A FURTHER TEST OF THE COMPETITIVE EFFECT IN SHIFT-SHARE ANALYSIS

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Introduction

Shift-share analysis has been used to examine regional and urban development by breaking growth into three more easily understood components: (1) the national growth component, which represents growth that would have occurred in the region if all industries had grown at the national average; (2) the industrial-mix component, which measures growth that would have occurred if existing industries had grown at the same rate as those industries in the national economy, and, thus, is viewed as a measure of the effect of the existing industrial structure on regional growth; and (3) the regional share (differential or competitive) component, measured residually, which is interpreted as a measure of regional competitiveness. The usefulness of shift-share analysis, especially with respect to the regional competitive share component, has received considerable debate in the literature.¹

A recent paper by Ireland and Moomaw (1981) follows a new approach by using the regional competitive share component to predict the level of capital information by a given industry in the region. Their results, while not conclusive, tend to support use of such relationships in a forecast environment, but data limitations prevented them from undertaking an out-of-sample test of the predictive performance of the model.

The purpose of this paper is to test further the hypothesis set out by Ireland and Moomaw by applying the same analysis to data for twenty two-digit industries for the provinces of Ontario and Quebec and by extending the analysis to include an out-of-sample *ex post* forecast evaluation.

The Model

The model by Ireland and Moomaw is designed to test the competitive share of the shift-share model as a measure of the region's competitive advantage. Following Browne, Mieszkowski and Syron (1980), and Hodge (1981), the investment in a particular industry in the region is assumed to be a function of the regional comparative advantage and the growth prospects for the industry nationally. In addition, lagged value-added is included

to proxy the need for replacement investment.

Ireland and Moomaw follow Bishop and Simpson (1972) and Esteban-Marquillas (1972) in defining the competitive component as the difference between the regional and national growth rates for the industry multiplied by the homothetic output.

The exact form of the investment model by Ireland and Moomaw is as follows:

$$I_i = a + bQI_i + cRN_i + dCOM_i + \text{Random Term}, (1)$$

where a , b , c , and d are parameters to be estimated, I_i is real investment in industry i , QI_i is lagged real output (value-added) in industry i , RN_i is the national growth rate in real output (value-added) in industry i , and COM_i is the competitive effect in industry i from shift-share analysis of real output (value-added).

As an alternative hypothesis, Ireland and Moomaw test a similar functional form with the industry growth rate in the region, R_i , substituted for both RN_i and COM_i . Thus, the alternative form of the model is the following:

$$I_i = f + gQI_i + hR_i + \text{Random Term} (2)$$

where f , g , and h are parameters to be estimated, R_i is the regional growth rate of industry i , and all other variables are as previously defined.

Empirical Results

We estimated equations (1) and (2) using data for twenty two-digit industries from the provinces of Ontario and Quebec for the period 1962 to 1977. As well as looking at the in-sample results, we have tested the model's ability to predict events out of the sample by simulating the equations for the period 1978-1982. We follow the simple procedure of calculating the shift and share components for the value-added of each industry in each province. The regional competitive share is used as a proxy for the competitive share variable, COM , in equation (1).

The data on value-added by industry were obtained from Statistics Canada catalogue #31-203 and the data on investment were obtained from the Construction Division of Statistics Canada. The estimated results for Ontario are presented in Table 1 with those for Quebec in Table 2.

The regression results in Tables 1 and 2 are quite comparable to those found by Ireland and Moomaw for

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Oklahoma. The coefficient on lagged value-added is positive in all cases and significantly different from zero in all cases, except for knitting mills in Quebec. Overall, the fit of the equations using the competitive component as a major factor explaining the amount of investment in each industry is slightly better than the naive alternative hypothesis. Although the differences tend to be quite small, the competitive share version has a higher R^2 in twenty-two of the forty cases. However, the true test of

whether the competitive share is an important determinant of investment decisions hinges on whether the comparative advantage term is significant in the investment equations.

The regional comparative advantage term is significantly positive at least at the ten percent level in only nine of the forty equations.² The national growth effect is slightly more successful, with a positive coefficient found to be statistically significant in twenty-one of the forty

Table 1

Regression Results Province of Ontario

Industry	Intercept	Q1	COM	RN	R	R ²	DW
Food & Beverage	-205.87	0.00025 ^a	0.00036	1422.6 ^a		0.802	1.68
	(2.98)	(3.48)	(0.49)	(1.45)			
	-200.81	0.00026 ^a			1185.8 ^b	0.812	1.69
	(3.21)	(6.76)			(1.78)		
Tobacco Industries	-0.116	0.00008 ^a	-0.00019	52.79 ^a		0.728	1.54
	(0.05)	(3.86)	(1.45)	(3.84)			
	-0.944	0.00010 ^a			16.95 ^b	0.572	1.67
	(0.35)	(4.73)			(1.96)		
Rubber & Plastics Products & Industries	-27.67	0.00026 ^a	0.00003	26.38		0.833	1.74
	(1.78)	(9.09)	(0.21)	(0.44)			
	-24.38	0.00026 ^a			5.40	0.843	1.74
	(1.83)	(9.36)			(0.14)		
Leather Industries	-19.69	0.00027 ^a	-0.00075	48.79 ^a		0.907	1.56
	(7.43)	(10.69)	(2.78)	(3.54)			
	-15.54	0.00024 ^a			19.54 ^a	0.839	1.55
	(5.09)	(7.96)			(1.42)		
Textile Industries	-27.29	0.00037 ^a	-0.00026	-153.10		0.777	1.49
	(1.38)	(7.53)	(0.73)	(1.33)			
	-27.20	0.00035 ^a			-135.93	0.788	1.53
	(1.41)	(7.67)			(1.64)		
Knitting Mills	-2.55	0.00010	0.00024	8.25		0.172	1.03
	(0.42)	(1.06)	(0.92)	(0.92)			
	-4.96	0.00014 ^b			12.89	0.210	0.87
	(1.19)	(1.91)			(0.83)		
Clothing Industries	-6.42	0.00005 ^a	0.00005	23.43		0.506	1.29
	(1.91)	(2.42)	(0.42)	(0.84)			
	-6.36	0.00005 ^a			23.11	0.547	1.29
	(2.38)	(2.81)			(1.01)		
Wood Industries	-21.31	0.00037 ^a	-0.00004	-49.54		0.900	0.90
	(3.06)	(12.08)	(1.28)	(2.02)			
	-22.31	0.00037 ^a			-53.79	0.903	0.88
	(3.29)	(12.27)			(2.05)		
Furniture & Fixture Industries	-12.44	0.00011 ^a	-0.00108	50.46 ^a		0.841	1.90
	(3.40)	(9.00)	(3.64)	(2.56)			
	-8.10	0.00011 ^a			13.36	0.683	1.47
	(1.65)	(6.03)			(0.57)		

Paper & Allied Products	-189.97 (4.90)	0.00057 ^a (10.69)	0.00022 (0.98)	196.60 ^b (1.78)	0.884	1.00
	-185.28 (5.11)	0.00056 ^a (11.46)			180.19 ^b (1.80)	0.891 1.04
Printing Publishing and Allied Industries	-69.39 (3.71)	0.00022 ^a (6.09)	0.00086 (1.23)	252.56 (1.17)	0.856	1.35
	-72.80 (4.09)	0.00023 ^a (6.79)			204.62 (0.96)	0.855 1.34
Primary Metal Industries	-451.72 (4.23)	0.00082 ^a (10.08)	-0.00033 (0.51)	480.46 (0.82)	0.898	1.29
	-485.08 (4.83)	0.00086 ^a (11.63)			444.89 (0.80)	0.896 1.49
Metal Fabricating	-92.89 (3.70)	0.00021 ^a (12.86)	-0.00208 (3.50)	186.05 ^a (1.42)	0.942	1.81
	-138.67 (4.23)	0.00023 ^a (10.71)			419.75 ^a (2.43)	0.879 2.02
Machinery Industries	-75.17 (5.90)	0.00021 ^a (13.54)	0.00072 ^a (2.36)	279.12 ^a (5.25)	0.927	1.91
	-72.96 (5.72)	0.00020 ^a (13.33)			264.22 ^a (5.07)	0.925 2.09
Transportation Equipment Industries	-116.91 (1.95)	0.00024 ^a (9.03)	-0.00096 (2.16)	197.59 (0.76)	0.858	1.27
	-104.42 (1.57)	0.00025 ^a (8.63)			-90.43 (0.41)	0.823 1.52
Electrical Products Industries	-66.84 (3.30)	0.00017 ^a (10.25)	-0.00026 (0.83)	151.57 ^a (1.55)	0.878	1.95
	-70.12 (3.42)	0.00017 ^a (10.61)			150.12 ^a (1.53)	0.874 1.83
Non-metallic Mineral Products Industries	-93.37 (4.19)	0.00053 ^a (11.25)	-0.00115 (2.26)	100.49 0.87	0.936	1.56
	-108.75 (4.35)	0.00059 ^a (12.95)			40.03 (0.32)	0.912 1.65
Petroleum & Coal Products Industries	-64.39 (4.20)	0.00111 ^a (14.98)	0.00069 ^a (2.49)	184.25 ^a (3.97)	0.942	2.18
	-65.20 (4.19)	0.00111 ^a (14.73)			203.17 ^a (5.05)	0.940 1.71
Chemical & Chemical Products Industries	-606.78 (5.63)	0.00108 ^a (8.54)	-0.00307 (0.98)	422.06 (0.73)	0.895	0.58
	-646.60 (6.39)	0.00116 ^a (11.33)			207.78 (0.39)	0.894 0.40
Miscellaneous Manufacturing Industries	-7.21 (4.43)	0.00010 ^a (4.43)	0.00022 (0.31)	14.12 (0.38)	0.542	1.71
	-6.12 (0.56)	0.00010 ^a (4.82)			13.67 (0.39)	0.571 1.67

^aDenotes significance at 0.10 level.

^bDenotes significance at 0.05 level.

^cDenotes significance at 0.025 level.

Table 2
Regression Results Province of Quebec

Industry	Intercept	Q1	COM	RN	R	R ²	DW
Food & Beverage Industries	-117.26 (3.26)	0.00023 ^a (3.77)	0.00002 (0.06)	918.87 ^a (1.75)		0.803	1.64
	-97.28 (2.97)	0.00023 ^a (3.77)			677.98 ^c (1.37)	0.797	1.58
Tobacco Industries	-13.38 (3.41)	0.00016 ^a (5.37)	0.00060 ^a (1.47)	64.71 ^a (3.48)		0.770	1.58
	-11.87 (3.19)	0.00015 ^a (5.31)			59.82 ^a (3.26)	0.765	1.31
Rubber & Plastics Industries	-6.42 (0.75)	0.00029 ^a (5.18)	0.00001 (0.02)	5.07 (0.14)		0.663	1.02
	-6.59 (0.80)	0.00029 ^a (6.05)			4.73 (0.26)	0.688	1.02
Leather Industries	-10.27 (4.04)	0.00014 ^a (5.51)	0.00051 ^a (1.46)	24.66 ^a (2.43)		0.727	1.26
	-9.43 (3.97)	0.00013 ^a (5.78)			23.48 ^a (2.30)	0.724	1.49
Textile Industries	-90.69 (3.07)	0.00047 ^a (6.66)	0.00157 ^a (1.63)	-126.53 (1.05)		0.729	1.73
	-97.11 (3.12)	0.00044 ^a (5.99)			-9.15 (0.08)	0.682	1.47
Knitting Mills	-5.43 (1.03)	0.00012 ^a (2.87)	0.00019 (0.14)	29.54 (1.05)		0.404	1.65
	-5.60 (1.14)	0.00012 ^a (3.76)			23.23 (1.03)	0.432	1.56
Clothing Industries	-5.67 (1.10)	0.00003 ^a (2.13)	0.00032 (0.38)	35.80 (0.69)		0.330	1.43
	-5.16 (1.07)	0.00003 ^a (2.53)			35.99 (0.77)	0.367	1.46
Wood Industries	-19.19 (3.24)	0.00029 ^a (13.08)	-0.00002 (0.26)	-18.05 (0.81)		0.915	0.85
	-19.35 (3.40)	0.00029 ^a (13.39)			-21.85 (0.99)	0.919	0.80
Furniture & Fixture Industries	-13.10 (2.92)	0.00016 ^a (6.96)	-0.00073 (1.23)	35.30 ^a (1.71)		0.801	1.55
	-11.08 (2.84)	0.00014 ^a (8.19)			30.14 ^a (1.52)	0.803	1.48
Paper & Allied Products Industries	-191.63 (3.95)	0.00060 ^a (8.34)	-0.00065 (1.00)	254.00 ^b (1.93)		0.867	1.12
	-154.02 (3.57)	0.00053 ^a (9.09)			344.36 ^a (2.73)	0.860	0.79
Printing Publishing and Allied Industries	-27.26 (3.56)	0.00015 ^a (5.60)	-0.00034 (1.33)	172.53 ^b (1.80)		0.856	1.50
	-22.90 (3.02)	0.00018 ^a (8.62)			22.78 (0.47)	0.835	1.42
Primary Metal Industries	-190.01 (3.33)	0.00078 ^a (7.28)	-0.00003 (0.11)	377.98 (1.19)		0.810	1.30

	-166.82 (3.71)	0.00078 ^a (7.80)		152.47 ^a (1.37)	0.820	1.02
Metal Fabricating Industries	-53.24 (5.82)	0.00020 ^a (12.72)	0.00032 ^b (1.95)	161.71 ^a (3.58)	0.915	2.13
	-50.27 (5.51)	0.00017 ^a (11.84)			150.35 ^a (3.51)	0.905 2.06
Machinery Industries	-14.54 (5.44)	0.00018 ^a (14.68)	0.00005 (1.14)	46.43 ^a (3.80)	0.937	1.78
	-12.10 (4.24)	0.00018 ^a (12.86)			28.26 ^a (2.86)	0.916 1.55
Transportation Equipment Industries	-23.20 (1.10)	0.00021 ^a (4.46)	0.00015 ^a (2.95)	65.01 (0.93)	0.662	0.68
	-32.99 (1.92)	0.00022 ^a (4.95)			138.59 ^a (3.20)	0.693 0.78
Electrical Products Industries	-33.44 (3.58)	0.00019 ^a (9.98)	0.00024 ^a (2.45)	125.30 ^a (2.80)	0.872	2.08
	-28.77 (3.08)	0.00019 ^a (9.00)			78.98 ^a (2.52)	0.838 1.85
Non-metallic Mineral Products Industries	-58.11 (4.43)	0.00049 ^a (9.58)	0.00068 ^a (2.33)	105.56 ^c (1.50)	0.861	1.43
	-54.90 (4.37)	0.00045 ^a (9.65)			134.86 ^a (2.57)	0.857 1.80
Petroleum & Coal Product Industries	-1.36 (0.09)	0.00061 ^a (6.40)	0.00036 (0.84)	125.137 ^c (1.67)	0.793	1.07
	-0.93 (0.06)	0.00061 ^a (7.52)			107.24 ^a (3.89)	0.801 1.19
Chemical & Chemical Products Industries	-159.41 (4.41)	0.00064 ^a (8.36)	-0.00005 (0.05)	231.02 (1.03)	0.845	1.37
	-159.54 (4.71)	0.00066 ^a (9.01)			178.01 (0.97)	0.849 1.29
Miscellaneous Manufacturing Industries	-10.79 (4.31)	0.00011 ^a (8.44)	0.00012 (1.34)	19.09 ^a (2.49)	0.838	1.09
	-11.24 (4.91)	0.00011 ^a (9.15)			21.20 ^a (3.07)	0.849 1.13

^aDenotes significance at 0.10 level.

^bDenotes significance at 0.05 level.

^cDenotes significance at 0.025 level.

cases.³ On the other hand, the naive alternative, using the actual growth in the industry in the region, was found to be statistically positive in twenty-one of the cases. Thus, we conclude that using the competitive share component as a measure of regional comparative advantage is not vastly superior to the naive alternative of simply using industrial growth in the region as the main determinant of investment.⁴

In order to test more effectively the ability of the regional comparative advantage variable to forecast the future levels of investment in each industry, Ireland and Moomaw simulated the models and calculated various test statistics to measure the predictive powers of the two versions of the model. All such tests, limited by data to be

performed in the estimation period, showed that in over two-thirds of the industries studied, the version of the model with the regional comparative advantage and the national growth effects entered separately outperformed the naive alternative model.

In this paper, we have followed a similar process and extended the analysis to include an ex post forecast evaluation of the two versions of the model. The results of these simulations are summarized in Table 3.

Our simulation results for the in-sample period again confirm those for Oklahoma by Ireland and Moomaw. The Theil's U statistics calculated from the in-sample simulations reveal that the regional share version of the model outperforms the naive version in all but four

of the forty cases. In addition, the simple average of the Theil's U statistics for Ontario is 0.630 for the regional share version, as compared to 0.692 for the naive version, and for Quebec the comparable values are 0.712 and 0.743 respectively. However, the ex post simulations fail to support the use of the regional share version of the model. The Theil's U statistics for the out-of-sample simulations

support the use of the naive alternative hypothesis in twenty-nine of the forty cases. Moreover, in twenty of the forty cases, the Theil's U statistic is greater than the critical value of unity for the model containing the regional share and national growth components.⁵ Therefore, we conclude that the competitive effect in shift-share analysis is not particularly useful in predicting regional investment patterns.

Table 3

Predictive Performance of the Models

Industry	Theil's U in sample		Theil's U ex post	
	COM	R	COM	R
Ontario				
Food & Beverage	0.690	0.699	0.979	0.887
Tobacco	0.574	0.737	1.376	1.311
Rubber & Plastics	0.660	0.665	1.195	1.292
Leather	0.529	0.751	1.643	0.868
Textile	0.586	0.593	2.383	1.149
Knitting Mills	1.012	1.015	0.747	0.684
Clothing	0.888	0.880	0.678	0.577
Wood	0.571	0.591	1.626	1.743
Furniture	0.571	0.760	0.658	0.447
Paper	0.742	0.746	0.427	0.418
Printing	0.646	0.672	1.186	1.832
Primary Metals	0.565	0.590	1.068	0.588
Metal Fabricating	0.387	0.580	0.933	0.714
Machinery	0.478	0.501	0.525	0.751
Transportation	0.530	0.611	1.803	1.719
Electrical Products	0.575	0.607	0.916	0.791
Non-metallic	0.510	0.615	1.028	0.882
Petroleum & Coal	0.594	0.626	3.919	1.890
Chemical Products	0.822	0.860	2.926	3.160
Miscellaneous	0.737	0.739	0.509	0.433
Simple Average	0.630	0.692	1.326	1.069
Quebec				
Food & Beverage	0.738	0.776	1.244	1.369
Tobacco	0.594	0.618	0.469	0.323
Rubber & Plastics	0.978	0.977	2.484	2.508
Leather	0.788	0.821	1.211	1.043
Textile	0.540	0.622	2.903	0.879
Knitting Mills	0.765	0.776	0.992	0.970
Clothing	0.835	0.843	0.938	0.818
Wood	0.683	0.689	1.575	1.627
Furniture	0.694	0.717	0.764	0.165

Paper	0.693	0.734	0.879	0.414
Printing	0.643	0.728	1.161	1.419
Primary Metals	0.903	0.916	1.729	1.510
Metal Fabricating	0.511	0.559	0.597	0.499
Machinery	0.516	0.596	0.320	0.396
Transportation	0.843	0.835	1.049	0.563
Electrical Products	0.549	0.655	0.560	0.433
Non-metallic	0.627	0.661	1.543	1.410
Petroleum & Coal	0.885	0.889	0.251	0.329
Chemical Products	0.667	0.677	0.966	0.941
Miscellaneous	0.782	0.781	0.716	0.577
Simple Average	0.712	0.743	1.118	0.909

Summary and Conclusion

In this paper, using data for the provinces of Ontario and Quebec, we have tested the Ireland and Moomaw hypothesis that the regional share component of the shift-share model may be used as an important explanatory variable for predicting future investment decisions. Most of our results are quite comparable to those originally presented by Ireland and Moomaw. The estimation results and the in-sample predictive power tend marginally to support the use of this variable.

However, the results from the ex post forecasts yield the opposite conclusion. The results for both Ontario and Quebec fail to show any systematic support for the use of the regional competitive share component in models of industrial investment behaviour.

NOTES

¹Brown (1969), Houston (1967), and Richardson (1978) are highly critical of the process. Ashby (1968), Dunn (1980), Danson, Lever and Malcolm (1980), and Fothergill and Gudgin (1979) have all shown useful applications of it. Brown (1969) claimed that the competitive share is not stable enough to allow for prediction and is too broadly defined for useful analysis. Paraskevopoulos (1971), Floyd and Sirmans (1973), and James and Hughes (1973) found shift-share projection models to be superior to naive alternative models. Although Brown (1971 and 1973) attempted to refute these claims of stability, Chalmers and Beckhelm (1976) and Andrikopoulos (1977) used formal regression analysis to show that the regional share component can be explained effectively by standard economic variables such as wages and capital formation.

²Ireland and Moomaw found a significantly positive result in six of twelve cases for this variable.

³This variable was significantly positive in six of twelve cases in Ireland and Moomaw.

⁴Again this finding is consistent with Ireland and Moomaw who conclude, "Thus, this variable performs somewhat better than the two variables it replaces in terms of significance levels," p. 79.

⁵The Theil's U statistic is the ratio of the root mean squared forecast error to the root mean actual change in the data series. Thus, a model with a U statistic greater than unity is performing worse than the naive no-change forecast and is not considered to be useful for prediction.

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