March 2002 FREC SP02-01

Is the Export-Lead Growth Hypothesis Valid for Canada?

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FOOD & RESOURCE ECONOMICS

FREC Staff Paper

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Is the export-led growth hypothesis valid for Canada?

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Abstract

Empirical evidence linking exports to economic growth has been mixed and inconclusive. This study re-examine the export-led growth (ELG) hypothesis for Canada by testing for Granger causality from exports to national output growth using vector error correction models (VECM) and the augmented vector autoregressive (VAR) methodology developed in Toda and Yamamoto (1995). Application of recent developments in time series modeling and the inclusion of relevant variables omitted in previous studies help clarify the contradictory results from prior studies on the Canadian economy. The empirical results suggest that a long-run steady state exists among the model's six variables and that Granger causal flow is unidirectional from real exports to real GDP.

JEL Classification: F43, C32

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1. Introduction

The nature of the relationship between exports and national output growth has been one of the most debated in the recent past, yet with little consensus. Central to this debate is the question of whether strong economic performance is export-led or growth-driven. This question is important because the determination of the causal pattern between export and growth has important implications for policy-maker's decisions about the appropriate growth and development strategies and policies to adopt. The fact that strong correlation exists between exports and real GDP growth has been well documented in the literature. But previous empirical studies have produced mixed and conflicting results on the nature and direction of the causal relationship between export growth and output growth. Although most studies focus on the causal link between exports and output growth in developing countries (Michaely 1977; Balassa 1978; Chow 1987), some researchers have examined the export-led hypothesis with emphasis on industrialized countries (Marin 1992; Serletis 1992; Henriques and Sadorsky 1996; Yamada 1998). However, very few empirical studies have been done in the recent past to investigate the export-led growth (ELG) hypothesis for Canada (Serletis 1992; Henriques and Sadorsky 1996).

Using data from selected industrialized countries, Marin (1992) examines the causal link between exports and productivity and finds that the ELG hypothesis cannot be rejected for Germany, Japan, the United Kingdom, and the United States. But Marin's (1992) study did not include Canada. Only two recent studies are found that use Canadian data. The first study by Serletis (1992) examines the ELG hypothesis by using

single equation techniques to analyze Canadian annual data (exports, imports, and GNP) from 1870 to 1985. Serletis (1992) finds empirical support for the ELG hypothesis in Canada. More recently, Henriques and Sadorsky (1996) also focused on the export and output growth relationship for Canada using just three variables (GDP, exports, and terms of trade). They employ a multivariate cointegration estimation methodology that accounted for potential feedback and simultaneity effects between the three variables. In contrast to Serletis' (1992) earlier result, Henriques and Sadorsky (1996) find that "changes in GDP precede changes in exports."

The lack of consistent causal pattern between exports and output growth in the studies on Canada may be due to one or more of the following modeling issues. The causal models in these studies may be mis-specified because of: i) the omission of an important variable such as capital, labor, and foreign output shocks; ii) traditional Granger causality F-test in a regression context may not be valid if the variables in the system are integrated since the test statistic does not have a standard distribution (Toda and Philips 1993); and iii) temporal aggregation issues from use of annual time series may yield erroneous causation results (Bahmani-Oskooee and Alse (1993).

This paper contributes to the literature on the export-output growth nexus in the following ways. First, previous studies on the dynamic linkages between exports and output growth are extended through the application of recent advances in time series statistical techniques: i) vector error correction modeling (Toda and Philips 1993), and ii) augmented level VAR modeling with integrated and cointegrated processes of arbitrary orders (Toda and Yamamoto 1995; and Dolado and Lutkepohl 1996). These two

methodological procedures are useful because they allow tests of Granger causality between exports and output growth while accounting for the long-run information often ignored in systems that requires first differencing and pre-whitening prior to inference. In contrast to previous studies on Canada that used annual data in their analysis, this study uses a higher frequency quarterly time series data on Canada from 1961:1 -2000:4.

In addition to employing recently developed time series modeling techniques and use of higher frequency data, this study also expands on the three variables used by Henriques and Sadorsky (1996) to include labor, capital, and foreign output shock. Using VECM and Toda and Yamamoto's (1995) augmented VAR procedure, our results suggest that changes in real exports precede changes in real GDP. Furthermore, our inclusion of additional variables appear to be justified, as capital, labors, and foreign output shocks are statistically significant in the models. Our finding of evidence in support of ELG hypothesis for Canada is consistent with Serletis' (1992) results, but different from Henriques and Sadorsky (1996) findings.[1] The rest of this paper is organized as follows. Section 2 discusses the analytical framework and methodological issues while section 3 presents empirical findings and section 4 summarizes the paper's findings.

2. Analytical Framework and Methodological Issues

2.1. Exports and Output Growth Nexus

In the literature, causality from exports to real output is denoted as ELG hypothesis while the reverse causal flow from real output to exports is termed growth-driven exports. ELG hypothesis reflects the view that export-oriented policies help stimulate economic

growth. Export expansion can be a catalyst for output growth both directly, as a component of aggregate output, as well as indirectly through efficient resource allocation, greater capacity utilization, exploitation of economies of scale, and stimulation of technological improvement due to foreign market competition. Exports provide foreign exchange that allows for increasing levels of imports of capital goods and intermediate goods that in turn raise the growth of capital formation and thus stimulate output growth (McKinnon 1964; Balassa 1978; Buffie, 1992). Furthermore, export growth through expanded market base allows for the exploitation of economies of scale for open economies and promotes the transfer and diffusion of technical knowledge in the long run (Helpman and Krugman 1985; Grossman and Helpman 1991). Exports can be viewed as economies of scale that are external to the individual firms in the non-export sector but internal to the overall economy. The ELG hypothesis implies that the rate of export growth will lead to economy-wide efficiency and productivity growth.

Early empirical formulations tried to capture the causal link between exports and real GDP growth by incorporating exports into the aggregate production function (Balassa 1978; Sheehey 1990). This paper expands on the growth equation by including other potentially relevant variables such as terms of trade, and foreign output shock. The terms of trade reflects the possible linkages of the real exchange rates (and the possible effects of restrictive trade policy such as tariff and non-tariff barriers) and real output. The foreign output shock variable controls for export growth not influenced by Canadian price competitiveness or productivity, but by growth in the rest of the world. Accordingly, the aggregate production function is expressed as:

$$Y = F[(K, L); X, TT, Y^*] \quad (1)$$

where Y represents real GDP growth, K, L, X, TT, Y^* represent real capital, labor, real exports, real terms of trade, and a foreign output shock respectively. The export-output growth causal link is a long-run behavioral relationship whose analysis requires estimation techniques appropriate for long-run equilibria. Therefore, the variables in the system must be tested for cointegration, prior to testing for Granger causality. This paper will apply recent advances in time series techniques by estimating VECM and level VAR models with integrated and cointegrated processes of arbitrary orders (Toda and Yamamoto 1995; and Dolado and Lutkepohl 1996).

2.2. Multivariate Cointegration Analysis and Error Correction Modeling

The concept of cointegration is intuitively appealing because it is supported by the notion of long-run equilibrium in economic theory. While variables in a system may fluctuate in the short run, they are expected to return to their steady state in the long run. A common method for testing for cointegration between economic series is the Engel-Granger's two-step bivariate residual-based method. Although this approach is an improvement over simple correlation coefficient analysis, it has been shown to be weak in modeling multivariate cases because it: i) is sensitive to the choice of endogenous variables in the cointegrating regression; ii) makes *a priori* assumption of a single cointegrating vector in the system; and iii) tends to yield biased parameter estimates in small samples (Banerjee, et al 1990). Johansen (1988) and Johansen and Juselius' (1990) maximum likelihood (ML) procedure is a very popular alternative to the Engle-Granger

method. The main attraction of this procedure is that it tests for the possibility of multiple cointegrating relationships among the variables. Johansen and Juselius (1992) modeled time series as reduced rank regression in which they computed the ML estimates in the multivariate cointegration model with Gaussian errors. The model is based on the error correction representation given by

$$\Delta X_t = \mu + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-1} + \varepsilon_t \qquad (2)$$

where X_t is an (nx1) column vector of p variables, μ is an (nx1) vector of constant terms, Γ and Π represent coefficient matrices, Δ is a difference operator, k denotes the lag length, and ε_t is i.i.d. p-dimensional Gaussian error with mean zero and variance matrix Λ (white noise disturbance term). The coefficient matrix Π is known as the impact matrix and it contains information about the long-run relationships.

Equation (2) resembles a VAR model in first differences, except for the inclusion of the lagged level of X_{t-1}, an error correction term, which will contain information about the long run among variables in the vector X_t. This way of specifying the system contains information on both the short- and long-run adjustment to changes in X_t through the estimates of Γ and Π respectively. The VECM equation above allows for three model specifications. (a) If Π is of full rank, then X_t is stationary in levels and a VAR in levels is an appropriate model. (b) If Π has zero rank, then it contains no long run information, and the appropriate model is a VAR in first differences (implies variables are not cointegrated). (c) If the rank of Π is a positive number, r and is less than p (where p is the number of variables in the system), there exists matrices α and β, with dimensions

(p x r), such that $\Pi = \alpha\beta'$. In this representation β contains the coefficients of the r distinct long run cointegrating vectors that render $\beta' X_t$ stationary, even though X_t is itself non-stationary, and α contains the short run speed of adjustment coefficients for the equations in the system.

Johansen's methodology requires the estimation of the VAR equation (2) and the residuals are then used to compute two likelihood ratio (LR) test statistics that can be used in the determination of the unique cointegrating vectors of X_t. The first test which considers the hypothesis that the rank of Π is less than or equal to r cointegrating vectors is given by the trace test below:

$$Trace = -T \sum_{i=r+1}^{n} \ln(1 - \lambda_i) \tag{3}$$

The second test statistic is known as the maximal eigenvalue test which computes the null hypothesis that there are exactly r cointegrating vectors in X_t and is given by:

$$\lambda_{max} = -T \ln(1-\lambda_r). \tag{4}$$

The distributions for these tests are not given by the usual chi-squared distributions. The asymptotic critical values for these likelihood ratio tests are calculated via numerical simulations (see Johansen and Juselius 1990; and Osterwald-Lenum 1992).

2.3 Toda-Yamamoto Levels Vector Autoregression (VAR)

Sims, Stock, and Watson (1990) show that inference based on levels VAR is valid since the Wald test used in Granger causality restrictions has a limiting chi-square distribution if the time series are cointegrated and the long run relationship involves the

variable that is excluded under the null hypothesis. However, this approach has limitations because of its dependence on pre-tests for cointegration and its inapplicability to mixed orders of integration processes. A recent method proposed by Toda and Yamamoto (1995) is complementary to the Sims, et al. (1990) technique because it allows for causal inference based on augmented level VAR with integrated and cointegrated processes. This method is useful because it bypasses the need for potentially biased pre-tests for unit roots and cointegration, common to other formulations.

The Toda and Yamamoto (1995) procedure uses a modified Wald (MWALD) test to test restrictions on the parameters of the VAR(k) model. This test has an asymptotic chi-squared distribution with k degrees of freedom in the limit when a VAR[k+d(max)] is estimated (where d(max) is the maximal order of integration for the series in the system). Two steps are involved with implementing the procedure. The first step includes determination of the lag length (k) and the maximum order of integration (d) of the variables in the system. Measures such as the Akaike Information Criterion (AIC) and Hannan-Quinn (HQ) Information Criterion can be used to determine the appropriate lag structure of the VAR. Given the VAR(k) selected, and the order of integration d(max) is determined, a levels VAR can then be estimated with a total of p=[k+d(max)] lags. The second step is to apply standard Wald tests to the first k VAR coefficient matrix (but not all lagged coefficients) to conduct inference on Granger causality.

3. Empirical Analysis and Results

3.1. Data and Integration Properties

The data set consists of Canadian observations on real GDP, real exports, real terms of trade (export unit value divided by import unit value), manufacturing employment as proxy for labor, gross capital formation as proxy for capital, and industrial production index for all industrialized nations as the proxy for foreign output shock. Industrial production for all industrialized countries control for export growth not influenced by Canadian price competitiveness or productivity, but by growth in the rest of the world. The data set is quarterly and covers the period 1961:1 to 2000:4. All data series are in natural logarithms and are obtained from the IMF database. Time series univariate properties were examined using two unit root tests: augmented Dickey and Fuller (1979) and Phillip and Perron (1988) tests. Neither of these tests reject the I(1) null for any of the variables (see Table 1). Both the AIC and HQ information criteria test results suggest using a lag length of five (which has white noise residuals). Subsequent analysis therefore proceeds with the use of VAR with lag length k=5.

Results of cointegration rank tests, presented in Table 2, suggest the existence of at most one cointegrating vector present in the system. This implies the presence of five independent common stochastic trends in this system of six variables. This finding is consistent with results of Henriques and Sadorsky (1996) that also found evidence of cointegration between Canadian real exports, real GDP, and real terms of trade.

3.2. Granger causality tests based on VECM

Since there exist a unique cointegrating vector in the six-variable VAR used in the cointegration tests, it is best to estimate models with one error correction term included to capture long run relationships. Beyond the analysis of the long-run relationships among the six variables in the system, the short-run dynamics is also explored by performing multivariate Granger causality tests for the VECM. F-statistics and probability (in parentheses) for Granger causality tests from the VECM specification are presented in Table 3. Also included in Table 3 are the t-statistics for the error correction terms (ECT) from each of the six equations. Emphasis is placed only on the relationships between Canadian real exports and real GDP. For each variable in the system, at least one channel of Granger causality is active: either in the short-run through the joint tests of lagged-differences or a statistically significant ECT. This latter channel is provided by the VECM specification and is only significant in the two equations for real GDP and foreign output shocks. A significant ECT coefficient implies that past equilibrium errors pay a role in determining current outcomes. The short-run dynamics are captured by the individual coefficients of the differenced terms. It is noted that the ECT coefficient for the real GDP equation is statistically significant while the ECT coefficient for the real exports equation is not significant. This implies that export growth did Granger cause the growth in real GDP (but not vice versa) in the long-run.

Similarly, in the short-run, the ELG hypothesis is also supported since the test that real GDP does not Granger-cause real exports could not be rejected at the 5% level.

The empirical evidence strongly suggests that real exports Granger-causes real GDP at the 1% level of significance. In support of our inclusion of other variables omitted in other studies, changes in capital and labor do influence real GDP growth. This finding for labor and capital, which was omitted in previous studies on Canada, is consistent with the augmented aggregate production function assumed earlier. This implies that in addition to the influence of exports, other variables (such as capital/investment, terms of trade, employment level, and foreign output shocks) also matter for the growth of national output. In contrast results from the output equation, real exports seem to be exogenous at the 5% level of significance. Only foreign output shocks have a notable influence on the growth of real exports. These results provide strong empirical evidence in support of the ELG hypothesis.

3.3. Granger causality tests based on Toda-Yamamoto Levels VAR

Results from a VAR estimated using the procedure developed by Toda and Yamamoto (1995) are presents in Table 4. Although the optimal lag order chosen by the AIC, FPE, HQ, and likelihood ratio criteria was five, a (k+1=6) order VAR was estimated with restrictions placed on lagged terms up to the k^{th} lag. Since all the variables are in levels, no short-run causality flows exist as was the case with the VECM. Rather the results provide information about the long-run causal relationships among the variables in the system. Consistent with the VECM approach, this model specification tends to further confirm the ELG hypothesis for Canada in the long-run.

Furthermore, real exports growth is Granger-caused by foreign output shocks measured by real industrial production index for all industrialized nations. Also of importance in Table 4 is the result that real exports does not Granger-cause real terms of trade. This contrasts with the conclusion from Henriques and Sadorsky (1996) that their result "suggests that historically Canada may not be the small open economy that it is often though of." The result of the present study is consistent with the ELG hypothesis and supports the widely held view that Canada is a small open economy.

3.4 Structural Stability Results

Evidence from test plots for the recursive residuals and CUSUMSQ for the six equations suggest that structural breaks may have occurred at the following points: 1973:4 and 1992:2. Chow test results confirm structural instability for all six equations at 1973:4, but the hypothesis of no structural break at 1992:2 could not be rejected.[3] The break point at 1973:4 is plausible because it coincides with the OPEC oil price shocks of late 1973 that had impacts on productivity in the world economies. Given the results from the tests for structural break, the VAR system was re-estimated over two sub-samples: 1960:1-1973:4 and 1974:1-2000:4. The F-statistics and p-values for the resulting Granger-causality tests over the two sub-periods are generally consistent with those reported for the full sample. The notable difference is the finding of a bi-directional causal flow between productivity and exports in the early sub-sample (1961:4-1973:4). This result supports the view that in the post-1974 period the Canadian economy has become increasingly dependent on exports abroad, especially to the United States.

4. Concluding Remarks

The objective of this paper is to determine if the export-led growth (ELG) hypothesis is valid for Canada. Two recent studies on the causal linkage between exports and output growth in Canada (Serletis 1992; Henriques and Sadorsky 1996) yielded contradictory findings. This paper extended these previous studies on Canada by employing recently developed time series estimation techniques and including previously omitted relevant variables. To determine whether Canadian data are consistent with export-led growth or growth driven exports, two alternative methodological procedures were used to test for Granger causality: VECM and the augmented level VAR model with integrated and cointegrated processes of arbitrary orders developed by Toda and Yamamoto (1995). The analysis focused on the dynamic causal relationship between exports, capital, labor, terms of trade, foreign output shock, and output growth using quarterly Canadian data (1961:1-200:4).

Empirical evidence from Granger causality tests based on both alternative models indicate that changes in real exports precede changes in real GDP. Furthermore, our inclusion of additional variables was justified, as capital, labor, and foreign output shocks are statistically significant in the models. In addition to finding support for the ELG hypothesis in the short-run, the results from cointegration analysis and levels VAR also provide support for ELG in the long-run. This paper's conclusions supporting the validity of the ELG hypothesis are similar to results from Serletis' (1992) for Canada and Marin (1992) empirical findings for other industrialized nations such as the United

States, Japan, United Kingdom, and Germany. Given recent depreciations of the Canadian dollar and improved access to U.S. and other foreign markets, this finding is plausible and consistent with prior expectations that increasing Canadian exports stimulates economic growth. One limitation of this study is the absence of an explanation for the contemporaneous relationship between exports and productivity growth. A useful extension of this paper would be to complement the Granger causality analysis with a "structural" analysis of the contemporaneous error structure. Some recent studies advocate the use of directed graphs theory as an alternative means of identifying contemporaneous VAR innovations (see Bessler, et al 2002).

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Table 1. Unit Roots Tests, 1961:1 - 2000:4

	ADF (k)	PP (k)
Levels		
GDP	**-2.52(1)**	**-2.75(1)**
EXP	-2.54**(4)**	**-1.63(3)**
TOT	-1.49**(1)**	-1.37**(1)**
K	-2.56**(1)**	-2.48**(1)**
L	-2.62**(5)**	-2.72**(3)**
IP	-2.23**(1)**	**-3.04(1)**
First differences		
ΔGDP	-7.18**(1)** ***	**-9.93(1)** ***
ΔEXP	-5.72**(3)** ***	**-36.59(3)** ***
ΔTOT	-7.55**(1)** ***	-10.62**(1)** ***
ΔK	-6.65**(1)** ***	-8.19**(2)** ***
ΔL	-4.57**(4)** ***	-10.99**(3)** ***
ΔIP	-5.87**(1)** ***	-6.60**(1)** ***

Notes:

***, **, and * denote that a test statistic is significant at the 1 %, 5%, and 10% signigificance level, respectively. The critical values for the tests at the 1%, 5%, and 10% significance level, respectively, are -3.51, -2.89, and -2.58 respectively. Values in parentheses are lag lengths.

Table 2. Johansen Cointegration Test Results, 1961:1 - 2000:4

# of Cointegrating	Trace		λ-max	
Vectors	Statistics	C(5%)	Statistics	C(5%)
r=0	112.86**	94.15	46.77**	39.37
r≤1	66.09	68.52	27.29	33.46
r≤2	38.80	47.21	17.66	27.07
r≤3	21.14	29.68	12.67	20.97
r≤4	8.47	15.41	5.16	14.07
r≤5	3.31	3.76	3.31	3.76

Notes:
Critical values used are taken from Osterwald-Lenum (1992)
** indicates rejection at the 95% critical values

Table 3. Granger causality test results based on VECM

	Short run lagged differences						
	ΔGDP	**ΔEXP**	**ΔTOT**	**ΔK**	**ΔL**	**ΔIP**	**Lagged ECT**
Dep. Variables			F-Statisitics				t-statistic
ΔGDP		24.3867	9.4106	16.4925	14.1324	6.9763	[4.63125]
		(0.0002)	(0.0938)	(0.0056)	(0.0148)	(0.2224)	
ΔEXP	5.0736	-	1.4809	1.9249	2.7519	10.8223	[-0.99646]
	(0.407)		(0.9153)	(0.8594)	(0.7382)	(0.055)	
ΔTOT	3.4490	5.0241	-	1.5497	2.3077	6.3932	[1.62995]
	(0.6311)	(0.413)		(0.9073)	(0.8051)	(0.2698)	
ΔK	7.1604	9.5095	7.7207	-	8.0635	1.9868	[1.67959]
	(0.209)	(0.0904)	(0.1723)		(0.1528)	(0.851)	
ΔL	2.7518	6.8499	5.9292	14.2087	-	11.6272	[0.26676]
	(0.7382)	(0.232)	(0.3132)	(0.0143)		(0.0403)	
ΔIP	10.5266	5.8072	8.5824	9.0227	11.7277	-	[3.19124]
	(0.0616)	(0.3254)	(0.1269)	(0.1082)	(0.0387)		

Notes:
Figures presented in final column are estimated t-statistics testing the null that the lagged error correction term (ECT) is statistically insignificant for each equation. All other estimates are asymptotic Granger F-statistics. Values in parentheses are p-values.

Table 4. Granger causality test results based on Toda-Yamamoto Procedure

	GDP	EXP	TOT	K	L	IP
Dep. Variables	**Modified Wald Statistics**					
GDP		18.8303	12.1429	13.4062	9.3199	8.8916
		(0.0045)	(0.0589)	(0.037)	(0.1564)	(0.1798)
EXP	5.6633	-	3.3359	1.8317	6.4550	12.9240
	(0.4619)		(0.7657)	(0.9345)	(0.3742)	(0.0443)
TOT	6.9814	5.7835	-	2.6884	6.7598	8.3179
	(0.3226)	(0.4479)		(0.8468)	(0.3436)	(0.2157)
K	11.5921	7.6059	5.8779	-	11.6992	3.7550
	(0.0717)	(0.2684)	(0.437)		(0.069)	(0.7098)
L	2.9371	10.7324	9.7526	14.7767	-	11.9449
	(0.8167)	(0.097)	(0.1355)	(0.0221)		(0.0632)
IP	23.1542	10.9203	8.6471	9.9760	12.4330	-
	(0.0007)	(0.0909)	(0.1944)	(0.1257)	(0.053)	

Notes:

The [k+d(max)]th order level VAR was estimated with d(max)=1 since the order of integration is 1.
Lag length selection of k=5 was based on AIC and HQ information criteria test results.
Reported estimates are asymptotic Wald statistics. Values in parentheses are p-values.

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Statistical Analysis and Research Methods

The department's research in these areas is part of the organized research program of the Delaware Agricultural Experiment Station, College of Agriculture and Natural Resources. Much of the research is in cooperation with industry partners, other state research stations, the USDA, and other State and Federal agencies. The combination of teaching, research, and service provides an efficient, effective, and productive use of resources invested in higher education and service to the public. Emphasis in research is on solving practical problems important to various segments of the economy.

The department's coordinated teaching, research, and service program provides professional training careers in a wide variety of occupations in the food and agribusiness industry, financial institutions, and government service. Departmental course work is supplemented by courses in other disciplines, particularly in the College of Agriculture and Natural Resources and the College of Business and Economics. Academic programs lead to degrees at two levels: Bachelor of Science and Masters of Science. Course work in all curricula provides knowledge of tools and techniques useful for decision making. Emphasis in the undergraduate program centers on developing the student's managerial ability through three different areas, Food and Agricultural Business Management, Natural Resource Management, and Agricultural Economics. The graduate program builds on the undergraduate background, strengthening basic knowledge and adding more sophisticated analytical skills and business capabilities. The department also cooperates in the offering of an MS and Ph.D. degrees in the inter disciplinary Operations Research Program. In addition, a Ph.D. degree is offered in cooperation with the Department of Economics.

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