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Assessing Economic Base Relationships in South Dakota

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Abstract. Despite enduring criticism of both the conceptual foundation and empirical implementation of economic base models, recent research has continued to investigate the validity and estimation of such models. This paper applies economic base models to South Dakota and three of its counties in order to assess the applicability of the model and to estimate aggregated basic sector multipliers and sector-specific multipliers. Time series analysis of annual, quarterly, and monthly data reveals a variety of multiplier magnitudes dependent on the particular specification, data bifurcation method, and geographic unit. Distinct sector-specific multipliers are identified, including instances of dominant sectors with little influence beyond the direct basic sector change. Neither informal models of annual data nor VAR analysis of monthly data supports Granger causality from basic to nonbasic activity. In contrast to several other recent studies, cointegration of basic and nonbasic employment is not evident.

1. Introduction

Export base theory has a long and rich history in the study of regional economies. It is widely used to generate multipliers which can then be used to assess the overall impact of an employment or income change in one sector of the economy. Its popularity stems largely from its ease of use – one need only find data series on employment or income by sector, classify the sectoral activity into basic and nonbasic components, find the ratio of basic to nonbasic activity, and compute a multiplier for policy guidance. There has, however, been much controversy about estimating economic base multipliers, assigning economic activity, testing the basic economic base framework, and even the foundational conception of economic base analysis. However, despite being "castigated for decades, the economic-base model has survived as a very succinct expression of the power of demand in regional income determination" (Schaffer 1999, 9).

Many recent works concerning economic base theory have focused on testing the theory using time series data. This research adds to this line of work by examining whether economic base theory explains economic change for the state of South Dakota and three of its counties. Progressing from simple annual models with aggregated basic and nonbasic sectors to sector-specific annual and quarterly models and, finally, monthly models, it investigates both multiplier values and the efficacy of the economic base model. The use of a state with a large agricultural presence and one county dependent on agriculture help provide an interesting extension to current work.

2. Literature Review

Economic base theory and empirical work date back to early in the 20th century, when it was first recognized that a regional economy could be conceptually split into "basic" or export-oriented sectors which bring income into the economy and "nonbasic" or local sectors. Since then, much theoretical and empirical debate has followed. Krikelas (1992) provides an instructive division of the history of economic base analysis into five periods. The first period was the origin of the concept, followed by early development of the theory, accompanied by some initial empirical work. The third period was one primarily of theoretical debate, especially about whether export activity really was the dominant driving force of economic growth. The fourth phase was much more empirical, examining methods of identifying export activity, calibrating export identification techniques, extending the model to include new influences and more disaggregated sectors, and testing whether the economic base hypothesis was true. The results of empirical research were mixed, and, given the growth of more sophisticated techniques like input-output analysis, economic base theory seemed to be declining in importance.

Rather than disappear as inferior to more complex models, however, economic base theory has experienced a resurgence during its current fifth phase associated with growth in time series econometric applications. The theory, whose impact timing had long been discussed, was an excellent candidate for modeling using values from past periods to trace effects over time. One very influential work in this literature was Lesage and Reed (1989), whose vector autogregression (VAR) analysis of employment in selected Ohio MSA counties verified economic base theory using Granger causality tests of whether changes in one data series precede those of another series. Lesage (1990) extended the analysis through a vector error correction model (VECM), again finding Granger causality in the expected direction and noting an improvement in forecasts using the VECM.

Although Krikelas' (1991) VAR modeling of Wisconsin provided a rebuttal to Lesage and Reed's findings, several additional papers have investigated time series system modeling of economic base theory. Nishiyama (1997) tested economic base theory using quarterly state employment data for Texas, California, and Massachusetts. He estimated VAR models for basic and nonbasic employment in each state using a variety of methods for calculating basic employment. Nishiyama's Granger causality results showed that economic base theory was verified in some cases but not in others and that it was sensitive to the specification of basic employment.

Lego, Gebremedhin, and Cushing (1999) presented a more disaggregated model of intersectoral relationships. Studying West Virginia metropolitan statistical areas (MSAs) and focusing extensively on long-run relationships in addition to short-run impacts, they found that there were significant long-run relationships between the mining, manufacturing, and service (broadly-defined) sectors. The relationships were sometimes negative, however, and basic employment in the service sector was found to be an important determinant of local employment in other basic sectors. Based on their results, Lego, Gebremedhin, and Cushing concluded that "the export-base model should no longer be thought of as inferior to better, more sophisticated regional models in use today" (p. 14).

McKenzie and Miller (2002) examined employment in MSAs from a number of states to assess the economic base model. Their VAR models also found mixed results, and they noted the sensitivity of results to the export/local split, the level of aggregation of data, the sectors chosen, and the model fitting procedure (e.g., the number of lags specified). They concluded that "though our model does not support the economic base model, we don't purport to disprove the economic base model" (p. 18).

At a lower level of aggregation, two studies of note were conducted by Cook (1979) and Robertson (2003). Cook, one of the earliest to incorporate time series techniques, analyzed economic base effects in two Washington counties, finding a significant basic to nonbasic effect in employment. Robertson studied cities and boroughs in Alaska. His city studies, using monthly employment data aggregated to quarters, and his borough studies, using annual data on income, both failed to confirm economic base theory.

Cutler, England, and Weiler (2003), citing the earlier work of Brown, Engle, and Coulson (1992) on identifying basic and nonbasic employment through cointegration techniques, analyzed annual employment in Denver. They identified eight sectors based on cointegration and used VECM modeling to assess intersectoral relationships. The cointegration vector findings were mixed relative to export base expectations, but impulse response functions showed export base relationships, with the white collar effect stronger than manufacturing.

Harris, Shonkwiler and Ebai (1999) focused on rural Nevada counties, using monthly non-agricultural employment data. Multiple definitions of basic employment were combined in an indicator model to construct the basic employment data series. VECM modeling found that the expected Granger causality held in four of the five counties. Long-run multipliers based on the cointegration coefficients ranged from 1.48 to 2.49.

A more complete review can be found in Robertson (2003), but those discussed here convey the mixed findings and variety of techniques used. The overall impression from previous work is that results have neither verified nor conclusively rejected the economic base model. Further, there is a good deal of sensitivity to the data series selected, the assignment of economic activity to basic and nonbasic categories, and estimation procedures.

3. Research Design and Data

This research applies the economic base model in a progression of data analyses and model estimations, exploring both general specifications and more specific time series applications. In doing so, both state- and county-level data are used, and annual, quarterly, and monthly series are examined. The use of South Dakota provides a contrast to most of the studies cited above, which emphasized more industrialized states or MSAs. Within the state, Kingsbury County has been chosen as a typical agriculture-dominated county, and has been included along with Minnehaha County, the central county of Sioux Falls, the state's largest MSA, and Pennington County, the second-largest county in the state. (Henceforth the counties will typically be referenced by county name only.)

3.1 Annual Models

Initially, annual data from the Bureau of Economic Analysis' Regional Economic Information System (REIS) are used to assess economic base relationships. While the yearly time frequency is not ideal, the REIS provides the only comprehensive dataset with state and county information on agriculture, a critical sector for South Dakota and most of its counties. The SIC-based data reaches from 1969 to 2000, providing 32 annual observations, terminating with the shift to the NAICS data classification scheme. Data has only been disaggregated at the division level to avoid suppression problems. All REIS data was converted to real earnings using the Consumer Price Index.

Four sets of annual models, one for the state and each county, are estimated. Each set of models consists of eight separate specifications differentiated by the method of calculating basic and nonbasic employment, the use of levels data and first differences, and the included variables. The two types of basic and nonbasic calculation are the location quotient (LQ) method and the assignment method. For the LQ method, any earnings in the state or county above a sector's share of national earnings in that sector were deemed basic, and all other earnings were deemed nonbasic. In the assignment method, earnings in the farming, mining, manufacturing, federal, and military sectors are deemed basic and all others nonbasic.

The first four specifications for each area are for total earnings as a function of basic earnings. For each method, LQ and assignment, regressions are run on levels and on first-differences. The second set of four specifications investigates the basic/nonbasic relationship by regressing one category (basic or nonbasic) on its lag and the current and lagged value of the other category. This pair of regressions is estimated for both the LQ and assignment data using first differences.

In addition to the analysis of the aggregated basic and nonbasic sectors, models are specified to assess individual sector relationships, deriving what can be referred to as "differentiated multipliers" (as termed by Schaffer (1999) in reference to Weiss and Gooding's (1968) research). All of these models are fit using first differences and include a trend variable to account for possible drift in the difference series.

In each of the geographic areas, four differential-multiplier models are fit. In the first model, total earnings by place of work (ERW) is estimated as a function of lagged total earnings and current year and lagged earnings in the sectors most widely consider basic: farming (FAR), manufacturing (MFG), combined federal civilian and military spending (FDML), and mining (MIN), which is used only at the state level due to suppression at the county level. The specified state model is as shown in equation 1.

$$\begin{aligned} ERW_t &= \beta_0 + \beta_1 Trend_t + \beta_2 ERW_{t-1} + \beta_3 FAR_t + \beta_4 FAR_{t-1} + \\ &\beta_5 MFG_t + \beta_6 MFG_{t-1} + \beta_6 MIN_t + \beta_7 MIN_{t-1} + \\ &\beta_8 FDML_t + \beta_9 FDML_{t-1} + \varepsilon_t \end{aligned} \quad (1)$$

The county models include all but the mining sector variables. For each geographic area, retail (RTL), service (SVC), and finance, insurance, and real estate (FIR) sector earnings are also modeled as a function of the same independent variables.

3.2 Quarterly Models

Given the differential basic sector effects found using the annual data, the quarterly models maintain the differential-multiplier approach. The quarterly state models are estimated using the same specification as the annual models with four lags of the basic sector values. Data for the state models is available from the REIS, which provides earnings data back to 1958 for all sectors, including agriculture. The quarterly earnings data set was seasonally adjusted and then deflated using a seasonally-adjusted consumer price index.

The quarterly county models are based on fifteen years' worth of quarterly data (1990-2004) from the Quarterly Census of Employment and Wages (QCEW) available on the Bureau of Labor Statistics website. The move to the BLS data, which is based on social security filings for wage and salary workers, has the drawback of losing data on proprietors and farmings, so the results must be viewed in that context. Due to suppression in the data set and the greater importance of farming in Kingsbury, the analysis is limited to Minnehaha and Pennington.

The quarterly data uses the North American Industry Classification System (NAICS), so the composition and names of sectors differ from the prior analysis. As in the previous models, the level of disaggregation is below total employment but above the old two-digit SIC classification. Using this data, total quarterly wages serves as the dependent variable, and the basic sectors are Natural Resources and Mining (RESMIN), Manufacturing (MFG), and Federal (FED). The nonbasic sectors analyzed are Trade, Transportation, and Utilities (TTU), Information (INFO), Finance (FIN), Business Services (BSV), Education and Health (EDH), and Leisure (LEIS). In addition, the effect of the basic sectors on total (TOT) wages and on combined service sector (SVC) wages is examined.

The QCEW data was downloaded for each year and read into SAS data sets. The data was converted to real dollars using the CPI and then seasonally adjusted using the X11 routine in SAS. Given the nonstationarity of the series, all data is converted to first-differences. With the final real, seasonally-adjusted, differenced series, the estimated regressions are of the form found in equation 2. A total of four lag terms was used for each basic sector. Given the exploratory nature of these analyses and the lack of cointegration found when testing the monthly data, none of the quarterly models or annual models have been tested for cointegration.

$$
\begin{aligned}
&TOT_t = \beta_0 + \beta_1 Trend_t + \beta_2 TOT_{t-1} + \beta_3 RESMIN_t + \\
&\beta_4 RESMIN_{t-1} + \beta_5 MFG_t + \beta_6 MFG_{t-1} \\
&+ \beta_6 FED_t + \beta_7 FED_{t-1} + addtional\ lag\ terms + \varepsilon_t \\
&SVC_t = \beta_0 + \beta_1 Trend_t + \beta_2 SVC_{t-1} + \beta_3 RESMIN_t + \\
&\beta_4 RESMIN_{t-1} + \beta_5 MFG_t + \beta_6 MFG_{t-1} \\
&+ \beta_6 FED_t + \beta_7 FED_{t-1} + addtional\ lag\ terms + \varepsilon_t \\
&\quad \vdots \\
&LEIS_t = \beta_0 + \beta_1 Trend_t + \beta_2 LEIS_{t-1} + \beta_3 RESMIN_t + \\
&\beta_4 RESMIN_{t-1} + \beta_5 MFG_t + \beta_6 MFG_{t-1} \\
&+ \beta_6 FED_t + \beta_7 FED_{t-1} + addtional\ lag\ terms + \varepsilon_t
\end{aligned}
\tag{2}
$$

3.3 Monthly VAR and Cointegration Modelling

Finally, to fully explore the dynamics of economic base relationships within South Dakota, a set of vector autoregressive models were specified. Since most of the prior literature used monthly employment data and some sectoral aggregation, these analyses used the BLS QCEW monthly employment data for the 1990-2004 time period, with aggregation to basic and nonbasic sectors. In addition to using the LQ method, the second scheme used here is a hybrid which sums the excess LQ components for traditionally nonbasic sectors and adds the sum to all employment in the traditionally basic resources/mining, manufacturing, and federal sectors. As with the BLS wage data, given the lack of agriculture data and its importance for Kingsbury and the state as a whole, only Minnehaha and Pennington are examined. The data were corrected for seasonality, which is especially prominent in Pennington given its substantial tourism-related employment.

4. Descriptive Statistics for Annual Data

Data for the state of South Dakota is summarized in Table 1. The descriptive statistics provide insight into the importance of the various sectors and their volatility. While farming is probably the most prominent industry in South Dakota, its mean value is less than fifteen percent of the state average. It is rivaled by state and local government and exceeded by the service sector. Perhaps more notable is the pronounced negative first difference mean for farming. Mining is the only other sector that has a negative average difference. The similarity in standard deviation magnitude for total earnings and farm earnings is also of key importance, indicating that farming is the only sector volatile enough to generate some of the large swings in total earnings.

Correlation matrices, shown in Appendix 1, also reveal important relationships. The correlation matrix for levels shows the strong positive relationship between total earnings and most sectors, although farming has little correlation and mining has a negative correlation. To some extent, these measures probably indicate a shared trend. Among the basic sectors, manufacturing and federal earnings have much stronger associations with nonbasic sectors, but this could also simply be trend-related. When looking at the correlations among the first differences, we see decidedly different results. Farming has a very strong association with total earnings, while no other correlation exceeds 0.5. In examining the basic/nonbasic relationships, manufacturing again stands out as having stronger ties to the nonbasic sectors. The correlations between a given sector's change and the lagged changes in other sectors reveal much weaker relationships, which is not very surprising given the time frequency of years. Lagged manufacturing and federal earnings again have stronger ties to nonbasic sectors than does farming. The farming-agricultural services/forestry/fisheries relationship is fairly strong, however.

Table 1. State Annual Data Statistics

	Descriptive Statistics for Levels				Descriptive Statistics for Changes			
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Total Earnings	5968727	1069989	4427676	8254872	123458	434098	-1037126	1218579
Farm	780949	394068	154744	2301685	-10083	371196	-919417	962960
Ag. Services/Forestry/Fish	52363	14896	28085	78893	560	6756	-12336	15269
Mining	77744	16657	41391	104043	-539	6627	-15526	9648
Construction	340089	71126	228678	481629	7867	31418	-80202	59915
Manufacturing	638104	240223	331452	1179886	27369	31568	-43289	95549
Transp. & Pub. Utilities	423877	45653	312202	506117	5915	16266	-31784	40154
Wholesale	363792	59560	242933	453628	6732	18727	-29914	67607
Retail	663086	60010	573800	807036	7092	30429	-68027	69196
Finance, Insurance, RE	304007	123342	162883	615985	14616	16271	-6534	59444
Services	1085025	399918	594626	1941166	43422	32954	-14619	125596
Federal/Military	510360	52469	355259	595664	5545	19949	-31495	48073
St. & Local Government	729330	132906	535054	998869	14962	19260	-23408	55263

n=32 for levels and 31 for changes.

4.1 Counties

Minnehaha is home to Sioux Falls and is the central county of the state's most populous MSA. In looking at the descriptive statistics in Table 2, it is clear that Minnehaha has a much smaller, but not trivial, agricultural base to its economy. The economy is diversified, with no sector's average accounting for more than one quarter of the county's average total earnings. As seen in the difference variables, the services sector has grown significantly over the years, although it still has a smaller standard deviation than the farming sector. The correlation relationships, not shown for the counties, are similar to those at the state level, but the farming change/total change correlation is much smaller and the other basic sector change correlations with nonbasic sector changes are weaker both within the same time period and when lagged.

Pennington is home to Rapid City and the central county of the state's second MSA. It is also home to Ellsworth Air Force Base, which is apparent when looking at Table 3. The largest sector is the federal sector, with over twenty per cent of average earnings. Services is a large sector, much of the earnings related to the Black Hills and Mount Rushmore, and farming is a small sector. Unlike the state and Minnehaha, Pennington's most volatile sector is the federal sector. Correlations (not shown) for earnings measured in levels show very strong relationships between total earnings and most sectors, while farming has a negative relationship with all other variables. When measured as annual changes, several sectors have moderate positive correlations with total earnings.

Table 2. Minnehaha County Annual Data Statistics

	Descriptive Statistics for Levels				Descriptive Statistics for Changes			
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Total Earnings	1435649	454532	811643	2469611	53483	53470	-95228	171031
Farm	30495	15531	3318	79779	-419	16279	-41223	29825
Ag. Services/Forestry/Fish	10177	5293	3040	23760	330	3589	-7220	10051
Mining	3621	949	2074	5444	95	729	-1426	1253
Construction	90786	31387	37809	161348	3763	9845	-17739	18129
Manufacturing	205866	49463	140734	323625	5073	13782	-21772	29785
Transp. & Pub. Utilities	144721	22050	86163	184051	3158	6954	-10935	16453
Wholesale	129247	26297	83632	182098	3124	5511	-9381	13703
Retail	160699	37924	104698	248606	4642	7628	-14220	20295
Finance, Insurance, RE	137697	87925	44655	349423	9821	11068	-1933	49726
Services	354608	180431	140616	762049	20021	15985	-793	78124
Federal/Military	75126	11302	50259	96664	1497	3625	-13528	8570
St. & Local Government	89770	23077	55828	135328	2564	3052	-5065	11517

Table 3. Pennington County Annual Data Statistics

	Descriptive Statistics for Levels				Descriptive Statistics for Changes			
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Total Earnings	813531	147161	484185	1058125	18514	31109	-66512	77021
Farm	7519	5865	552	29489	-206	5634	-18444	15029
Ag. Services/Forestry/Fish	2294	822	996	4023	66	396	-747	888
Mining	10225	4350	3017	18123	88	2053	-4470	4104
Construction	58707	14122	24910	80582	1796	7306	-17122	13672
Manufacturing	65046	18047	32068	98232	2134	6356	-12002	20210
Transp. & Pub. Utilities	50801	4389	38166	57782	540	2419	-4143	4504
Wholesale	43718	11873	23642	62616	1113	2121	-3877	5181
Retail	101654	17898	69835	136081	1869	5347	-11757	11664
Finance, Insurance, RE	33498	12602	18185	69908	1626	3816	-4478	17192
Services	168062	65886	79196	297985	7058	4966	-1579	16003
Federal/Military	196341	38052	131888	259275	432	14356	-33528	23966
St. & Local Government	75906	17930	47501	108555	1969	1996	-3125	5387

Table 4. Kingsbury County Annual Data Statistics

	Descriptive Statistics for Levels				Descriptive Statistics for Changes			
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Total Earnings	43807	9389	24369	71405	152	9323	-19968	20386
Farm	15118	8933	-2828	41977	-13	9303	-18637	19370
Ag. Services/Forestry/Fish	541	177	201	921	1	157	-413	345
Mining	48	58	-47	150	0	50	-105	150
Construction	1974	658	1062	3731	2	389	-825	893
Manufacturing	3507	1768	644	6279	172	404	-730	1157
Transp. & Pub. Utilities	2870	268	2395	3589	-36	250	-629	414
Wholesale	2897	661	2219	4340	15	312	-784	900
Retail	3977	1257	2505	6453	-109	412	-1419	517
Finance, Insurance, RE	2122	397	1629	2907	35	129	-297	328
Services	4787	1025	1757	5840	129	391	-555	1127
Federal/Military	1582	104	1444	1812	3	110	-364	334
St. & Local Government	4378	554	3682	5672	-51	175	-413	344

The descriptive statistics for Kingsbury (Table 4) illustrate its dependence on agriculture. On average, more than a third of earnings is in the farming sector, while no other sector provides more than eleven percent of earnings. The standard deviations of total earnings and farming are nearly identical, while no other sector approaches the same level of volatility. Correlation coefficients (not shown) for levels reveal a near perfect correlation in the time paths of total earnings and farming and only moderate to weak correlations of other sectors with total earnings. In terms of association with nonbasic sectors, however, both manufacturing and federal earnings have stronger associations. The correlations relative to changes and their lags are similar, although the farming sector's associations with nonbasic sectors are similar to, if not stronger than, those for manufacturing and federal earnings.

5. Findings –Basic and Nonbasic Sectors

The results for the aggregated sector models are shown in Table 5, with the multiplier relationships between basic and total earnings preceding the basic/nonbasic relationship. The average multipliers are simple averages of the total/basic ratios measured over the 1969-2000 time period. They immediately magnify one of the key findings of this set of runs: the basic/nonbasic bifurcation technique matters a great deal, with the LQ multipliers displaying their typical property of providing a lower estimate of basic activity. In addition, they reveal the typical tendency of state multipliers to be higher than county multipliers, as the state values are higher than those in both Pennington and Kingsbury.

Table 5. Multipliers and Basic/Nonbasic Effects Based on Annual Data

		Region			
Type		**State**	**Minnehaha**	**Pennington**	**Kingsbury**
Average multipliers based on levels:					
Assignment		3.01	4.20	2.29	2.70
LQ		6.02	6.35	4.47	3.14
Marginal multipliers based on levels:					
Assignment		1.85369***	5.51847***	3.55048***	1.57905***
LQ		0.1826	8.09869***	5.37835***	2.20887***
Marginal multipliers based on changes (first differences):					
Assign	Same Year	1.12132***	1.88839**	1.07090**	1.01997***
	Lagged	0.08044	0.09713	-0.13314	0.01543
LQ	Same Year	1.69471***	2.68942***	0.88549**	1.21313***
	Lagged	0.09753	1.87867**	-0.09	0.01113
Basic/Nonbasic Effects (all variables in first differences):					
Assignment					
Dependent Variable: Nonbasic					
	Basic	0.08555	0.33892	-0.26958	0.02042
	Basic(-1)	0.02436	-0.37063	-0.25648	0.01603
	Nonbasic(-1)	0.46582**	0.97978***	0.67352***	-0.02967
Dependent Variable: Basic					
	Basic(-1)	-0.35635*	-0.4764*	-0.22488	-0.65103***
	Nonbasic	0.98682	0.1188	-0.11035	1.97323
	Nonbasic(-1)	0.22159	-0.02838	0.21536	1.44543
LQ					
Dependent Variable: Nonbasic					
	Basic	0.65677***	1.2792	-0.02393	0.27520***
	Basic(-1)	-0.10913	1.60158*	-0.06247	0.15747*
	Nonbasic(-1)	0.29359	0.3024	0.53495***	-0.50410**
Dependent Variable: Basic					
	Basic(-1)	-0.13045	-0.40529	0.38078**	-0.73963***
	Nonbasic	0.88424***	0.11413	-0.00749	1.22797***
	Nonbasic(-1)	-0.09786	0.11737	-0.03728	1.07604***

5.1 State Multipliers and Basic/Nonbasic Interactions

For the state of South Dakota, the marginal multipliers based on levels differ markedly between the two bifurcation schemes. The assignment method data indicate a multiplier of 1.8, while the LQ method data indicate an absurd value of 0.18. The low value can most likely be attributed to the volatility of the agricultural sector, which can experience significant swings, including cases where downturns are not accompanied by losses in other sectors. This is most likely exaggerated by the use of earnings data, rather than employment data, as farm employment likely swings far less in reaction to farm economy volatility. The data measured in differences provides more reasonable results for the LQ data, with a current year multiplier of 1.69. The assignment method data analyzed in differences generates a multiplier of 1.12. In neither case is the lagged value statistically significant.

The basic versus nonbasic regressions, using each as the dependent variable with its own lag and the current and lagged values of the other sector as independent variables, also reveal sensitivity to the method of determining basic wages. Using the assignment method, only the lagged dependent variable is significant. When using the LQ method, we find a dominance of current year effects in each direction, with identical t-statistics for the two cross-sector current year coefficients. None of the lagged values are significant.

5.2 County Mutipliers & Basic/Nonbasic Interactions

For Minnehaha, the most striking result of the total wage regressions is the difference between the level and difference multipliers, regardless of basic sector employment determination. While there is a difference between the assignment and LQ multipliers using the level data, 5.5 as opposed to 8.1, they are both much higher than the multipliers based upon the differenced series. A significant shared trend effect could have led to inflated coefficients in the levels regression. Unlike the state estimation, the LQ data also indicates a significant lagged coefficient. The basic/nonbasic regressions again reveal a predominance of lagged dependent variable values using the assignment method. For the LQ method, however, we see the first evidence of Granger causality in the sense that lagged basic wages have a significant effect on current nonbasic wages without a corresponding opposite relationship.

Pennington generates more similar results for the two methods. When assessing levels of earnings, the assignment method indicates a multiplier of 3.55, and the LQ method indicates 5.4. The difference-based estimates are again much lower, but similar to each other at 1.1 for assignment and 0.88 for LQ. The intersector regressions are dominated by own-lag effects.

The Kingsbury total employment regression provide perhaps the most consistent and reasonable estimates of multiplier effects. The multipliers estimated when using levels are 1.58 for the assignment method and 2.21 for the LQ method. The difference-based multipliers are both smaller, but still comparable. In the assignment-based causality regressions the only significant variable is the the lagged dependent variable in the basic regression. The LQ-based causality regressions, on the other hand, reveal numerous relationships, ultimately leaving the question of causality open.

6. Findings – Differential Multipliers

6.1 State of South Dakota Annual Data

The multiple regression results (Table 6) are consistent with many of the observations drawn from the simple correlations described above. Farming is very significantly related to total earnings, but the coefficient is virtually identical to one. This suggests that changes in farm earnings affect total earnings, but only with a one-to-one ratio. The manufacturing and federal coefficients are 3.94 and 3.06, respectively, and lagged federal earnings also has a strong relationship with total earnings. The coefficients might be likened to multipliers, as they indicate total earnings changes in response to basic sector changes. This suggests much stronger economic base relationships between manufacturing and federal earnings and other sectors of the economy, especially with trend included in the model to account for simple temporal co-movement.

The nonbasic sector regressions should be interpreted differently. Instead of being multipliers, the coefficients now reflect only indirect effects on a single sector. Four of the six farming coefficients are not statistically significant, and the other two are negative and close to zero. Four of the manufacturing coefficients, on the other hand, are positive and statistically significant. The magnitudes of those four range from 0.31 to 0.51, indicating sizeable effects of manufacturing earnings changes. Three of the federal earnings coefficients, two of them lagged, are significantly positive. The magnitudes of those coefficients are even higher than the manufacturing effects. Mining has no significant positive coefficients, but does have two significant negative coefficients.

Table 6. State Annual Data Total and Nonbasic Sector Regressions

Independent\Dependent	**Total Earnings**	**Services**	**Retail**	**Finance**
Intercept	-42807	-5677	-5800	-12717**
	-0.98	*-0.42*	*-0.37*	*-2.11*
Trend	1734	1753**	-440	714*
	0.68	*2.25*	*-0.48*	*2.04*
Earnings(-1)	-0.11	-0.01	-0.08	-0.09***
	-0.54	*-0.21*	*-1.03*	*-3.02*
Farm	0.97***	-0.01	0.00	-0.01**
	24.14	*-0.76*	*0.24*	*-2.37*
Farm(-1)	0.11	0.00	0.09	0.07**
	0.50	*-0.01*	*1.21*	*2.50*
Manufacturing	3.94***	0.51***	0.48**	0.31***
	7.50	*3.15*	*2.58*	*4.33*
Manufacturing(-1)	0.81	0.08	0.40	0.50***
	0.89	*0.30*	*1.23*	*4.01*
Mining	-3.76	-1.21	-1.62*	-1.06***
	-1.50	*-1.57*	*-1.81*	*-3.08*
Mining(-1)	0.17	-0.08	-0.86	0.41
	0.07	*-0.10*	*-0.96*	*1.19*
Federal/Military	3.06***	0.62*	-0.18	0.20
	2.96	*1.97*	*-0.48*	*1.38*
Federal/Military(-1)	3.11*	0.35	1.26**	0.57**
	2.02	*0.75*	*2.29*	*2.72*
R^2	0.986	0.757	0.635	0.808
Adjusted R^2	0.979	0.630	0.442	0.707
Pr > F	<.0001	0.0005	0.0122	<.0001

Note: All variables are measured in first differences. T-statistics in italics.
***/**/* indicate significance at 1%/5%/10% levels.

6.2 Annual Data – County

The Minnehaha regression results (Table 7) reveal a significant farming change effect on total earnings, but with a coefficient of only 0.66. The manufacturing coefficient is significant and closer to 2, while the federal coefficients both exceed four. In the services and finance earnings regressions, only the trend variables were significant, indicating a strong independent growth of those sectors. These results reflect Sioux Falls' role as a regional center with some large 'export-oriented' businesses such as Citibank. The retail regression reveals a negative effect for farming, an insignificant effect of manufacturing, and a pronounced positive effect of lagged change in federal earnings.

In Pennington (Table 8) numerous significant effects on total earnings are apparent, but few effects on individual sectors are significant. Farming has a significant coefficient of 2.5 for total earnings and 0.42 for retail trade. Manufacturing has a significant coefficient of almost two for total earnings and of 0.33 for services. Federal earnings has a significant coefficient only for total earnings, but the magnitude is 1.0. In essence, farming and the federal sector have exchanged roles relative to the state and Minnehaha.

The Kingsbury regression results (Table 9) verify the significant relationship between farm earnings and total earnings, but only with a value of 1.03. Manufacturing earnings are significantly related to total earnings with a multiplier of 2.1. The federal multiplier, while not statistically significant, is 2.7. The only statistically significant positive association with earnings in any nonbasic sector is between manufacturing and services, with a coefficient of 0.38.

6.3 State Quarterly Model

Descriptive statistics for the state quarterly data (Table 10) reveal tendencies similar to those found with the annual data, although on a different scale. The quarterly data also reveal the same volatility of the farming sector and its similar standard deviation to changes in total earnings. Correlations (not shown) for levels are stronger among total earnings and all

Table 7. Minnehaha County Annual Data Total and Nonbasic Sector Regressions

Independent\Dependent	**Total Earnings**	**Services**	**Retail**	**Finance**
Intercept	-9671.40	-4039.69	-2332.15	-4991.07
	-0.97	*-0.82*	*-1.02*	*-1.26*
Trend	1433.06**	1015.39***	66.97	712.92***
	2.45	*3.5*	*0.5*	*3.07*
Earnings(-1)	0.35675**	0.09321	0.07031**	-0.01187
	2.5	*1.32*	*2.14*	*-0.21*
Farm	0.65829*	-0.1023	-0.17255**	-0.1979
	2.05	*-0.64*	*-2.34*	*-1.55*
Farm(-1)	-0.69111*	-0.26588	-0.11468	-0.11356
	-1.93	*-1.5*	*-1.39*	*-0.8*
Manufacturing	1.78066***	0.08151	0.05996	0.10101
	5.51	*0.51*	*0.81*	*0.79*
Manufacturing(-1)	-0.30428	-0.08408	-0.08313	0.16326
	-0.66	*-0.37*	*-0.78*	*0.89*
Federal/Military	4.76393***	0.80715	0.47732	0.32716
	3.71	*1.27*	*1.62*	*0.64*
Federal/Military(-1)	4.61469***	0.63799	1.18129***	0.88761
	3.11	*0.87*	*3.47*	*1.51*
R^2	0.8664	0.6201	0.6587	0.5058
Adjusted R^2	0.8156	0.4754	0.5286	0.3176
Pr > F	<.0001	0.0035	0.0013	0.0332

Note: All variables are measured in first differences. T-statistics in italics.
***/**/* indicate significance at 1%/5%/10% levels.

Table 8. Pennington County Annual Data Total and Nonbasic Sector Regressions

Independent\Dependent	**Total Earnings**	**Services**	**Retail**	**Finance**
Intercept	9579.78	2145.59	2169.47	-1232.08
	1	*1.03*	*0.85*	*-0.63*
Trend	72.11	208.33*	-76.76	140.84
	0.14	*1.87*	*-0.56*	*1.36*
Earnings(-1)	0.23533	0.02701	0.03873	0.04785
	1.11	*0.58*	*0.68*	*1.11*
Farm	2.47902**	0.08923	0.42203*	0.20488
	2.7	*0.45*	*1.72*	*1.1*
Farm(-1)	0.28296	-0.099	0.10649	-0.08789
	0.3	*-0.48*	*0.43*	*-0.46*
Manufacturing	1.94116***	0.33124**	0.21823	-0.02951
	3.13	*2.45*	*1.32*	*-0.23*
Manufacturing(-1)	-0.15451	0.10154	0.06958	-0.15816
	-0.18	*0.54*	*0.3*	*-0.89*
Federal/Military	1.00414***	0.0165	-0.02118	0.05965
	3.19	*0.24*	*-0.25*	*0.93*
Federal/Military(-1)	-0.27177	-0.11638	-0.06549	-0.07367
	-0.69	*-1.36*	*-0.62*	*-0.92*
R^2	0.7275	0.491	0.3315	0.2512
Adjusted R^2	0.6236	0.2971	0.0768	-0.0341
Pr > F	0.0002	0.0421	0.2956	0.5485

Note: All variables are measured in first differences. T-statistics in italics.
***/**/* indicate significance at 1%/5%/10% levels.

Table 9. Kingsbury County Annual Data Total and Nonbasic Sector Regressions

Independent \ Dependent	**Total Earnings**	**Services**	**Retail**	**Finance**
Intercept	82.65	272.06	-259.76	20.84
	0.16	*1.5*	*-1.38*	*0.39*
Trend	-9.41	-12.87	7.34	2.56
	-0.38	*-1.5*	*0.83*	*1.02*
Earnings(-1)	0.15588	0.04703	0.03612	0.05543 **
	0.74	*0.65*	*0.49*	*2.65*
Farm	1.03168 ***	-0.00128	0.01959 *	-0.00279
	35.64	*-0.13*	*1.91*	*-0.97*
Farm(-1)	-0.12026	-0.03985	-0.03261	-0.05749 **
	-0.56	*-0.54*	*-0.43*	*-2.67*
Manufacturing	2.09894 ***	0.38079 *	0.33564	-0.00902
	3.43	*1.81*	*1.55*	*-0.15*
Manufacturing(-1)	-0.72366	0.01498	-0.1475	-0.17261 **
	-0.93	*0.06*	*-0.54*	*-2.24*
Federal/Military	2.65773	0.52863	0.16618	0.18571
	1.04	*0.6*	*0.18*	*0.73*
Federal/Military(-1)	-0.21413	0.1093	-0.05805	-0.33718
	-0.08	*0.12*	*-0.06*	*-1.24*
R^2	0.9892	0.2801	0.2631	0.3846
Adjusted R^2	0.9851	0.0058	-0.0176	0.1502
Pr > F	<.0001	0.4507	0.5075	0.1727

Note: All variables are measured in first differences. T-statistics in italics.

Table 10. State Quarterly Data Statistics

	Descriptive Statistics for Levels				Descriptive Statistics for Changes			
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Total Earnings	6039	1132	4256	8335	29.86	250.29	-1196.00	812.41
Farm	772	423	-373	2961	-3.84	234.09	-1021.00	750.99
Ag. Services/Forestry/Fish	53	15	27	82	0.10	3.32	-11.20	15.93
Mining	77	17	39	110	-0.06	5.11	-18.15	11.53
Construction	345	75	220	506	2.01	14.91	-57.68	38.38
Manufacturing	652	248	329	1240	5.68	19.50	-94.81	62.68
Transp. & Pub. Utilities	427	49	307	557	1.85	8.29	-20.97	28.21
Wholesale	367	61	239	477	1.77	9.25	-24.44	61.82
Retail	667	64	568	820	1.66	13.47	-44.18	55.20
Finance, Insurance, RE	317	141	160	729	4.27	16.91	-70.81	99.90
Services	1113	421	578	2018	10.91	23.61	-79.25	140.34
Federal/Military	511	54	349	615	1.41	21.96	-118.08	99.20
St. & Local Government	738	140	516	1053	4.10	18.50	-63.12	46.91

n=132 for levels and 131 for changes.

sectors but farming and mining, but the correlation in changes is very strong between total earnings and farming earnings. Most other correlations are moderate to weak for the change variables. The correlations between changes and lagged changes are generally quite weak.

The regression results (Table 11) for changes in total earnings indicate that the current quarter coefficients are similar to the annual coefficients, i.e., farming has a significant coefficient around 1 and manufacturing and mining have coefficients around 2. This pattern can be observed from Figure 1, which plots changes in total earnings along with changes in farm and manufacturing earnings. The most remarkable aspect of the graph is the close alignment of the farming and total earnings curves, but one can also observe cases in which the two deviate, and total earnings changes appear to be a multiple of changes in manufacturing earnings.

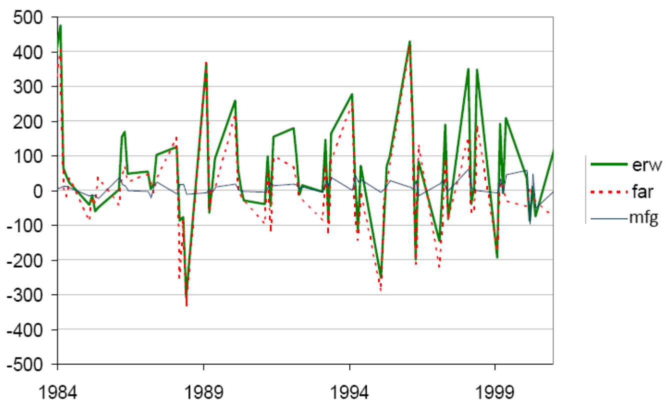

Figure 1. Changes in Total Earnings, Farming Earnings, and Manufacturing Earnings, 1984-2001

While several current quarter coefficients were significant, none of the lagged earnings values for the farming, manufacturing, and mining sectors have significant coefficients. For the federal sector, however, the current period change and the first two lags are statistically significant. All five of the federal sector variables have positive coefficients, with the sum of the current period coefficient (1.19), first lag coefficient (0.94), and second lag coefficient (0.66) summing to a longer term multiplier of close to 3.

The regression results for changes in service sector earnings show little effect of farming, with coefficients close to zero and no statistical significance. The current manufacturing coefficient is a statistically significant 0.23, but none of the lagged values are statistically significant. None of the mining coefficients is statistically significant. The current period and first two lags are significant for federal earnings, although the current period value is negative and the lag values positive. The sum of the three is about 0.3. Retail and FIR sector earnings have a positive and statistically significant relationship with current sector manufacturing and mostly mixed and statistically insignificant relationships with other sectors.

6.4 Quarterly County Models

The results of the quarterly county models are shown on Tables 12 (Minnehaha) and 13 (Pennington). For Minnehaha, the basic sector model explains around seventy per cent of the variation in total wages, but the current period and once-lagged manufacturing coefficients are the only statistically significant ones. The current period coefficient indicates a multiplier of 3.06, a reasonable finding. If one adds up the coefficients on all of the manufacturing time periods, the multiplier rises to over 5. The service sector regression reveals similar results, with an effect on service sector wages which is 1.75 times the manufacturing wage change in the current period.

For individual sectors, manufacturing has the sole significant coefficient for TTU and information, with estimated effects of 0.56 and 0.11 respectively. Three coefficients are significant relative to the finance sector. Manufacturing again has a modest positive coefficient, federal has a 0.74 coefficient for the current period, and the RESMIN sector has a startling 19.6 coefficient for the current time period. This is presumably some sort of statistical artifact. There are no notable coefficients in the business services regression, but the education and health model shows a modest and significant manufacturing effect. Finally, the leisure sector regression finds the current and all of the lagged manufacturing changes statistically significant, but with a combined magnitude of under 0.5. Curiously, the current and first two lagged federal coefficients are negative and statistically significant.

The Pennington results are striking. Relative to total wages, current manufacturing again has a strong and significant multiplier of 2.82, and manufacturing lagged two quarters also has a multiplier of around 1. However, we also find a quite large negative relationship (-5.7) between twice-lagged RESMIN and a statistically significant negative relationship (-0.98) with the federal sector. An examination of the Pennington wage data reveals that each of the two sectors experienced a sharp decline at some point over the time period, likely generating a misleading result concerning multiplier effects. The service sector results are similar, with a significant 1.16 coefficient for manufacturing and significant negative coefficients for the same two lags of RESMIN and federal.

When individual sectors are examined, for TTU we find a positive manufacturing coefficient of 0.53, a positive thrice-lagged manufacturing coefficient of about the same magnitude, and a negative coefficient for thrice-lagged RESMIN. The only significant coefficients relative to the information and finance sectors are for twice-lagged or thrice-lagged RESMIN, and there are no significant coefficients relative to business services. Current manufacturing has a significant coefficient of 0.43 relative to education and health, and federal wages lagged four quarters have a small but significant relationship with the leisure sector.

Table 11. State Quarterly Data Total and Nonbasic Sector Regressions

Independent \ Dependent	**Total Earnings**	**Services**	**Retail**	**Finance**
Trend	0.40225***	0.13362**	-0.00957	0.11845**
	2.84	*2.12*	*-0.26*	*2.38*
Earnings(-1)	-0.02629	-0.04414	0.05975**	-0.05384
	-0.26	*-1*	*2.29*	*-1.54*
Farm	1.01209***	0.00462	0.00621	0.00347
	51.39	*0.53*	*1.21*	*0.5*
Farm(-1)	0.03012	0.04665	-0.05686**	0.04643
	0.29	*1.01*	*-2.09*	*1.27*
Farm(-2)	0.00564	-0.00030	0.00782	0.00408
	0.3	*-0.04*	*1.6*	*0.62*
Farm(-3)	0.01356	-0.00261	0.00737	-0.00173
	0.72	*-0.31*	*1.5*	*-0.26*
Farm(-4)	0.01026	0.0121	0.00881*	-0.00411
	0.54	*1.43*	*1.77*	*-0.62*
Manufacturing	1.79183***	0.22725**	0.14225**	0.06514
	7.59	*2.17*	*2.31*	*0.79*
Manufacturing(-1)	0.28561	0.15014	-0.04599	-0.04122
	0.97	*1.15*	*-0.6*	*-0.4*
Manufacturing(-2)	0.31764	-0.12159	-0.00819	0.22028***
	1.34	*-1.16*	*-0.13*	*2.65*
Manufacturing(-3)	-0.39046	0.06441	-0.06193	-0.09815
	-1.59	*0.59*	*-0.97*	*-1.14*
Manufacturing(-4)	-0.2599	-0.1379	0.0516	-0.06634
	-1.1	*-1.31*	*0.83*	*-0.8*
Mining	2.23412**	0.15799	0.02203	0.32018
	2.35	*0.37*	*0.09*	*0.96*
Mining(-1)	-0.11108	0.44179	-0.49809*	-0.08164
	-0.11	*0.98*	*-1.88*	*-0.23*
Mining(-2)	-1.44651	-0.48066	-0.35865	-0.00467
	-1.47	*-1.1*	*-1.39*	*-0.01*
Mining(-3)	-0.50325	-0.88142*	0.01889	-0.21284
	-0.5	*-1.98*	*0.07*	*-0.6*
Mining(-4)	-0.27891	-0.14888	-0.26881	-0.24777
	-0.28	*-0.34*	*-1.04*	*-0.72*
Federal/Military	1.19227***	-0.30517***	0.03748	0.02968
	5.4	*-3.11*	*0.65*	*0.38*
Federal/Military(-1)	0.94031***	0.31607**	0.09088	0.12741
	3.42	*2.59*	*1.27*	*1.32*
Federal/Military(-2)	0.6598**	0.28383**	0.03811	0.047
	2.54	*2.46*	*0.56*	*0.52*
Federal/Military(-3)	0.41531*	-0.01649	-0.01814	0.07535
	1.68	*-0.15*	*-0.28*	*0.87*
Federal/Military(-4)	0.38136*	-0.07119	0.10271*	0.02491
	1.65	*-0.69*	*1.7*	*0.31*
R^2	0.9718	0.3695	0.333	0.2396
Adjusted R^2	0.9658	0.2361	0.1919	0.0788
Pr > F	<0.0001	0.0003	0.002	0.0938

Note: All variables are measured in first differences. T-statistics in italics.
***/**/* indicate significance at 1%/5%/10% levels.

Table 12. Quarterly Total and Nonbasic Sector Regressions for Minnehaha County

Minnehaha

	Total	**SVC**	**TTU**	**INFO**	**FIN**	**BSV**	**EDH**	**LEIS**
Trend	20732	27166	14966	1164	138	-10917	28485	10760 ***
Dependent(-1)	-0.263 *	-0.175	-0.512 ***	-0.391 **	0.067	0.198	-0.454 ***	-0.164
Mfg.	3.064 ***	1.749 ***	0.560 ***	0.112 *	0.350 ***	0.086	0.479 **	0.059 *
Mfg. (-1)	1.220 *	0.631	0.235	0.044	0.239	0.061	0.194	0.092 **
Mfg. (-2)	0.423	0.454	0.201	0.057	0.078	0.164	-0.261	0.148 ***
Mfg. (-3)	0.058	0.205	0.044	0.126	-0.158	-0.300 *	0.402	0.089 **
Mfg. (-4)	0.537	0.482	0.205	-0.037	0.241	0.237	-0.096	0.065 *
ResMin	17.330	11.811	-3.592	-0.536	19.635 ***	-0.412	-2.517	-2.274 *
ResMin(-1)	-6.927	-12.698	-8.649	-0.172	0.397	-5.774	-7.204	1.157
ResMin(-2)	-1.804	-8.824	-2.610	-1.978	-5.467	5.138	-2.910	-0.770
ResMin(-3)	-7.664	-6.784	2.876	0.373	2.151	-1.075	-8.540	-0.609
ResMin(-4)	13.039	13.449	1.462	0.590	3.636	0.237	7.267	-1.326 *
Federal	1.109	-0.351	-0.176	-0.192	0.742 *	-0.206	-0.490	-0.254 **
Federal(-1)	-0.991	-2.103	-0.384	0.065	-0.876	-0.479	-0.510	-0.269 **
Federal(-2)	-2.865	-2.808 *	-0.785	-0.168	-0.514	-0.486	-0.545	-0.267 **
Federal(-3)	-2.656	-2.376	-0.190	-0.373	-0.544	-0.051	-1.396	0.043
Federal(-4)	-0.165	0.446	-0.321	-0.107	-0.118	-0.527	0.802	0.081
R^2	0.7090	0.5736	0.5698	0.3971	0.6269	0.3664	0.6253	0.5628
Adjusted R^2	0.5753	0.3776	0.3722	0.1201	0.4555	0.0752	0.4531	0.3619
Pr > F	<0.0001	0.0031	0.0035	0.1764	0.0005	0.2716	0.0005	0.0044

Note: All variables are measured in first differences. ***/**/* indicate significance at 1%/5%/10% levels.
ResMin=Resources and Mining; Mfg.=Manufacturing; SVC=Services; TTU=Trade, Transp., & Utilities;
INFO=Information; FIN=Finance; BSV=Business Services; EDH=Education & Health; LEIS=Leisure.

Table 13. Quarterly Total and Nonbasic Sector Regressions for Pennington County

	Total	SVC	TTU	Info	Fin	BSVC	EdH	LEIS
Trend	8102	3442	7298	-212	-5468	959	4519	-1349
Dependent(-1)	-0.388 **	-0.176	-0.233 *	-0.117	-0.430 **	-0.234	-0.495 ***	-0.203
Mfg	2.825 ***	1.159 **	0.531 *	0.060	0.101	0.172	0.433 ***	0.057
Mfg(-1)	0.617	-0.480	-0.078	-0.045	-0.214	0.112	-0.024	-0.020
Mfg(-2)	0.993 *	0.606	0.058 *	0.024	0.415	0.099	-0.192	0.000
Mfg(-3)	0.695	0.922 *	0.492	0.055	0.255	0.156	0.159	-0.001
Mfg(-4)	-0.159	0.269	0.061	0.000	0.109	0.045	0.255	-0.026
ResMin	-0.508	-0.097	-0.282	-0.089	-0.409	-0.465	0.625	0.127
ResMin(-1)	0.681	0.328	0.611	0.038	-0.456	-0.230	0.254	0.232
ResMin(-2)	-5.740 ***	-4.490 ***	0.094 **	-0.261 **	-4.219 ***	-0.158	0.190	0.008
ResMin(-3)	-0.600	0.726	-1.627	-0.018	1.794 *	-0.342	-0.063	-0.205
ResMin(-4)	0.446	1.088	1.106	0.037	1.468	-0.217	-0.176	-0.181
Federal	1.927 ***	0.796 *	0.284	0.058	0.213	0.042	-0.057	0.097
Federal(-1)	0.102	-0.108	-0.024	0.062	0.163	-0.170	-0.031	-0.094
Federal(-2)	-0.804	-0.282	-0.242	0.008	0.195	-0.062	-0.116	-0.032
Federal(-3)	-0.977 *	-0.877 *	-0.132	-0.007	-0.328	-0.031	-0.223	-0.067
Federal(-4)	-0.217	0.067	-0.293	0.049	-0.140	-0.010	-0.009	0.136 *
R^2	0.8253	0.6004	0.4255	0.3272	0.7135	0.2206	0.6061	0.5326
Adjusted R^2	0.7451	0.4168	0.1615	0.0180	0.5819	-0.1376	0.4251	0.3179
Pr > F	<0.0001	0.0013	0.1110	0.4257	<0.0001	0.8575	0.0010	0.0104

Note: All variables are measured in first differences. ***/**/* indicate significance at 1%/5%/10% levels.
ResMin=Resources and Mining; Mfg.=Manufacturing; SVC=Services; TTU=Trade, Transp., & Utilities;
INFO=Information; FIN=Finance; BSV=Business Services; EDH=Education & Health; LEIS=Leisure.

7. Findings – VAR Modelling

The final step in the investigation of economic base modeling was the estimation of vector autoregression models for Minnehaha and Pennington. Since the data were non-stationary, VAR models were fit in first differences, testing for lag length using GRETL's lag specification search procedure. The Schwartz and Hannan-Quinn measures both consistently identified only one monthly lag, but the Akaike (AIC) criterion indicated eight lags for the hybrid data in Minnehaha and nine lags for the LQ data. Although the AIC indicated only one month in Pennington for both measurements, eight lags were used since one month adjustment seems implausible, and a significant eighth lag was identified.

A summary of the VAR models is shown in Table 14. The most interesting results are from the Granger causality tests. For both of the basic/nonbasic runs, the Minnehaha results show causality running in the nonbasic to basic direction only. The Pennington results reveal only a borderline case (p-value=0.0596) for nonbasic employment changes leading basic employment changes. Only a few coefficients from the equations were significant, and the R^2 values were fairly low. Accumulated impulse response functions, shown in Appendix 2, illustrate the nonbasic to basic effect, which is generally positive for Minnehaha and largely neutral for Pennington. In both counties, the effect of an innovation in basic employment is generally negative for both counties and both bifurcation schemes.

While we had anticipated reporting on vector error correction models as well, cointegration tests indicated that the basic and nonbasic series were not cointegrated. Both Engle and Granger and Johansen (trace and maximum eigenvalue) tests indicated a lack of cointegration, with just one borderline exception. Interestingly, a cointegrating equation based on the data in levels showed greater similarity of multipliers based on the different bifurcation schemes than did the earlier estimations with earnings and wages data and less frequent data. Estimated multipliers were around 2.3 for Minnehaha and 4.4 for Pennington.

Table 14. County Monthly VAR, Granger Causality, and Multiplier Results

		Hybrid Method	LQ Method
Minnehaha:			
Basic Equation	Basic Lags		3
	Nonbasic Lags	2,5,(8)	2,5,(8)
	R^2	0.177	0.220
Nonbasic Eqn.	Basic Lags		
	Nonbasic Lags	(2), 8	(2), 8
	R^2	0.191	0.181
Granger Causality	Basic Cause Non.	9.93[0.2700]	8.34[0.5003]
Chi^2[p-value]	Non. Cause Basic	17.52[0.0251]	22.62[0.0071]
AIC		29.85	29.97
Multiplier for Levels		2.24	2.43
Pennington:			
Basic Equation	Basic Lags	(1)	(1)
	Nonbasic Lags	(5)	(5)
	R^2	0.245	0.266
Nonbasic Eqn.	Basic Lags	(1)	
	Nonbasic Lags		(6)
	R^2	0.119	0.142
Granger Causality	Basic Cause Non.	5.04[0.7536]	10.28[0.2456]
Chi^2[p-value]	Non. Cause Basic	14.98[0.0596]	11.85[0.1580]
AIC		26.99	27.06
Multiplier for Levels		4.34	4.50

8. Conclusion.

This exploratory analysis of the South Dakota economy and three of its counties has revealed very interesting effects of basic sector activity, both as an aggregated basic sector and disaggregated into individual sectors of the economy. As is typical of economic base studies, multipliers vary substantially depending on the particular specification, data bifurcation methods, and geographic unit.

One key finding is that, while farming has proven to be very important in explaining changes in total earnings, overall changes seem to be limited to only the direct farm sector effects. Multiplier effects are observed only for other sectors, particularly manufacturing and federal earnings. The results are seen not only in total earnings, but in the way in which the non-farm basic sectors influence the retail, service, and finance sectors. An interesting exception occurs in Pennington, where farming effects are multiplied but federal employment effects are not, perhaps suggesting a more general pattern of dominant sectors having lower multipliers.

While these results provide strong evidence of the importance of non-agricultural sectors, it would be a mistake to conclude that farming lacks in importance. A better interpretation might be that while farming does, of course, support a broader part of the economy, the overall economy is not very sensitive to changes in farm earnings. That is, the infrastructure built around farming seems to be fairly stable in the face of marked volatility in the farming sector.

As to questions of the basic/nonbasic relationship, Granger causality results are not supportive of the basic to nonbasic causality of economic base models. The informal assessments of causality in the annual data found numerous significant relationships between basic and nonbasic earnings, but only one county/bifurcation combination revealed a basic to nonbasic relationship without a reciprocal effect. The explicit tests using the monthly employment data much more strongly indicated an opposite direction of cause and effect, and impulse response functions showed generally negative effects on nonbasic employment of innovations in basic employment. While these are discouraging results, there always persist questions about the validity of the basic/nonbasic bifurcation that essentially render causality tests joint tests of proper bifurcation and economic base relationships.

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Appendix 1. Intersectoral Correlations for South Dakota, Levels, Changes, and Lags

Correlations of Levels

	erw	far	ags	min	con	mfg	tpu	whl	rtl	fir	svc	fdml	stl
erw	1.00	0.09	0.71	-0.46	0.80	0.91	0.84	0.75	0.89	0.91	0.90	0.44	0.93
far	0.09	1.00	0.08	-0.36	0.06	-0.28	-0.22	-0.34	0.07	-0.27	-0.31	-0.19	-0.24
ags	0.71	0.08	1.00	-0.37	0.36	0.59	0.42	0.37	0.50	0.61	0.70	0.55	0.73
min	-0.46	-0.36	-0.37	1.00	-0.31	-0.37	-0.05	0.01	-0.45	-0.43	-0.34	0.34	-0.37
con	0.80	0.06	0.36	-0.31	1.00	0.71	0.84	0.83	0.93	0.68	0.62	0.32	0.71
mfg	0.91	-0.28	0.59	-0.37	0.71	1.00	0.86	0.81	0.81	0.99	0.97	0.35	0.97
tpu	0.84	-0.22	0.42	-0.05	0.84	0.86	1.00	0.91	0.83	0.83	0.81	0.57	0.84
whl	0.75	-0.34	0.37	0.01	0.83	0.81	0.91	1.00	0.76	0.77	0.76	0.50	0.79
rtl	0.89	0.07	0.50	-0.45	0.93	0.81	0.83	0.76	1.00	0.80	0.74	0.30	0.81
fir	0.91	-0.27	0.61	-0.43	0.68	0.99	0.83	0.77	0.80	1.00	0.98	0.36	0.96
svc	0.90	-0.31	0.70	-0.34	0.62	0.97	0.81	0.76	0.74	0.98	1.00	0.48	0.98
fdml	0.44	-0.19	0.55	0.34	0.32	0.35	0.57	0.50	0.30	0.36	0.48	1.00	0.48
stl	0.93	-0.24	0.73	-0.37	0.71	0.97	0.84	0.79	0.81	0.96	0.98	0.48	1.00

Correlations of Changes

	erwdif	fardif	agsdif	mindif	condif	mfgdif	tpudif	whldif	rtldif	firdif	svcdif	fdmldif	stldif
erwdif	1.00	0.94	0.08	-0.04	0.58	0.40	0.51	0.18	0.53	0.24	0.40	0.21	0.22
fardif	0.94	1.00	0.00	-0.02	0.31	0.17	0.28	0.05	0.29	0.05	0.15	0.14	-0.02
agsdif	0.08	0.00	1.00	0.03	0.07	-0.03	0.09	0.06	0.38	-0.08	0.22	0.29	0.16
mindif	-0.04	-0.02	0.03	1.00	0.07	0.00	0.06	0.33	-0.08	-0.45	-0.40	-0.02	-0.25
condif	0.58	0.31	0.07	0.07	1.00	0.64	0.76	0.33	0.77	0.38	0.53	0.25	0.54
mfgdif	0.40	0.17	-0.03	0.00	0.64	1.00	0.60	0.28	0.48	0.52	0.58	-0.28	0.39
tpudif	0.51	0.28	0.09	0.06	0.76	0.60	1.00	0.31	0.59	0.30	0.36	0.31	0.46
whldif	0.18	0.05	0.06	0.33	0.33	0.28	0.31	1.00	0.05	0.10	0.13	0.14	0.20
rtldif	0.53	0.29	0.38	-0.08	0.77	0.48	0.59	0.05	1.00	0.42	0.55	0.20	0.45
firdif	0.24	0.05	-0.08	-0.45	0.38	0.52	0.30	0.10	0.42	1.00	0.71	-0.06	0.26
svcdif	0.40	0.15	0.22	-0.40	0.53	0.58	0.36	0.13	0.55	0.71	1.00	0.06	0.61
fdmldif	0.21	0.14	0.29	-0.02	0.25	-0.28	0.31	0.14	0.20	-0.06	0.06	1.00	0.35
stldif	0.22	-0.02	0.16	-0.25	0.54	0.39	0.46	0.20	0.45	0.26	0.61	0.35	1.00

Correlations of Changes with Lags

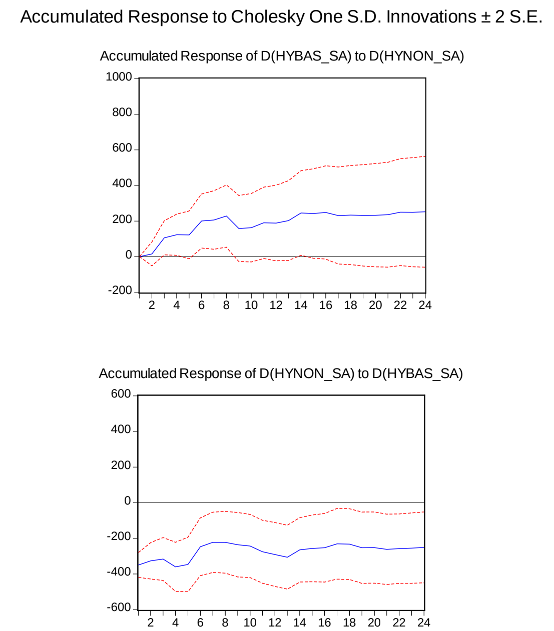
	erwdif	fardif	agsdif	mindif	condif	mfgdif	tpudif	whldif	rtldif	firdif	svcdif	fdmldif	stldif
erwlag1	-0.11	-0.24	0.49	0.03	0.19	0.20	0.26	0.15	0.36	-0.01	0.06	0.01	0.23
farlag1	-0.24	-0.32	0.55	0.02	0.06	0.04	0.17	0.02	0.27	-0.14	-0.07	0.01	0.10
agslag1	0.06	0.10	-0.16	0.17	0.00	-0.04	-0.05	0.12	-0.12	-0.14	-0.16	0.02	0.05
minlag1	-0.26	-0.13	-0.14	0.26	-0.30	-0.37	-0.07	0.03	-0.37	-0.30	-0.55	-0.16	-0.44
conlag1	0.19	0.05	0.11	0.06	0.36	0.35	0.38	0.47	0.29	0.21	0.24	0.11	0.36
mfglag1	0.05	-0.02	-0.07	-0.09	0.01	0.35	0.05	0.22	0.11	0.48	0.23	-0.33	0.04
tpulag1	0.23	0.15	0.09	0.25	0.27	0.23	0.25	0.39	0.26	0.07	0.06	0.03	0.18
whllag1	-0.23	-0.37	-0.05	0.26	0.24	0.24	0.15	0.43	0.16	0.22	0.01	-0.12	0.05
rtllag1	0.18	0.09	-0.09	0.06	0.30	0.30	0.24	0.23	0.18	0.07	0.11	0.04	0.35
firlag1	0.38	0.24	-0.04	-0.34	0.44	0.50	0.19	0.00	0.48	0.56	0.62	-0.05	0.26
svclag1	0.25	0.10	0.15	-0.25	0.27	0.48	0.10	0.06	0.41	0.46	0.60	-0.09	0.46
fdmllag1	0.40	0.31	0.36	0.36	0.48	-0.07	0.42	0.24	0.46	-0.18	0.01	0.67	0.32
stllag1	0.35	0.20	0.13	0.04	0.43	0.52	0.41	0.28	0.35	0.17	0.39	0.02	0.61

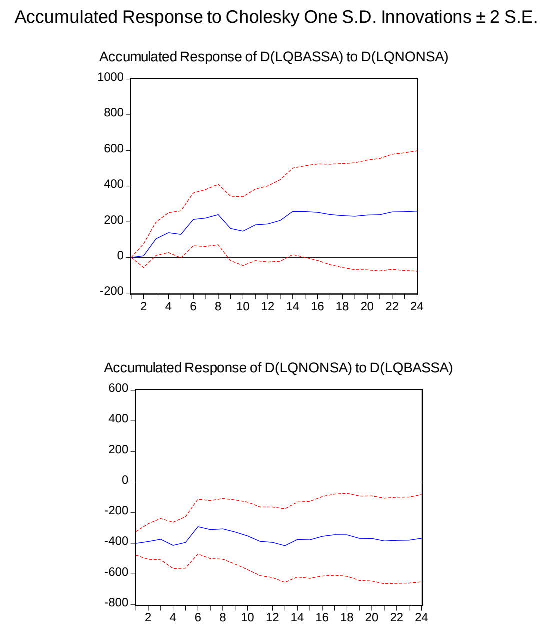
Sector abbreviations are: total earnings (erw), farming (far), agricultural services, forestry, and fisheries (ags), mining (min), construction (con), manufacturing (mfg), transportation and public utilities (tpu), wholesale (whl), retail (rtl), finance, insurance, and real estate (fir), services (svc), combined federal civilian and military (fdml), and state and local government (stl).

Appendix 2. Accumulated Impulse Response Functions

(The left panel is for hybrid method and the right panel LQ; the top graph in each pair is the basic response to nonbasic innovation and the bottom graph is the nonbasic response to basic innovation).

Minnehaha





Pennington