Macroeconomic Impacts on DSM Program Participation

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ABSTRACT

DSM planners need to consider business capital investment cycles within program designs to optimize program participation, manage free-ridership, and adjust program delivery strategies. Macroeconomic conditions form a broad set of parameters that the DSM planner must monitor and implement adaptation strategies accordingly.

The economic uncertainty following the recession of 2008-2009 has brought the potential impacts of the economy on DSM participation to the forefront for DSM planners in all jurisdictions. The impact of economic uncertainty is further exacerbated in Ontario by the broader uncertainties related to re-introducing major industrial DSM programs after many years with no activity.

This research project will focus on answering the following key questions:

1. What are the key macroeconomic factors impacting industrial DSM program performance and energy efficiency levels? What is the quantification of the correlation between these factors? At a minimum, directionally what is the correlation and strength of the correlation? In particular how closely does capital investment correlate with energy efficiency and DSM program participation levels?
2. Is there a disproportionate growth or decline during various economic conditions between industrial sub-sectors?

Scope of Research:

1. Program participation impacts for at least five industrial programs in North America.
2. Large manufacturing / industrial sectors in Ontario in terms of energy use, changes in capital investment, etc.
3. The research should examine business investment and capacity utilization trends from a period long enough to capture a few business cycles.

Introduction

Historically, DSM planners have not incorporated macro-economic factors into their DSM planning activities. In fact a literature scan by the authors was unsuccessful in identifying any previous papers that quantify the impact of macro-economic factors on DSM program participation. The nearest equivalent paper that could be identified was a September 2008 ACEEE report “Trends in Industrial Decision Making” (report # IE081). That paper focused on the economic trends current in 2008 to predict the need for new capital investment but does not quantify the linkage between capital investment and DSM participation.

This study is an attempt to quantify the impacts of macro-economic factors on DSM program participation and energy efficiency so that DSM planners may begin to more formally include these factors in their DSM planning activities.

It is generally acknowledged that industrial DSM program participation and energy efficiency will increase during economic growth and decrease in recessionary periods. However it is not clear what macro-economic variables are most important for the DSM planner to monitor and how these variables should be interpreted.

In Ontario, Canada the impacts of the macro-economy on industrial DSM participation and energy efficiency are even more difficult to assess considering that there has been very little or no industrial DSM activity in the province in the last 15 years.

Industrial DSM activity has recently resumed in Ontario with a major industrial DSM program launched for transmission connected participants in 2010 and another major program for local distribution connected facilities coming later this year.

The economic uncertainty following the recession of 2008-2009 has brought the potential impacts of the economy on DSM participation to the forefront for DSM planners in all jurisdictions. The impact of economic uncertainty is further exacerbated in Ontario by the broader uncertainties related to re-introducing major industrial DSM programs after many years with no activity.

The quality and quantity of macro-economic data presents an opportunity for statistical analysis. DSM programs are typically difficult or impossible to quantify and analyze statistically. Data for variables such as program design and pre-existing levels of installation of efficiency measures are not easily measured and not widely available. However, macro-economic time-series data of excellent quality is available for both Canada and the USA.

The limiting factor in analysis of macro-economic impacts on DSM program participation then becomes availability of DSM program results. While there is no recent industrial DSM program data available for Ontario, there is nearly a decade of time series data readily available for 6 major industrial DSM program in the USA. As described in the methodology later in this paper, in the absence of true DSM data for Ontario, DSM program participation is assumed to be a constant proportion of energy efficiency. This assumption is then assessed by comparing the Ontario model against our model of macro-economic impacts on actual US DSM data for 6 large industrial programs.

Initial Assumptions and Limitations of Scope

The focus of this study is on external, macro-economic factors and their impact on DSM program performance and energy efficiency levels.

There are clearly a number of important, internal and micro-economic factors that directly impact DSM program performance and energy efficiency levels as well. These include the regulatory environment (eg. energy efficiency incentives), the level of previously installed or implemented energy efficiency measures, and rate design (eg. time-based pricing and demand charge structures) among others.

These other factors were deliberately excluded from this study under the assumption that variations in their impact on changes to DSM participation and energy efficiency levels is likely to be insignificant in comparison to macro-economic influences when averaged out over time and across the entire sample. We recognize that inclusion of these other factors is likely to significantly change the model coefficients and lead to a more accurate overall prediction of DSM program participation and energy efficiency levels. However the methodology used in this paper does provide a clear indication of the significance and direction of influence that various macro-economic factors will have on DSM participation and energy efficiency levels.

As such the results of this analysis provide a tool to guide the DSM planner in assessing how changes in the economy may impact DSM participation rates and required resource levels.

Methodology

The study was conducted in 2 parts (1) study of macro-economic impacts on actual, US-based DSM program performance for 6 industrial programs and (2) study of macro-economic impacts on trends in industrial energy use in Ontario. For both Part 1 and Part 2 the impacts of the following macro-economic variables were considered: Manufacturing Capital Investment, Manufacturing Capacity Utilization Rates, Manufacturing Sales/Shipments, Nominal GDP, Energy Prices and Interest Rates. In Part 2, Commodity Price impacts were also included in the analysis. For Part 1, DSM program investment levels were factored into the analysis. The results of both parts were then examined to see if they were comparable and how, in combination, they could be used to model levels of DSM participation in Ontario.

Part 1 Methodology – Macroeconomic Impacts on 6 US-Based DSM Programs

Part 1 is a study of actual performance for 6 US based DSM programs. This enabled us to draw a direct link between macro-economic indicators and DSM participation in recent years that cannot be inferred using Ontario-specific data (since there has been no recent industrial DSM in Ontario from 1995 until 2010). The 6 programs were selected from datasets made available by the Energy Information Administration (EIA). These programs are:

1. Pacific Gas and Electric Company
2. Southern California Edison Company
3. Connecticut Light and Power Company
4. Northern States Power Company
5. The Narragansett Electric Company
6. Tampa Electric Company

The programs were selected for the completeness of their data. Complete data for these programs was available for the full 9 year period of 2001 to 2009 with the exception of missing 2003 data for Pacific Gas and Electric Co. Table 1 shows the macroeconomic variables and data sources used.

In order to analyze how certain macroeconomic variables affect industrial DSM program performance, we will need to construct various models which aim to capture these different impacts and relationships. The equation on the next page is a typical example of how we would aim to capture these relationships:

Table 1. Summary of Data Used for Part One Analysis of US DSM Programs

Macroeconomic Variable	Description	Source
Manufacturing Capital Investment	Annual data on U.S. wide manufacturing investment	U.S. Census Bureau
Individual DSM Program Investment	Annual data on individual DSM program expenditure	Energy Information Administration (EIA)
Manufacturing Capacity Utilization Rates	Annual data on U.S. wide capacity utilization rates	Federal Reserve Board (FRB) and U.S. Census Bureau
Manufacturing Shipments	Seasonally adjusted annual data on U.S. wide manufacturing shipments	U.S. Census Bureau
Individual Utility DSM Program Sales	Annual data on individual utility DSM program sales	Energy Information Administration (EIA)
Nominal GDP (state)	Annual data on Nominal GDP by U.S. state	Bureau of Economic Analysis (BEA)
Real GDP (state)	Annual data on Real GDP by U.S. state	Bureau of Economic Analysis (BEA)
Energy Prices	Annual data on estimated energy prices by end-user for the Industrial sector	Department of Energy (DOE)
Interest Rates	Annual data on the U.S. Federal Funds interest rate (akin to the "base-rate")	Federal Reserve

$$DSM = f\,(bI + bU + bD + bGn + bi + bP + e)$$

Where:
DSM = DSM program participation levels
I = Manufacturing Investment Levels
U = Capacity Utilization Rates
D = Manufacturing Shipments
Gn = Nominal GDP
i = Interest Rates
P = Energy Price Index
e = Error term (residual)
b = Coefficient

Such an equation is typically estimated using statistical or econometric regression techniques to estimate what the coefficients, statistical significance, correlations and overall fit (predictability) of the model is. The estimates given for the regression model typically will tell us which macroeconomic indicators have the biggest impact (positive or negative) on energy efficiency levels as well as the size and magnitude of these impacts. The results of such analysis can potentially assist a DSM program planner when implementing or monitoring new or existing DSM programs and participation levels by understanding how the different variables impact on their individual DSM programs and within certain industries.

The results of the equation should tell us several things about the relationship between DSM performance and the macroeconomic variables on the right-hand side of the equation. In particular, the results should show us three key pieces of information:

The explanatory power of the model (R-Squared) – which simply shows us how well the combined effects of the different macroeconomic variables explain the outcome of DSM program performance;

The individual significance of each different macroeconomic variables (T-Stats) – which shows us which particular macroeconomic variables are statistically significant within the equation;

The individual correlations of each different macroeconomic variables with DSM program performance – which will show us the strength and magnitude of the correlations between different macroeconomic variables and energy efficiency levels.

These three key pieces of information will allow us to make certain statements and draw certain conclusions regarding the relationships between the various macroeconomic variables and industrial DSM program performance across the six selected DSM programs within the six different U.S. regions.

Part 2 Methodology– Macro-economic Impacts on Industrial Energy Use/Efficiency in Ontario

In Part 2 we drew a link between macro-economic indicators and expected changes in DSM participation in Ontario. DSM program participation rates are typically measured in one of two ways[1]:

- *Energy Efficiency Megawatt-Hours (MWhs) Saved* – this is typically the main component of a DSM program
- *Load Management Peak Reduction MWhs Saved* – this is typically a minor component of a DSM program

Energy Efficiency in terms of MWhs saved is significantly more favorable to any given manufacturing industry for a number of reasons. The biggest of these is that this form of DSM program participation allows output to continue unobstructed, whereas with Load Management certain manufacturing activities may have to be temporarily put on hold in a bid to reduce energy usage.

In periods of high economic growth, investment and consumer demand, load-management is typically not a viable way of increasing DSM program participation since much consumer demand has to be either satisfied by constant production of goods, or satisfied from previous inventory stock. Energy efficiency and implementation of new energy-saving technologies become more important and more viable ways to increase DSM program participation rates while still being able to satisfy consumer demand associated with high economic activity, growth and investment.

Because of this, the report will be concentrating on analyzing the impacts of certain macroeconomic variables on energy efficiency levels, as energy efficiency levels are deemed to be the largest significant component of a DSM program compared to Load-Management.

The closest possible related variable with DSM program participation would be that of the first variable in Table 2 (Total Energy Consumption). A key assumption we are making here is that energy efficiency levels in terms of MWhs saved, are generally 2% of that of total energy consumption. For example, if total energy consumption of the manufacturing industries in 2005 were 2.5m terajoules (TJs) then we can say that of this 2.5m TJs, 50,000TJs is energy efficiency participation in Ontario as this is 2% of total energy consumption.

[1] This is consistent with the Energy Information Administrations (EIA) definitions of DSM program components as in their annual reporting survey of DSM program participants under form EIA-861 Schedule V

Table 2. Summary of Data Used for Part Two Analysis of Ontario Energy Use/Efficiency

Macroeconomic Variable	Time Period	Source
Total Energy Consumption	1995 – 2008	Statistics Canada
Total Electricity Consumption	1995 – 2008	Statistics Canada
Manufacturing Investment Levels	1995 – 2010	Statistics Canada
Manufacturing Capacity Utilization Rates	1995 – 2010	Statistics Canada
Energy Price Index	1995 – 2009	Bank of Canada
Commodity Price Index	1995 – 2009	Bank of Canada
Manufacturing Sales & Shipments	1995 – 2009	Statistics Canada
Ontario Nominal GDP	1995 – 2009	Statistics Canada
Total Energy Consumption	1995 – 2008	Statistics Canada

A large proportion of the dataset used in Part 2 is taken from the Statistics Canada website. Statistics Canada currently has the largest and most comprehensive datasets on a range of macroeconomic data (for both Canada and the provinces, including Ontario), and the data relating to the manufacturing industries has been compiled by Statistics Canada from manufacturing industry respondents who complete the "Annual Survey of Manufacturers" once a year. A key benefit of this data is that it has been grouped together in the same format for the last several years, which allows us to be consistent with our analysis within this project.

In addition, the macroeconomic data taken from the Statistics Canada website has been disaggregated in the same format which allows us to control for various macroeconomic impacts across the different manufacturing industry sub-sectors. This has allowed us to study which macroeconomic variables have had bigger or smaller impacts on energy efficiency levels, and in which particular manufacturing industry sub-sector.

Table 3 shows us the various manufacturing industry sub-sectors within the Ontario manufacturing industries that we will be analyzing.

In order to analyze how certain macroeconomic variables affect DSM program participation within the different manufacturing industry sub-sectors, we will need to construct various models which aim to capture these different impacts and relationships. The equation on the next page is a typical example of how we would aim to capture these relationships:

Table 3. Manufacturing Industries in Ontario

	Manufacturing Industry
1	Total Manufacturing
2	Food Manufacturing
3	Beverage Manufacturing
4	Textile Mills
5	Clothing Manufacturing
6	Wood Product Manufacturing
7	Paper Manufacturing
8	Printing & Related Support Activities Manufacturing
9	Chemicals Manufacturing
10	Plastics & Rubber Products Manufacturing
11	Non-Metallic Minerals Product Manufacturing
12	Primary Metal Manufacturing
13	Fabricated Metal Products Manufacturing
14	Machinery Manufacturing
15	Computer & Electronic Product Manufacturing
16	Transportation Equipment Manufacturing
17	Furniture & Related Product Manufacturing

$$E = f\,(bI + bU + bD + bP + bC + bGn + e)$$

Where:
E = Energy Efficiency Levels
C = Commodity Price Index
All others have the same meanings as indicated in the Part 1 methodology.

The model R square, T-stats and individual correlations for each variable with energy efficiency will allow us to make certain statements and draw certain conclusions regarding the relationships between the different macroeconomic variables and energy efficiency levels within the different manufacturing industry sub-sectors in Ontario.

Results

The following section presents a summary of the results of the quantitative modeling analysis between the different macroeconomic variables and energy efficiency in:

- Part 1 for 6 US-based DSM programs based on the dataset from 2001-2009 and;
- Part 2 for the manufacturing industries in Ontario based on the dataset for 1995 – 2008.

Part 1: – Macroeconomic Impacts on 6 US-based DSM Programs

In total there were twenty-four econometric regression models conducted to test the relationship between the macroeconomic variables and the DSM program data for the six different industrial DSM programs in the United States.

These twenty econometric regression models were broken down into four distinct econometric regression models for each of the six DSM programs. These two different categories of DSM data each formed the dependent variable within the four regression models and are defined as follows:

i) Industrial Annual Energy Efficiency DSM Data – Models 1 and 2 in Table 4 reflects the aggregate change in energy consumption for Industrial customers (as measured in megawatt-hours) that participate in a utility-led industrial DSM program;
ii) Industrial Annual Actual Peak-Load Reduction DSM Data – Models 3 and 4 in Table 4 reflects the actual reduction in a utility's annual peak-load (as measured in megawatts) as a result of industrial customers who participate in a utility-led industrial DSM program

In order to account for the potential effects of the recession, the models in figures 1 and 3 were conducted for the time period from 2001-2008 and the models described in figures 2 and 4 were performed using the full data set from 2001-2009. This way the impact of the 2009 recession year data could be observed.

Table 4. Summarized Correlations for the Regression Models of DSM Program Performance

	Average Correlations between various Macroeconomic Variables and Industrial Energy Efficiency		Average Correlations between various Macroeconomic Variables and Industrial Peak Load Reduction	
	Model 1 (2001-2008)	Model 2 (2001-2009)	Model 3 (2001-2008)	Model 4 (2001-2009)
Economic Growth/GDP	0.88	0.87	0.76	0.76
Manufacturing Shipments	0.86	0.67	0.74	0.63
Energy Prices	0.57	0.48	0.52	0.46
Utilization Rates	0.56	(0.24)	0.57	(0.05)
Manufacturing Investment	0.55	0.18	0.50	0.26

	Average Correlations between Interest Rates and DSM program investment/expenditure	
	Model 5 (2001-2008)	Model 6 (2001-2009)
Interest Rates	(0.21)	(0.24)

Relationship trends between the four regression models. In all four regression models, economic growth/GDP seems to have the strongest positive relationship with both sets of DSM data. This is unsurprising, given that the economy heavily dictates demand for manufactured goods across virtually all industries.

In addition, manufacturing shipments comprise the second strongest positive relationship with both sets of DSM data in all four regression models. Also note that the relationship tends to be higher in regression models 1 and 3, which is the time-period of 2001 – 2008. In this time period, manufacturing shipments seem to be increasing year on year, but fall dramatically in 2009 presumably as a result of the global economic recession. DSM participation seems to continue to increase in 2009, presumably as a result of continued manufacturing output, which seems to suggest a 1-year lag in the relationship between the two variables. For this reason, manufacturing shipments show a stronger positive relationship for both sets of DSM data specifically for the time-period 2001 – 2008, as opposed to 2001 – 2009.

The relationship between energy prices and both sets of DSM data seem to average around the 50% mark for the four regression models, with little variation in the relationship results between the four regression models. This seems to suggest that while energy prices have an important impact on DSM program participation, they do not heavily dictate the overall performance of any given DSM program.

Manufacturing Investment is shown to have a similarly moderate relationship with both sets of DSM program data, but only for regression models 1 and 3 which comprise the time period 2001 – 2008. In this time-period, manufacturing investment seems to increase year on year but then falls dramatically in 2009 presumably as a result of the recession. DSM participation seems to increase in 2009, presumably as a result of individual manufacturers utilizing existing technology more efficiently. Intuitively, there would be a lag between a fall in investment and DSM program performance, since increased DSM program participation cannot continually be sustained by low levels of investment. For this reason the time period 2001 – 2008 seems to show a stronger relationship with both sets of DSM program data, compared to regression models 2 and 4, where the relationship is shown to be significantly weaker for both sets of DSM program data for the 2001 – 2009 period.

Interestingly, manufacturing utilization rates seem to only show a positive relationship with both sets of DSM data in regression models 1 and 3. In these regression models, the relationship seems to be a moderate positive one, but in regression models 2 and 4 the relationship seems to be weakly negatively correlated with both sets of DSM data. A DSM planner can almost discount the results of regression models 2 and 4 since this heavily contradicts conventional knowledge. When manufacturing output increases as a result of capacity utilization, we would expect an overall increase in DSM program participation as manufacturing industries look to continue to produce output with lower levels of energy costs. A possible explanation for the unconventional relationship in regression models 2 and 4 is the relatively small time-series used for the regression analysis. The DSM planner should discount the results for manufacturing utilization rates in models 2 and 4.

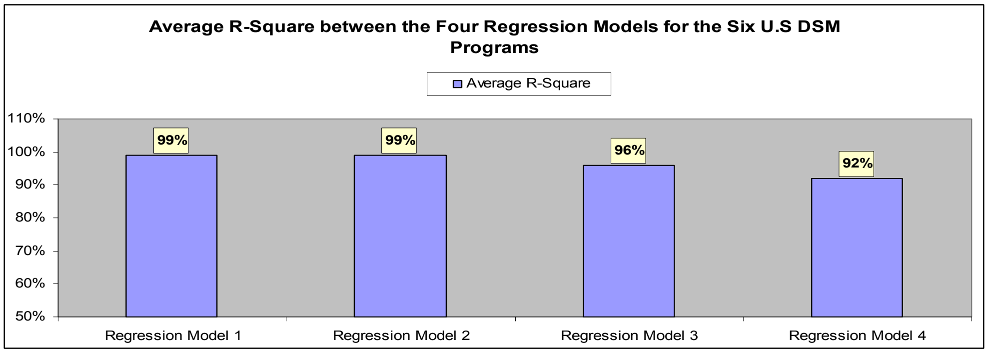
With interest rates, the relationship with both sets of DSM data is shown to be a weak negative relationship. Note here that we have correlated interest rates with actual program investment/expenditure rather than actual DSM program data since interest rates have an indirect effect on DSM program participation. For example, when interest rates are low then borrowing costs from banks or other financial institutions are also low, which makes borrowing to invest in a DSM program attractive. This increase in investment in DSM programs results in higher DSM program participation from industrial customers as a direct result of DSM program expenditure. The opposite is true when interest rates are high. Note also the weak negative relationship between the two variables in all four regression models. This seems to suggest that interest rates do not actually heavily dictate investment in DSM programs.

As intuitively expected, there are positive relationships between all the macroeconomic variables (except interest rates) and the DSM program data. With interest rates, a negative relationship with the DSM program data is expected.

In regression models 2 and 4, the relationship between the individual macroeconomic variables and both sets of DSM program data seem to be intuitively correct, except in the case of capacity utilization rates. Note also that the relationships between the macroeconomic variables and DSM data seem to be slightly weaker in regression models 2 and 4, which shows the importance of the year 2009 as a critical observation data point between the two sets of different regression models.

The explanatory power and statistical significance of the econometric regression models. Figure 1 below shows the average R-Square of each of the four regression models for the six DSM programs. Note that an R-Square close to 100% signifies an almost perfect fit between the macroeconomic variables and the DSM program data, where an R-Square close to 0% signifies that the macroeconomic variables with the regression model have almost no explanatory power to explain DSM program participation and performance:

Figure 1. Average R-Square between the Four Regression Models



There are two key observations to note from Figure 1. Firstly notice that the R-Squares are slightly higher in regression models 1 and 2. This seems to suggest that the chosen macroeconomic variables within the regression models better explain DSM program performance in the first set of DSM data i.e. industrial energy efficiency, etc. compared to regression models 3 and 4 which use utility's actual peak load reduction DSM data.

Secondly notice how high the R-Squares are for all four regression models. In practice, care must be taken in interpreting these statistics. At first glance it seems that these regression models perfectly explain how the chosen macroeconomic variables impact the performance of any given DSM program in the U.S. however this is not entirely true. The actual entirety of the time series spanned only 9 observations, which leads to high R-Squares if most of the macroeconomic variables show strong relationships with the DSM data. Increases in the time-series length tend to push down the R-Square slightly. Secondly the regression models were modeled in a way that the addition of extra macroeconomic variables does not push down the overall explanatory power of the model (and therefore the strong R-Square).

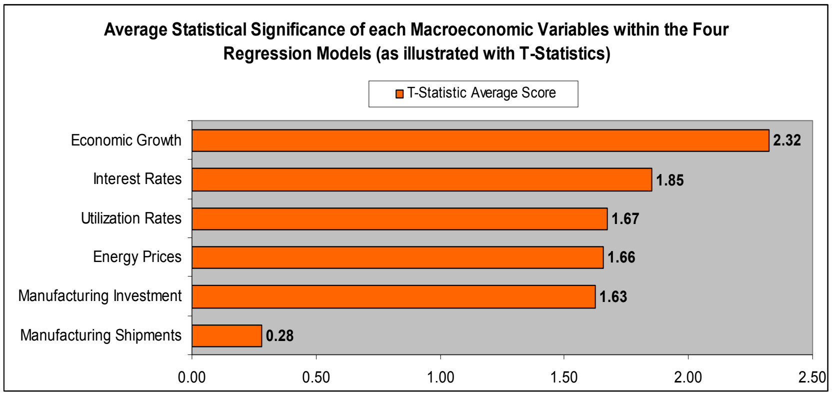
In any case, we would expect a relatively high R-Square between each of the four regression models primarily because of the fact that intuitively, each of the chosen macroeconomic variables has some relationship and impact on the performance of any given DSM program. In addition, the macroeconomic variable data were obtained from the most robust sources available i.e. data on interest rates were obtained from the Federal Reserve, data on economic growth obtained from the Bureau of Economic Analysis, etc. Thirdly, even with more observations we would not expect significant downward pressure on the R-Squares since these relationships are deemed to be robust.

Turning to the Statistical Significance of the Macroeconomic Variables within the regression models, Figure 2 below displays individual statistical significance results of the macroeconomic variables as estimated using their T-Statistic scores:

Figure 2 above shows that only Economic Growth is shown to have a definite statistical significance within the four regression models. All of the other variables (except for manufacturing shipments) have a moderate statistical significance where manufacturing shipments are deemed to be statistically insignificant in the model.

It is important to note that T-Statistic results given in any econometric regression model are very much a function of the way the model is estimated and designed. For example, a variable can be statistically significant in one model (i.e. have a score higher than +/-1.96) but then lose its statistical significance with the introduction or removal of other variables. This is due to the fact that some macroeconomic variables are actually correlated with each other, making it harder to pin-point the nature of causality between DSM program performance and macroeconomic variable performance.

Figure 2. Average Statistical Significance (Illustrated through T-Stats) of Macroeconomic Variables



T-Statistic Score	Statistical Significance
<1	No statistical significance
Between 1 and 1.49	Weak statistical significance within model
Between 1.50 and 1.95	Moderate statistical significance within model
Over 1.96	Statistically Significant within model

For this reason, care must be taken when interpreting the results of T-Statistics as one model may show any given macroeconomic variable to be statistically significant, whereas a slight alteration in another model may render the same variable as statistically insignificant.

Part 2: – Macro-Economic Impacts on Industrial Energy Use/Efficiency in Ontario

Table 5 on the next page illustrates the direction and magnitude of correlations between energy efficiency and macroeconomic indicators for the different manufacturing industries in Ontario (1995 – 2008).

From table 5 we can see that the direction and magnitude of correlation between different manufacturing industries in Ontario varies dramatically. The green highlighted values denote a strong positive relationship (correlation 0.6 or greater) and blue indicates a moderate positive correlation (0.15 to 0.59). The yellow highlighted values are moderate or strong negative relationships (-0.15 to -1).

However there is noticeable consistency in the direction and magnitude of relationships for energy prices, sales and shipments, GDP and Total Model to energy efficiency. In all of these cases at least 6 of the 12 industry sectors have at least a moderate impact in the same direction.

Table 5. Correlations between Manufacturing Investment & Energy Efficiency Levels

#	Industry	Capital Investment	Capacity Utilization	Energy Prices	Commodity Prices	Sales & Shipments	Nominal GDP	**Total Model R^2**
1	Wood Products Manufacturing	(0.37)	(0.19)	(0.48)	(0.50)	0.24	0.62	0.82
2	Paper Manufacturing	0.63	0.63	0.43	0.60	0.69	(0.79)	0.95
3	Printing Manufacturing	0.56	(0.67)	(0.57)	NA	0.34	0.72	0.59
#	Industry	Capital Investment	Capacity Utilization	Energy Prices	Commodity Prices	Sales & Shipments	Nominal GDP	**Total Model R^2**
4	Furniture Manufacturing	0.26	(0.49)	(0.81)	0.04	0.81	0.90	0.91
5	Plastics& Rubber Manufacturing	0.16	(0.14)	(0.86)	NA	0.84	0.95	0.95
6	Chemicals Manufacturing	(0.04)	0.22	0.35	NA	(0.63)	(0.67)	0.55
7	Non-Metallic Min Manufacturing	0.16	0.57	(0.16)	0.02	0.33	0.34	0.56
8	Primary Metals Manufacturing	0.33	0.43	(0.36)	(0.65)	0.14	0.23	0.60
9	Fabricated Metal Manufacturing	(0.42)	(0.33)	(0.46)	NA	0.40	0.71	0.76
10	Machinery Manufacturing	(0.30)	0.21	(0.47)	NA	0.41	0.81	0.56
11	Food Manufacturing	0.20	(0.29)	(0.58)	(0.50)	0.72	0.78	0.84
12	Transport Manufacturing	(0.31)	0.52	0.27	NA	0.11	(0.59)	0.52
13	**Total Manufacturing**	0.17	0.77	0.07	NA	0.07	(0.48)	0.85

The magnitude and direction of the impacts for Sales and Shipments, GDP and Total Model are interesting as they mirror the results from Part 1 where GDP and Shipments were found to have the greatest impact on DSM program participation. It is also interesting to note that, in combination, all macroeconomic factors have an R square of 85% when modeled for total manufacturing in Ontario. This is consistent with the strong R squares (0.92-0.99) from Part 1.

On the surface the consistent (for 9 or 12 sectors) negative correlations with energy prices and energy efficiency appears counterintuitive under the initial assumption that energy efficiency is directly proportionate to energy use. The result makes more sense considering that as energy prices increase, industries will naturally attempt to cut their costs by reducing total energy use as much as possible. Total dollar energy costs only come down with absolute total reductions in energy use. Therefore the initial assumption of energy efficiency as a constant percentage of total energy use does not hold as a useful approximation when modeling the energy price relationship.

The other relationships are the industry sector level are weak and in some cases counterintuitive. These should be discounted by the DSM planner. Further study is required to identify and model changes in true energy efficiency at the industry sector level (rather than using the 2% of total energy use assumption).

Conclusions

GDP and Manufacturing Sales/Shipments Provide the Strongest Relationship to DSM Participation

It is clear that in both Part 1 and Part 2 that GDP and Manufacturing Sales/Shipments have the strongest positive correlations with DSM participation/energy efficiency. Capital Investment, Capacity Utilization and Energy Prices have moderately positive correlations and the Interest Rates results do not show a significant correlation. The insignificance of interest rates is a fair assumption, given that most DSM programs are administered by multi-national utilities and tend to finance a significant amount of DSM investment through equity financing and/or re-investment of revenue and profits from their customer base into DSM program investment.

It can be concluded that across all industries and over time there is a strong correlation between the macroeconomic indicators studied with the exception of interest rates. The strength and direction of the correlation is quite strong (R square 0.85 to 0.99) regardless of the region in Canada or the USA. This regional consistency is likely due to industrial DSM participants' size, global industrial competition and close integration of the US and Canadian economies.

At the Ontario industry sector level, there is great consistency in the relative importance of GDP and Sales & Shipments as a positive correlation to industrial energy efficiency. The strength and even direction of the correlation for all other macroeconomic variables is not consistent for every industrial sector model. One reason for this may be that although the initial assumptions hold true over the larger data set for all industries over time, they are less applicable at the specific industry level. In fact we have done some subsequent analysis of actual annual energy efficiencies for various specific industries and found that the actual energy efficiency component as a percentage of annual energy use can vary significantly from one year to another.

Overall manufacturing utilization has a moderate relationship to DSM program participation and energy efficiency. The relationship may not be as strong due to the fact that many commodities industries will try to maintain maximum utilization even during times when prices and demand are low.

Manufacturing investment and energy prices should not be ignored. The statistical relationship between manufacturing investment and DSM performance and energy efficiency was not as strong or consistent as for GDP and Manufacturing Sales/Shipments. We do not believe that Manufacturing Investment should be overlooked in favor of these variables though. The statistical relationship may be hidden by a time lag between the actual investment expenditure and the final commissioning of the investment and subsequent realization of energy savings. For many projects this time lag can be a year or more. The business case is clearly strong for industry to make investments in energy efficiency most at times when their spending on new and upgraded equipment is highest.

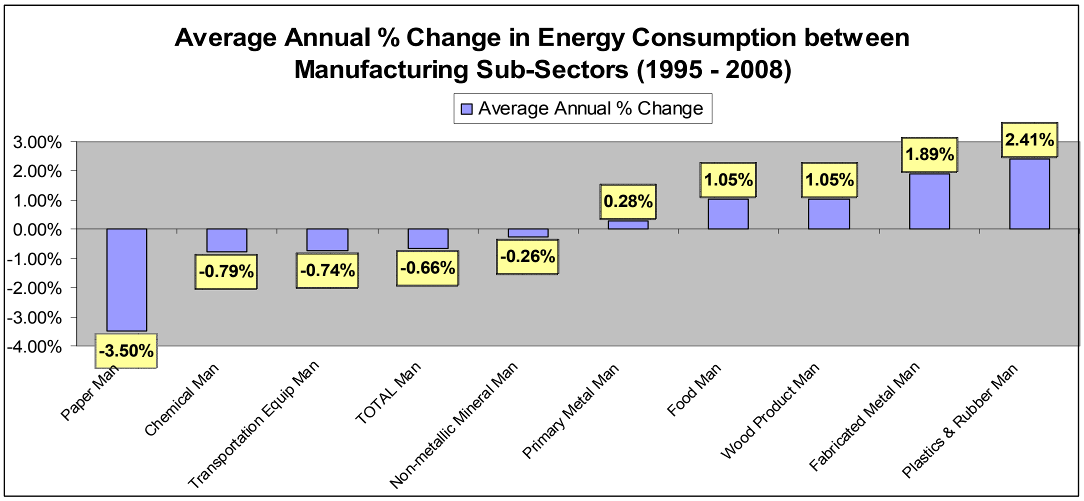
Similarly the financial benefits from energy efficiency logically increase as energy prices increase. Firms should be more interested in DSM program participation at times when energy prices are high. This is supported by a moderate relationship in our regression analysis. The relationship may not be as strong as expected due to competition for limited capital and lack of qualified resources to identify and implement DSM measures within organizations. GDP and

Manufacturing Sales/Shipments seem to have a stronger relationship because they relate more closely to the high points in the business cycle where availability of capital and resources is likely to be the greatest.

Equating changes in Ontario energy use with potential changes in DSM participation was a useful starting point but has limitations. The correlations for industry sector energy efficiency and energy use are counter-intuitively negative until it is considered that energy efficiency in this study was assumed to be a constant 2% of total energy use. High energy prices will put strong downward pressure on total absolute energy use as firms attempt to reduce costs. The assumption that energy efficiency is a constant proportion of total energy use does not appear to hold well when modeling for energy prices.

More work is needed at the industry sector level. Figure 3 below shows the average annual change in energy consumption between specific manufacturing sub-sectors in Ontario from 1995 to 2008.

Figure 3 – Average Annual % Change in Energy Consumption by Industry



This clearly shows that over the same period some industries reduced their energy consumption while others experienced an increase in energy use. This trend combined with the observed differences between industrial sector regression model results suggests that there are significant differences in trends between industrial sub-sectors.

Implications. Economic Cycles have shown to be major impacts on DSM program performance. DSM program planner should look into increasing investment in program promotional resources to take advantage of the increased favorability to investment in energy efficiency.

Conversely DSM program planners should consider scaling back on promotional activities going into economic downturns. In a downturn these resources may not yield as strong a return on investment as if the funds were conserved for more favorable periods in the economic cycle.

In an economic downturn the results of this study may also provide a defense for maintaining a minimum level of DSM program activity. Program participation may decrease but these results demonstrate that participation should increase again as the economy recovers. As a result the DSM program manager will want to maintain a market presence in order to take advantage of the next market recovery.

The DSM planner should exercise caution in using macro-economic inputs to guide investment in program incentive levels. While it seems likely that increasing incentives during an economic boom would increase participation, it is equally likely to increase the risk of free-ridership. As the economy improves, companies become more likely to consider investments that would have been rejected during a recession. As a result, during an economic boom, the increased investment in energy efficiency may be difficult to attribute to higher incentive levels.

One strategy for the DSM planner to consider during an economic boom might be to shift some investment out of incentive payments (to help control free-rider risks as companies relax their criteria for project acceptance) and into program outreach or marketing activities (to maximize the natural trend to increased participation in a strengthening economy). The practicality of shifting funds will depend highly on the particular DSM program design and local market conditions.

Next steps. Time series energy intensity data for Canadian industries has recently been obtained and can be used to separate more accurate trends in energy efficiency at the industry sector level. Further analysis is required to quantify these trends.

Until then it can be concluded that in aggregate, macroeconomic factors are a major influencer of DSM program participation and trends in GDP and Manufacturing Sales & Shipments have the strongest overall effect.

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