression of Y_1 on past, current, and future values of Y_2; the null hypothesis that Y_1 does not cause Y_2 implies that the coefficients of the future values of Y_2 are jointly equal to zero. The procedure is then reversed to test the hypothesis that Y_2 causes Y_1. These are estimated using the common practice of using eight-quarter lags and four-quarter leads. As indicated in Sims, Stock, and Watson, the OLS estimates of these regressions are consistent, though in certain cases (when both regressors have unit roots and are not cointegreted), the F statistics on causality may have nonstandard limiting distributions.

Three summary statistics are reported in table 4: the adjusted coefficient of determination, the Box-Ljung Q statistic for serially correlated errors, and the F statistic on the future values of the right-hand-side variable. According to the F-tests, seven industries Granger-cause industrial production (beverages, textiles, leather, wood products, paper, petroleum and coal products, and nonferrous metals), four industries are characterized by feedback (nonmetallic mineral products, fabricated metal products, transportation machinery, and miscellaneous manufactures), and in five industries (apparel, printing and publishing, other chemical products, iron and steel, and professional goods), industrial production Granger-causes industry output. In the remaining cases, no causal ordering could be established. In 10 cases (apparel, leather, footwear, wood, furniture, petroleum refining, plastic products, nonferrous metals, machinery, and electric machinery) the results should be treated with caution due to the apparent presence of multiple roots, as should the results for fabricated metals, where the hypothesis of white-noise residuals was rejected at the 1 percent level in one of the regressions.

More generally, as Lütkepohl (1982) has demonstrated, spurious inferences may be obtained in bivariate causality tests due to the omission of relevant explanatory variables. This problem, however, is simply a particular manifestation of the more general problem of omitted-variable bias, and concern does not appear to be warranted in the case at hand in the absence of either any particular reason to believe that the causality relations are more complicated than the simple bivariate approach modeled here or signs of possible omitted-variable problems (such as low coefficients of determination and serially correlated errors). With appropriate caveats about the interpretation of the F statistics, 11 industries exhibit either leading or feedback relationships with industrial production and hence might be appropriate targets for promotion. Two of these—iron and steel, and basic chemicals—were identified as sectors with particularly strong interindustry links. In contrast, the apparel sector would be a uniquely poor choice for targeting, as it has weak interindustry links and is a causally lagging sector.[5]

IV. DECOMPOSITION OF CHANGES IN OUTPUT

A final criterion for candidates for targeting would be that changes in output be characterized by substantial industry-specific micro shocks, as opposed to economywide macro shocks. These industry-specific policy interventions could be associated with things such as technological change, or indeed, when analyzing historical data, industry-specific policy interventions. Macro shocks would presumably be due to economywide phenomena such as changes in monetary policy, or the exchange rate, though again, in principle, in historical data they could be due to industry-specific policy interventions, which were then propagated economywide through interindustry input-output relationships. The point is that if either economywide macro shocks or policy interventions in other industries dominate changes in an industry's output, the industry would be a poor candidate for growth-enhancing interventions.

[5] One could object that the horizon for observing causal effects (four quarters) is too short, that the output effects might manifest themselves with only longer leads. The problems with testing this objection are two-fold: As the time horizon lengthens, presumably the power of the F-tests decline. Moreover, as the time horizon lengthens, degrees of freedom decline.

Changes in output have been decomposed into micro and macro components following the method of Yoshikawa and Ohtake (1987). The equations to be estimated are:

$$Q_t^i = M^i(L)\ Y_t + u_t^i, \qquad (1)$$

where the dependent variable Q is the log of industry real output, and Y is the log of industrial production, each detrended as indicated by the results in table 3; $M^i(L)$ is a polynomial function of the lag operator L defined as

$$L^n x_t = x_{t-n} \qquad (n=0,1,2,\ldots), \qquad (2)$$

and i and t refer to industry and time, respectively, and Y_t follows an autoregressive process,

$$Y_t = a(L)\ Y_{t-1} + e_t, \qquad (3)$$

where e_t is a white-noise error. The industry-specific micro shocks, u, are in turn generated by the autoregressive equation

$$u_t^i = a^i(L)\ u_{t-1}^i + v_t^i. \qquad (4)$$

In this case, v is a white-noise error, and $a^i(L)$ is a polynomial function of L.

From equations (1) and (4), the industry-specific micro shock can be expressed as

$$Q_t^i - M^i(L) Y_t = a^i(L)\ [Q_{t-1}^i - M^i(L) Y_{t-1}] + v_t^i, \qquad (5)$$

and has been estimated by nonlinear least squares for a second-order autoregressive model. The percentage changes in Q due to macro shocks can be calculated as

$$\frac{(M_0^2 + M_1^2 + M_2^2)\sigma_y^2 + 2(M_0 M_1 + M_1 M_2)\sigma_{yy-1} + 2\, M_0\, M_2\, \sigma_{yy-2}}{\sigma_Q^2} \qquad (6)$$

under the assumptions that industrial production is exogenous and that the macro shocks *(e)* and the micro shocks *(v)* are orthogonal. The problem is that the results in table 4 indicated that industrial production is not exogenous in a number of cases, violating the assumption underlying this decomposition. A broader measure, real GNP, was tried, but it too was found not to be exogenous in several cases.

Fortunately, Noland (1993) demonstrated that the real exchange rate, real US GNP, and the real US fiscal deficit are all causally prior to real Korean GNP. It is inconceivable that these variables are not exogenous to variations in output of individual Korean industries. Consequently, an instrument for Korean GNP was formed by taking the fitted values of a regression of the real exchange rate, real US GNP, and the real US budget deficit on Korean real GNP. Equation 5 was then estimated using this instrument, and the coefficient estimates, their t-statistics, the standard error of the regression (SEE), the standard deviation of the dependent variable (SDQ), the Box-Ljung Q statistic, and the macro shock share (MACRO) are reported in table 5.

The macro shares reported in table 5 range from nil (tobacco products, petroleum and coal products, nonmetallic mineral products, and transport equipment) to a high of 0.79 (textiles) with a mean value of 0.16, and a median value of 0.07. In only one case, machinery, where the Box-Ljung Q statistic indicates that v is not white noise, do the assumptions underlying equation 6 appear to be violated. These results imply that sectors with relatively high macro shares such as textiles, apparel, petroleum refining, and fabricated metals products would be inappropriate candidates for targeting. Such statements are subject to Lucas critiques, however: Sectors with historically high macro ratios might exhibit low macro ratios under a different policy regime and vice versa.

V. CONCLUSION

This paper has attempted to employ data-instigated methods to determine if conditions amenable to successful selective interventions to capture cross-industry externalities such as those posited by Pack and Westphal, Okuno-Fujiwara, and Murphy, Shleifer, and Vishny exist in practice. This analysis has been done by examining historical data for Korea, a country whose experience is often invoked in discussions of this subject. Three criteria are proposed in selecting good candidates for industrial promotion: (1) that they have strong interindustry links, (2) that they lead the rest of the economy in a causal sense, and (3) that they be characterized by a high share of industry-specific innovations in output growth.

Taken at face value, the results are summarized in table 6, which indicates whether an industry had a macro share of less than half; whether it was found to Granger-cause industrial production (in the case of feedback this is indicated with a question mark); whether its index of interindustry linkage was above the sample mean; whether it was promoted during the HCI drive; and finally the intersection of the first three sets: the candidates for successful intervention. As can be seen from table 6, 4 of the 26 sectors fulfill the first three criteria, demonstrating that conditions supportive of successful intervention are present in the data. Unfortunately, with regard to the specific historical experience of Korea, with the exception of nonferrous metals, these were not the sectors promoted during the HCI drive.

Indeed, with one exception, none of the sectors promoted by the HCI policy fulfill all three criteria. Basic chemicals, petroleum refining, iron and steel, and machinery all have low macro ratios and strong interindustry links but were not causally leading sectors. However, if Korea was assumed to be at full employment, then macro causality is not an important issue, and these sectors could be considered possible cases of successful targeting. Transportation equipment has a low macro ratio and feeds back to national income, but its interindustry links are lower than average.[6]

The calculations made in this paper are admittedly quite crude, and they should not be considered a test of the theoretical arguments in favor of selective intervention. Indeed, even accepting the argument put forward in this paper, one could quarrel with the specific statistical results for the reasons cited above. But beyond these questions of econometric technique, it is certainly correct to argue that the level of industry aggregation (imposed by data availability constraints) is far too high and that both the underlying externalities and the forms of intervention may be far more subtle than the relations modeled in this exercise. Nonetheless, this approach may provide a useful starting point for identifying potential candidates for industrial promotion.

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[6] Dollar and Sokoloff (1990), working from a completely different perspective, concluded that the transport machinery industry was the single "unqualified success" of the HCI program. They did not consider, however, the issue of interindustry linkages. If this criterion is ignored, transport machinery is one possible successful HCI candidate identified in the study at hand.

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Table 1 Correlations of Production Across Industries, 1975:Q1-1989:Q4

Sector	Ind	Food	Bev	Tobacco	Tax	Apparel	Leather	Footwear	Wood	Furniture	Paper	Print	B Chemicals	O Chemicals	P Refin
Industrial Prod.	1.00														
Food Processing	0.99	1.00													
Beverages	0.99	0.99	1.00												
Tobacco & Prods.	0.99	0.97	0.97	1.00											
Textiles	0.81	0.77	0.80	0.86	1.00										
Apparel	0.86	0.82	0.84	0.90	0.99	1.00									
Leather Prods.	0.97	0.95	0.95	0.94	0.72	0.78	1.00								
Footwear	0.90	0.90	0.91	0.93	0.77	0.81	0.89	1.00							
Wood Prods.	0.92	0.91	0.92	0.95	0.89	0.91	0.86	0.92	1.00						
Furniture	0.78	0.74	0.76	0.83	0.99	0.98	0.67	0.71	0.84	1.00					
Paper	0.99	0.98	0.98	0.98	0.80	0.84	0.96	0.88	0.91	0.77	1.00				
Printing and Pub.	0.98	0.96	0.96	0.98	0.87	0.90	0.91	0.88	0.93	0.84	0.98	1.00			
Basic Chemicals	0.98	0.96	0.96	0.99	0.87	0.90	0.92	0.91	0.96	0.84	0.97	0.97	1.00		
Other Chem. Prods.	0.99	0.99	0.99	0.98	0.82	0.86	0.95	0.92	0.93	0.78	0.99	0.98	0.97	1.00	
Petro. Refining	0.76	0.72	0.74	0.08	0.99	0.98	0.66	0.73	0.86	0.99	0.75	0.83	0.84	0.77	1.00
Petro. and Coal	0.98	0.96	0.95	0.97	0.80	0.84	0.94	0.88	0.89	0.77	0.98	0.97	0.95	0.97	0.75
Rubber Prods.	0.99	0.98	0.97	0.96	0.76	0.81	0.96	0.85	0.87	0.74	0.99	0.96	0.94	0.98	0.71
Plastic Prods.	0.84	0.81	0.83	0.89	0.99	0.99	0.74	0.81	0.92	0.98	0.83	0.89	0.90	0.85	0.99
Nonmetallic Prods.	0.98	0.96	0.97	0.98	0.87	0.90	0.92	0.88	0.94	0.85	0.98	0.98	0.98	0.98	0.83
Iron & Steel	0.99	0.98	0.98	0.99	0.81	0.86	0.97	0.90	0.92	0.78	0.99	0.97	0.97	0.99	0.76
Nonferrous Metals	0.97	0.96	0.95	0.94	0.73	0.78	0.94	0.81	0.82	0.71	0.98	0.95	0.92	0.96	0.67
Fabricated Metal	0.98	0.97	0.97	0.96	0.76	0.81	0.97	0.86	0.87	0.73	0.98	0.95	0.94	0.98	0.70
Indust. Machinery	0.97	0.97	0.96	0.93	0.68	0.74	0.95	0.83	0.84	0.66	0.97	0.93	0.92	0.96	0.63
Elec. Machinery	0.99	0.98	0.98	0.98	0.79	0.84	0.97	0.89	0.91	0.76	0.99	0.97	0.97	0.99	0.74
Trans. Machinery	0.99	0.97	0.97	0.98	0.82	0.87	0.96	0.88	0.91	0.80	0.99	0.98	0.98	0.98	0.78
Profes. Goods	0.99	0.97	0.97	0.98	0.82	0.87	0.95	0.91	0.94	0.79	0.99	0.97	0.98	0.98	0.78
Misc. Manu.	0.97	0.97	0.96	0.95	0.75	0.80	0.95	0.91	0.90	0.71	0.96	0.94	0.94	0.97	0.70

(table continues next page)

Table 1 Correlations of Production Across Industries *(continued)*

Sector	P & C	Rub	Plastic	N-Metal	I & S	N-fer	Fab M	Ind M	Elec M	Tra M	Prof G	Misc.
Industrial Prod.												
Food Processing												
Beverages												
Tobacco & Prods.												
Textiles												
Apparel												
Leather Prods.												
Footwear												
Wood Prods.												
Furniture												
Paper												
Printing and Pub.												
Basic Chemicals												
Other Chem. Prods.												
Petro. Refining												
Petro. and Coal	1.00											
Rubber Prods.	0.97	1.00										
Plastic Prods.	0.83	0.79	1.00									
Nonmetallic Prods.	0.95	0.97	0.89	1.00								
Iron & Steel	0.98	0.98	0.84	0.98	1.00							
Nonferrous Metals	0.96	0.99	0.75	0.95	0.97	1.00						
Fabricated Metal	0.97	0.98	0.78	0.95	0.98	0.98	1.00					
Indust. Machinery	0.94	0.98	0.72	0.94	0.96	0.97	0.97	1.00				
Elec. Machinery	0.98	0.99	0.82	0.98	0.99	0.97	0.98	0.97	1.00			
Trans. Machinery	0.98	0.98	0.85	0.98	0.99	0.97	0.98	0.96	0.99	1.00		
Profes. Goods	0.97	0.97	0.85	0.98	0.99	0.95	0.97	0.95	0.99	0.99	1.00	
Misc. Manu.	0.94	0.96	0.78	0.94	0.97	0.93	0.95	0.95	0.97	0.96	0.96	1.00

Table 2 Interindustry Linkages

Industry	Backward Linkage	Forward Linkage	Total Linkage
Food Processing	2.267269	1.572321	3.839590
Beverage	1.756841	1.958921	3.715763
Tobacco	1.281045	1.051235	2.332280
Textiles	2.163114	1.771415	3.934529
Apparel	2.145076	1.024679	3.169755
Leather	1.782901	1.747012	3.529913
Footwear	1.782901	1.747012	3.529913
Wood Products	1.698044	2.091918	3.789961
Furniture	2.013180	1.823123	3.836303
Paper	2.060614	3.186488	5.247102
Printing	2.163467	2.438758	4.602225
Chemical	1.932577	3.181606	5.114183
Other Chemical	1.740605	2.383885	4.124490
Petroleum Ref.	1.146829	2.859925	4.006754
Petro., Coal Prods.	1.293919	2.750794	4.044713
Rubber	1.924645	1.327635	3.252280
Plastic	2.042086	2.062823	4.104910
Nonmetallic Prods.	1.938187	2.370438	4.308624
Iron & Steel	2.464819	2.938392	5.403211
Nonferrous Metals	1.618080	2.509598	4.127677
Fabri. Metal Prods.	2.130569	1.722996	3.853565
Machinery	2.036547	1.744555	3.781102
Electric Mach.	1.790613	1.398499	3.189113
Transport Equips.	2.047274	1.292247	3.339521
Professional Goods	1.843012	1.446915	3.289926
Misc. Manuf.	2.076539	1.280840	3.357379

Table 3 Tests for Unit Roots, Cointegration

Series	MSW	SW	DF	Time	Constant	CO
Industrial Production					a	--
Food Processing	b	b		a		
Beverages	c	c		a		
Tobacco Products	a				a	
Textiles	c				a	
Apparel					a	
Leather					b	
Footwear					b	
Wood Products				b		
Furniture				a		
Paper	b	a	c	b	b	
Printing	b			a		
Chemical					a	c
Other Chemical				c	a	b
Petroleum Refining				b	b	
Petroleum, Coal	a	a	c	a	b	
Rubber		c		a	c	
Plastic					a	
Nonmetallic Products	a	a	c	a	b	
Iron and Steel					a	b
Nonferrous Metals				b	b	
Fabricated Metal Products				b		
Machinery				a		
Electrical Machinery				c	a	
Transport Equipment	b			c	a	
Professional Goods				c	a	b
Miscellaneous Manufactures	b	b	b	a		

Note: the letter *a* indicates significance at the 1percent level; *b* at the 5 percent level; and *c* at 10 percent level.

Table 4 Causality Regressions

Industry	Industry LHS Variable			Industrial Production (IP) LHS Variable			Interpretation
	RBAR**2	BLQ	F	RBAR**2	BLQ	F	
Food	0.80	23.1	1.5	0.73	28.5	1.0	
Beverage	0.89	30.9	8.4[a]	0.71	34.2	1.5	Industry causes IP
Tobacco	0.59	37.8	1.9	0.68	28.4	1.6	
Textile	0.38	24.8	2.2[c]	0.71	19.1	0.9	Industry causes IP
Apparel	0.48	21.4	1.2	0.80	19.7	5.2[a]	IP causes industry
Leather	0.22	17.0	3.0[b]	0.66	31.0	0.8	Industry causes IP
Footwear	0.26	18.8	1.8	0.70	10.1	0.7	
Wood	0.66	17.2	3.4[b]	0.78	27.3	0.6	Industry causes IP
Furniture	0.38	24.4	0.6	0.63	17.1	0.9	
Paper	0.93	24.2	3.1[b]	0.79	24.4	1.8	Industry causes IP
Printing	0.55	20.5	0.2	0.66	34.5	2.1[c]	IP causes industry
Chemical	0.28	23.6	1.9	0.65	31.5	1.3	
Other Chemical	0.36	21.7	0.4	0.70	25.1	3.9[a]	IP causes industry
Petroleum Ref.	0.47	16.5	1.3	0.63	22.7	1.8	
Petroleum, Coal	0.88	16.4	4.2[a]	0.69	19.5	1.2	Industry causes IP
Rubber	0.38	26.0	0.3	0.69	20.9	1.5	
Plastic	0.15	18.8	1.4	0.65	17.5	1.6	
Non-metallic	0.87	21.7	3.2[b]	0.77	23.1	4.6[a]	Feedback
Iron and Steel	0.34	27.9	0.2	0.72	22.3	3.6[a]	IP causes industry
Nonferrous metal	0.39	33.9	2.2[c]	0.73	34.6	0.7	Industry causes IP
Fabricated metal	0.43	53.8[a]	2.1[c]	0.75	20.1	2.1[c]	Feedback
Machinery	0.58	15.8	0.8	0.75	31.0	1.1	
Electrical Mach.	0.47	26.0	1.1	0.74	23.5	2.0	
Transport Mach.	0.40	25.7	2.4[c]	0.70	22.3	2.2[c]	Feedback
Professional	0.30	8.8	0.9	0.74	20.7	2.7[b]	IP causes industry
Miscellaneous	0.88	24.0	3.2[b]	0.78	22.2	4.7[a]	Feedback

Note: The superscript *a* indicates significance at the 1percent level, *b* at the 5 percent level, and *c* at the 10 percent level.

Table 5 Macro Regressions

Industry	A1	A2	M0	M1	M2	SEE	SDQ	BLQ	Macro
Food	0.6	0.2	0.2	-0.1	0.1	0.06	0.09	27.8	0.34
	(5.3)	(1.9)	(0.5)	(-0.3)	(0.8)				
Beverage	0.9	0.2	-0.1	-0.5	1.1	0.07	0.12	32.9	0.03
	(7.1)	(0.2)	(-0.4)	(-1.3)	(0.2)				
Tobacco	0.3	-0.1	-0.1	-0.4	-0.4	0.06	0.06	28.2	0.00
	(2.9)	(-1.2)	(-0.3)	(-0.5)	(-0.2)				
Textile	0.2	0.1	0.0	-0.1	-0.1	0.03	0.03	16.1	0.79
	(1.3)	(0.9)	(0.1)	(-0.4)	(-0.4)				
Apparel	-0.0	0.6	0.0	1.1	-0.2	0.07	0.07	11.4	0.46
	(-0.1)	(0.5)	(0.1)	(0.1)	(-0.2)				
Leather	0.1	0.2	0.0	0.6	-0.1	0.14	0.14	12.6	0.08
	(0.9)	(1.3)	(0.0)	(0.1)	(0.5)				
Footwear	-0.2	0.0	0.1	-0.1	1.6	0.07	0.07	11.4	0.05
	(-1.4)	(0.2)	(1.1)	(-0.5)	(0.2)				
Wood	0.2	0.2	0.1	0.4	0.6	0.07	0.08	18.2	0.12
	(2.0)	(1.8)	(2.7)	(1.7)	(1.9)				
Furniture	-0.2	-0.1	-0.1	0.2	0.8	0.13	0.13	12.2	0.07
	(-1.5)	(-1.7)	(-0.8)	(0.3)	(0.5)				
Paper	0.8	0.6	-0.1	-0.1	0.4	0.05	0.08	9.9	0.07
	(6.5)	(0.6)	(-0.3)	(-0.5)	(0.1)				
Printing	-0.4	-0.1	0.1	0.2	0.1	0.07	0.07	24.7	0.01
	(-3.4)	(-0.9)	(0.2)	(0.2)	(0.0)				
Chemical	-0.3	-0.3	0.1	0.4	-0.9	0.07	0.08	25.8	0.02
	(-3.0)	(-2.6)	(0.4)	(0.3)	(-0.1)				
Other Chem	-0.1	0.1	0.1	0.1	-0.0	0.05	0.05	22.9	0.02
	(-0.6)	(1.2)	(0.3)	(0.2)	(-0.2)				
Petro Ref	-0.2	-0.1	-0.0	0.0	0.1	0.05	0.05	17.1	0.47
	(-1.5)	(-0.7)	(-0.0)	(0.0)	(0.3)				

(table continues next page)

Table 5 Macro Regressions *(continued)*

Industry	A1	A2	M0	M1	M2	SEE	SDQ	BLQ	Macro
Petro, Coal	0.3	-0.1	-0.0	-0.1	0.1	0.11	0.11	33.5c	0.00
	(2.2)	(-1.1)	(-0.1)	(-0.0)	(0.0)				
Rubber	0.3	-0.2	0.0	0.0	-0.0	0.07	0.07	31.1	0.07
	(2.6)	(-1.6)	(0.9)	(0.3)	(-0.2)				
Plastic	0.1	0.3	0.1	-0.2	-0.4	0.08	0.08	11.9	0.02
	(0.7)	(2.4)	(0.3)	(-0.0)	(-0.2)				
Nonmetal	0.7	-0.1	0.1	-0.1	-1.4	0.06	0.09	15.1	0.00
	(6.1)	(-0.1)	(0.3)	(-0.2)	(-0.1)				
Iron, Steel	0.3	-0.1	0.2	-0.6	-0.1	0.07	0.07	27.6	0.26
	(2.9)	(-0.5)	(0.4)	(-0.4)	(-0.2)				
Nonferrous	-0.2	-0.1	-0.0	0.2	0.1	0.09	0.09	17.8	0.31
	(-1.4)	(-1.0)	(-0.9)	(0.4)	(0.2)				
Fabricated	0.5	-0.3	-0.1	0.2	-0.3	0.09	0.09	15.0	0.53
	(0.4)	(-0.3)	(0.2)	(0.2)	(-0.2)				
Machinery	-0.5	-0.1	0.2	-0.2	-0.1	0.12	0.12	40.9b	0.30
	(-0.4)	(1.2)	(0.2)	(-0.1)	(-0.3)				
Electrical	0.4	0.4	0.1	-0.1	0.1	0.09	0.09	21.8	0.05
	(3.0)	(0.4)	(0.3)	(-0.5)	(0.1)				
Transport	-0.1	-0.0	0.0	0.1	-0.7	0.16	0.16	23.4	0.00
	(-0.5)	(-0.2)	(0.2)	(0.1)	(-0.1)				
Profession	-0.3	0.1	0.6	0.3	0.3	0.15	0.15	16.6	0.06
	(-3.7)	(0.5)	(2.1)	(0.4)	(0.1)				
Misc. Manf.	-0.2	-0.1	0.0	0.1	-0.1	0.08	0.18	18.5	0.05
	(-1.6)	(-1.2)	(0.3)	(0.1)	(-0.2)				

Note: Numbers in parentheses are t-values. Superscripts in the Box-Ljung Q column indicate level of statisical significance: *a* indicates significance at the 1percent level, *b* at the 5 percent level, and *c* at the 10 percent level.

Table 6 Summary

Industry	Macro Ratio < 0.5	"Leading" Sector	Strong Links	HCI Sector	Candidate Sector
Food Processing	x		x		
Beverages	x	x			
Tobacco Products	x				
Textiles		x	x		
Apparel	x				
Leather	x	x			
Footwear	x				
Wood Products	x	x	x		x
Furniture	x		x		
Paper	x	x	x		x
Printing	x		x		
Chemicals	x		x	x	
Other Chemicals	x		x		
Petroleum Refining	x		x	x	
Petroleum, Coal Products	x	x	x		x
Rubber	x				
Plastic	x		x		
Nonmetallic Products	x	?	x		?
Iron and Steel	x		x	x	
Nonferrous Metals	x	x	x	x	x
Fabricated Metal Products		?	x		
Machinery	x		x	x	
Electrical Machinery	x			x	
Transport Machinery	x	?		x	
Professional Goods	x				
Miscellaneous Manufactures	x	?			