# The Effects of Governmental Energy Efficiency Activities on Electricity Consumption: An Econometric Analysis

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Activities = Direct or Indirect Programs which promote EE

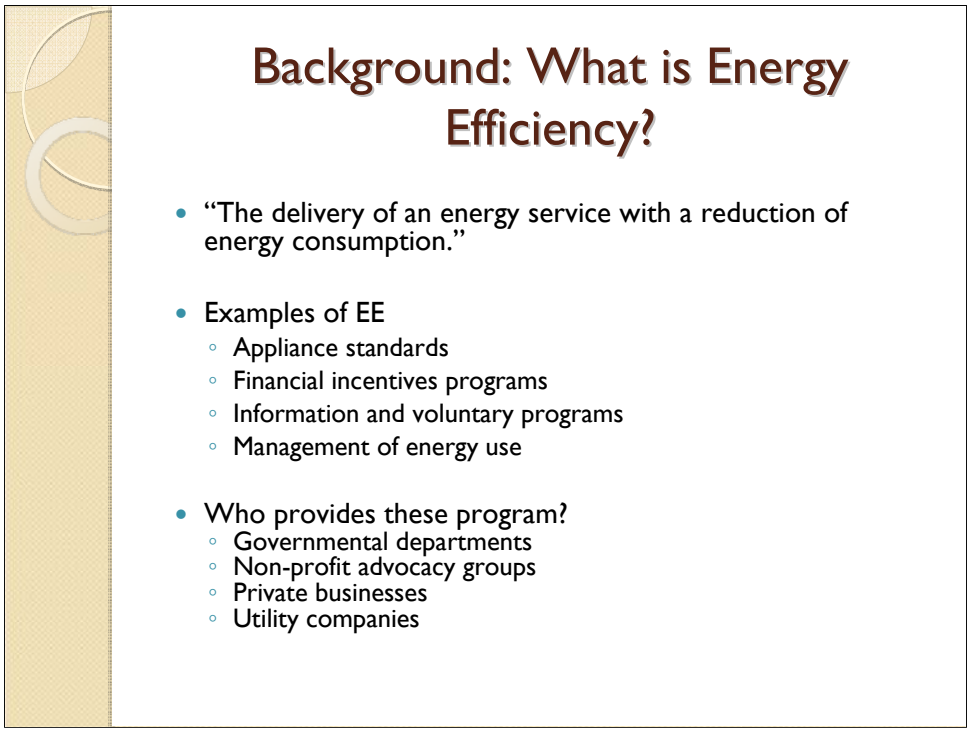
# Agenda

- Background Discussion on Energy Efficiency
- Discuss this Study
  - Analytical Framework
  - Data Used
  - Caveats
  - Conclusions

## Background: Growing Energy Demand in Canada

- Electricity demand in Canada is growing at a rapid pace.
- This growth creates externalities:
  - Greenhouse gas and other pollutants
  - Higher energy prices
  - Costly expansion of capacity and transmission infrastructure

**ENERGY DEMAND**
Larger homes, more electronic devices, industrial production growth, and a booming building sector.
Between 1990 and 2003, demand grew by 22 percent.

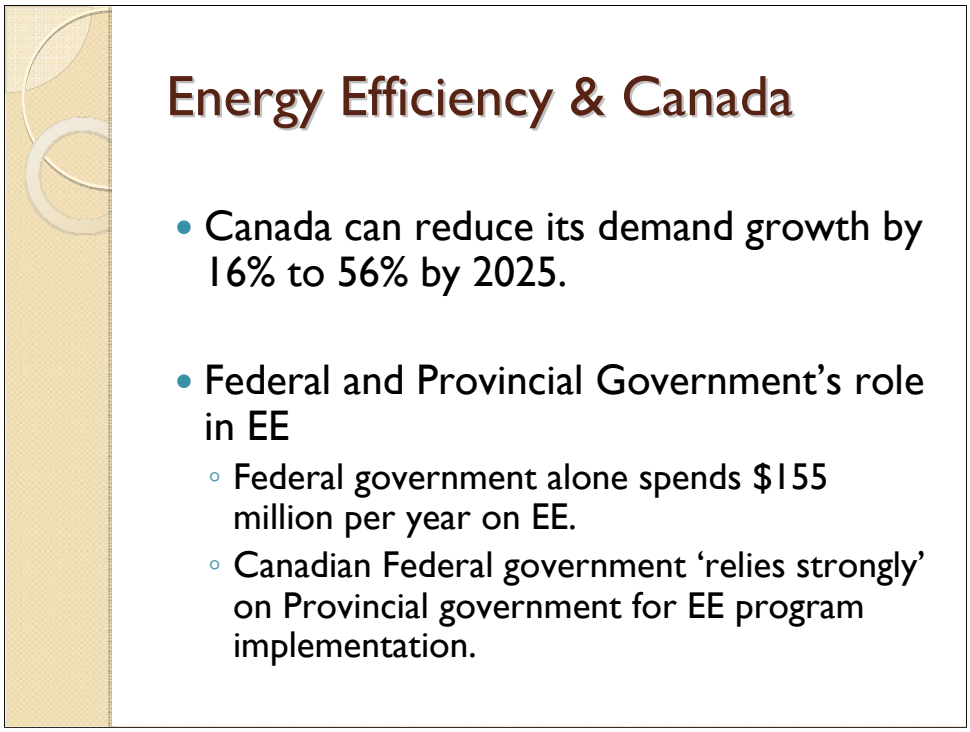



**THE DELIVERY**

Amulya Reddy "Barriers To Improvements In Energy Efficiency."

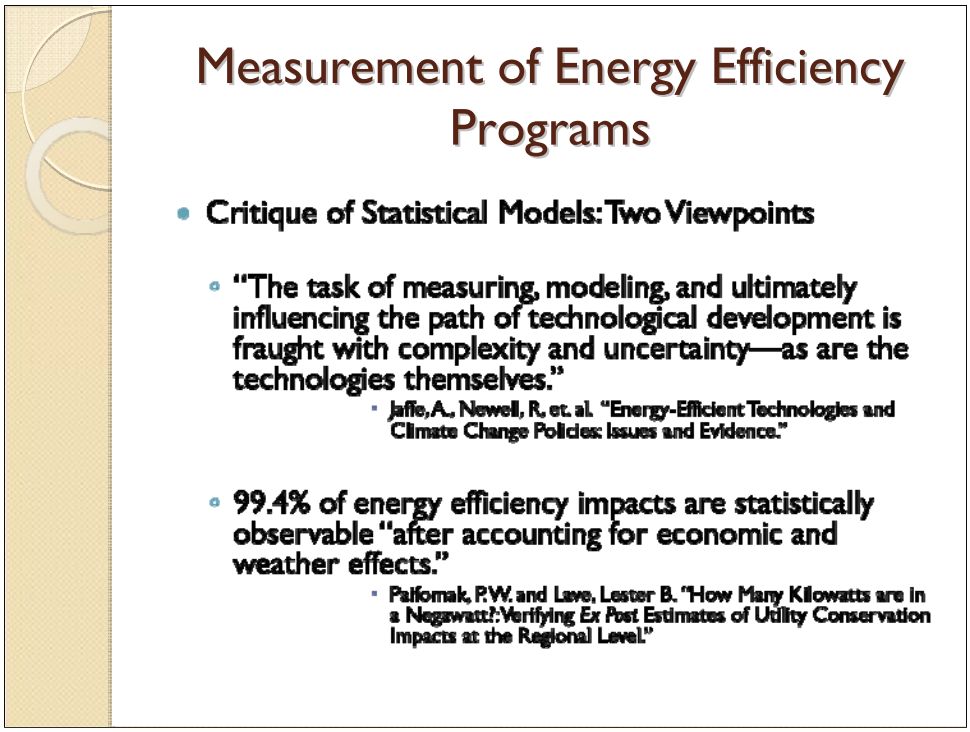
**WHO PROVIDES?**

All sectors with an interest in the delivery and consumption of energy.




**CANADA CAN REDUCE**
(Canadian Gas Association)

**FEDERAL AND PROVINCIAL**
History suggests that the Canadian federal and provincial governments will implement a large portion of any future EE programs.




**Engineering**
engineering analysis may be unrealistic due to the amount and scope of variables

**Stat Models**
Holds constant various factors that affect energy consumption in order to isolate
Complexity and uncertainty are due to data availability and correct model specification
It can also be extremely difficult to measure energy efficiency over time or between countries or sectors.

99.4%
This study controls for such impacts

# Analytical Framework

$$TE_{it} = f(PE_{it}, FE_t, EP_{it}, GD_{it}, UE_{it}, NG_{it}, CD_{it}, HD_{it})$$

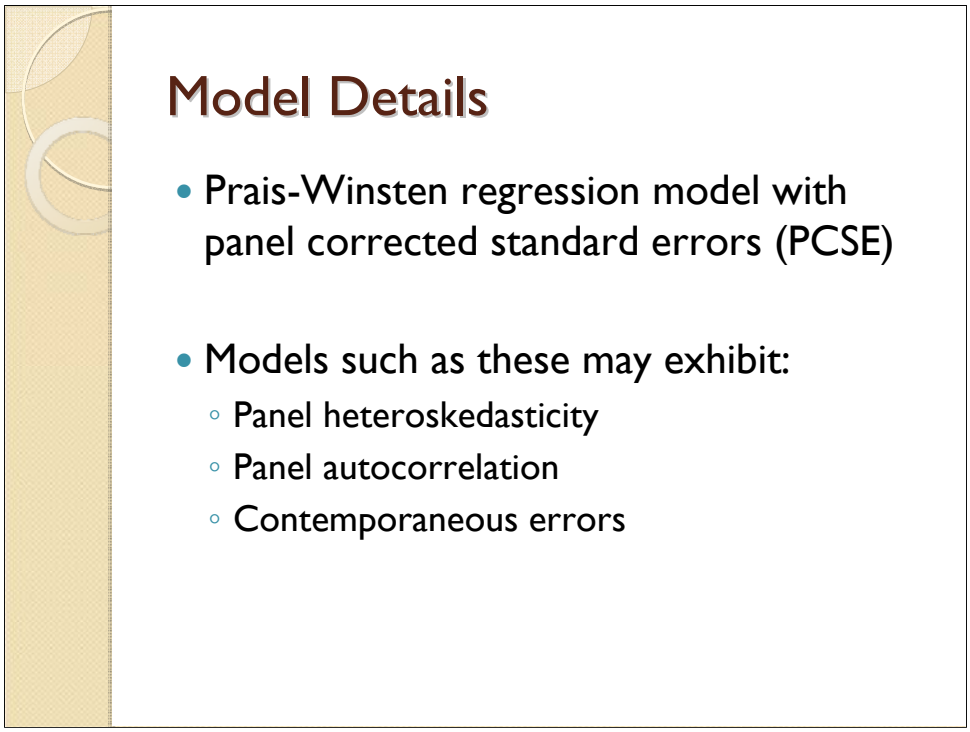
TE = Provincial Total Consumed Electricity (ln)
PE = Provincial Energy Efficiency Score (ln)*
FE = Federal Energy Efficiency Score (ln)*
EP = Average Provincial Electricity Price (ln)
GD = Provincial Gross Domestic Product (ln)
UE = Total Provincial Utility Expenditures in Energy Efficiency Programs (ln)
NG = Provincial Natural Gas Sales by Thousands of Cubic Meters (ln)
CD = Average Monthly Total Cooling Days per Capita (ln)
HD = Average Monthly Total Cooling Days per Capita (ln)
(From 1999-2005)

To determine the effects of Canadian provincial and federal government energy efficiency efforts on provincial electricity consumption

Panel level statistical model 1999 – 2005

Other recent studies have used a similar econometric analysis to evaluate energy efficiency efforts, including Berry (2008) and Horowitz (2007).

Total consumed electricity is the total electricity generated in the province, plus the total receipts (electricity received from other states or countries), minus the total deliveries (energy sent to other provinces or countries). This number provides an accurate measure of the total electricity consumed in the province during the period. This data was provided by Statistics Canada. (Table 127-0001)




Traditionally, a generalized least squares (GLS) model has been used for such panel analyses, to correct autocorrelation in time series.

However, more panels than time series, which rules out GLS. (Beck, 637)

Beck, N. and J. N. Katz. "What to do (and not to do) with time-series cross-section data." *American Political Science Review* 89

**PRAIS WINSTEN**

Instead, Prais-Winsten regression model with panel corrected standard errors (PCSE).

Similar estimates and is more efficient and consistent estimates. . (Beck, 637)

**MODELS:**

The statistical program STATA has various routines which tests for these errors.

These errors were tested for and, if necessary, corrected for in the modeling process.

Panel level heteroskedasticity - modified Wald test.

Autocorrelation - Wooldridge test for autocorrelation in panel data.

Contemporaneous errors - Breusch-Pagan Lagrange Modifier test for independence.

# Geographic Area Considered

- Provinces: Alberta, British Columbia, Manitoba, Ontario, Quebec, and Saskatchewan.


This study considered data from the provinces of Alberta, British Columbia, Manitoba, Ontario, Quebec, and Saskatchewan.

The other four Canadian provinces were dropped because of the unavailability of the data for one or more of the parameters in the model.

This is not particularly troublesome

According to the author's calculation, from Stats Canada, the six territories 92.5% of the Canadian population.

| | Model 1 | Model 2 (ln PE & FE) |
|---|---|---|
| Provincial Total Consumed Energy (Dependent Variable) | Change in Total Electricity Consumed (ln) | Change in Total Electricity Consumed (ln) |
| Constant | 7.00 (9.90)* | 6.970 (6.37)* |
| Provincial Energy Efficiency Score | -.0291 (-2.09)* | -.0590 (-1.67)* |
| Federal Energy Efficiency Score | 0.00989 (0.37) | -.00215 (-0.01) |
| Provincial GPD | 0.9764(14.06)* | 0.973 (11.67)* |
| Total Provincial Utility Expenditures in EE programs | -.0689 (-10.53)* | -.0683 (-8.10)* |
| Provincial Natural Gas Sales (Thousands of Cubic Meters) | -.650 (-11.69)* | -.642 (-9.83)* |
| Average Monthly Total Heating Days / Population | .734 (11.45)* | .734 (8.51)* |
| Average Monthly Total Cooling Days / Population | -.0325 (-1.98)* | -.033 (-1.64) |
| Average Provincial Electricity Price | -.900 (-10.83)* | -.885 (-9.06)* |
| Number of Observations | 41 | 39*** |
| R Squared | ** | ** |

strong correlation between provincial governmental energy efficiency efforts and a decline in provincial energy usage in Canada.

**Two models:**

The reasoning behind two models - ambiguity inherent in the scorecard measurement.

Model 1: interpreted the grades as a change in energy efficiency efforts, and therefore made no transformation.

Model 2 assumed cumulative yearly performance grading, and therefore measured the change in scorecard grades using a natural logarithm transformation.

What do they suggest?

natural logarithm transformation appropriate - regular model would correlate the natural growth of the variables - bias the model.

This transformation is repeated in other similar econometric studies.

**RESULTS**

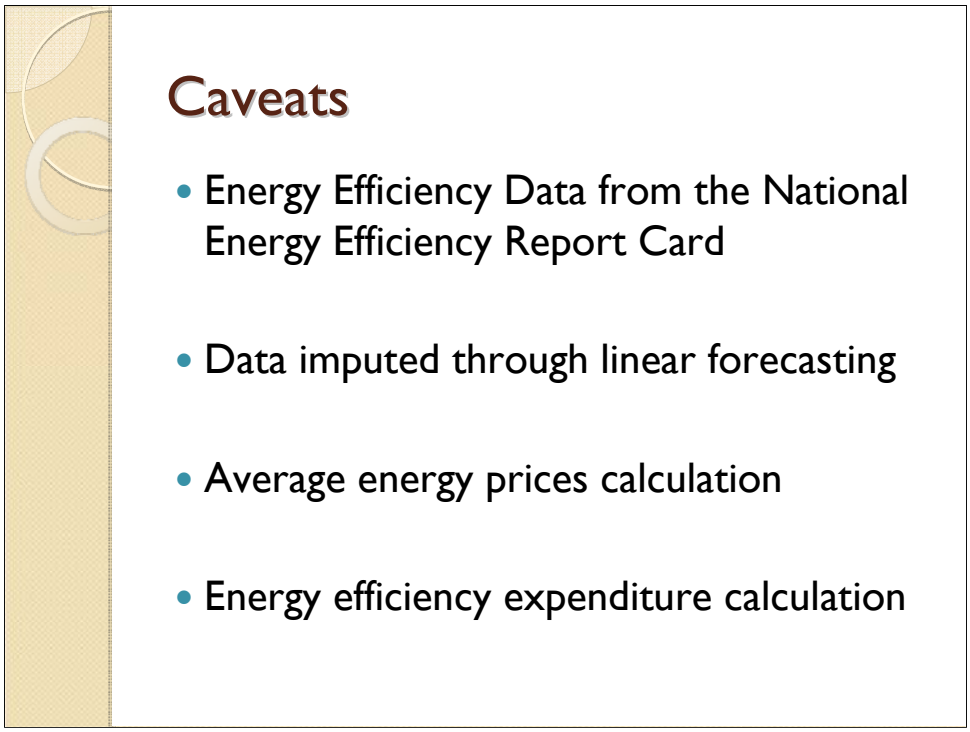
Provincial and Federal Significant?

federal grades themselves that the model cannot effectively capture the influence of the Canadian federal government activities.

All of the other parameters were significant and conformed to theory as delimited in the previous section. Discuss All

**BOTTOM OF GRAPH**

Z-scores- * 10% sig R^2 was not provided because of the nature. 2 less observations in model, due to natural log




**National Energy Efficiency Report Card**

No in depth explanation of the grading methodology. It also 'evolves' its grading on a yearly basis. (May bias the model)

"As such, the Year Six Report Card incorporates a more in-depth review of partnership roles in the delivery of public outreach and action-based programs."

**DATA**

imputed through linear forecasting. Because need to conserve degrees of freedom – may bias the model, overly efficient.

year 2003 in the scorecard, four data points in the energy pricing data, and two points in the utility prices calculations.

**AVERAGE ENERGY**

Without data from a centralized agency, average provincial price was assumed based on the utility data that was available.

assumption that the change in variance in electricity prices varies little from the available utility data.

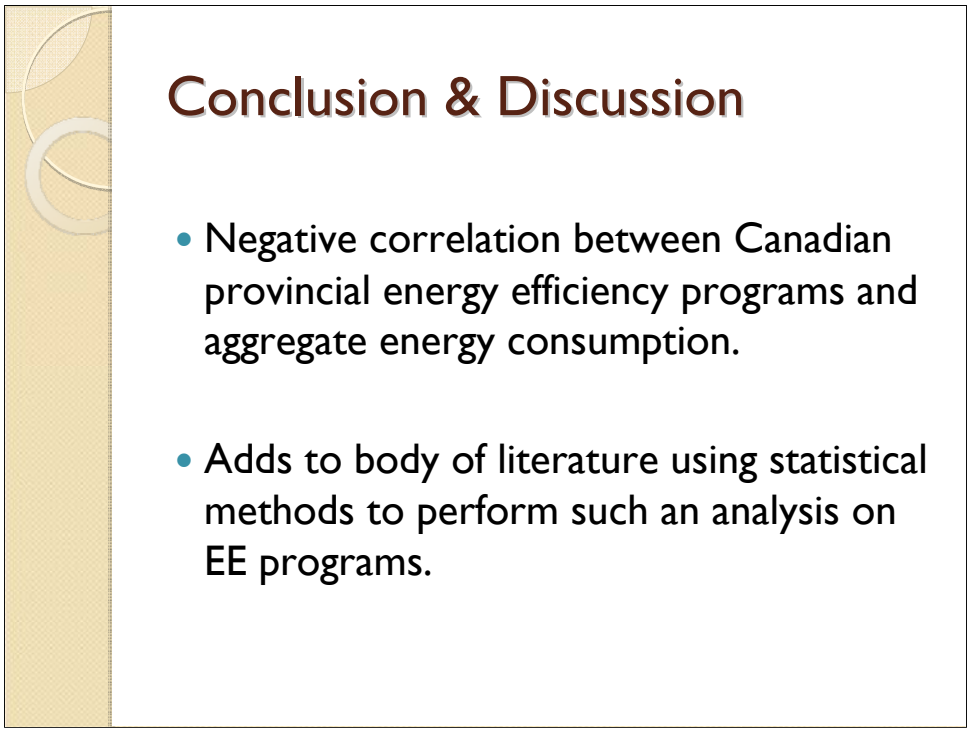
province like Quebec, representative of 94% of its population. What about utilities with less a percentage?

**ENERGY EFFICIENCY**

The same problem arose for the calculation of energy efficiency expenditures.

Difficult to locate, contact the utilities directly.

Then, based on their ratio of utility customers to total provincial population…




**Conclusion**

**NEGATIVE**

It furthers suggests that energy efficiency programs have a significant negative effect on electricity consumption

Without caveats this study could more effectively assess the relationship between energy efficiency programs and electricity consumption.

**ADDS**

This study adds to the growing body of literature - macro investment in energy efficiency programs does lead to electricity demand reduction

But other analyses, including cost-benefit analyses, may be needed - energy efficiency programs have positive net impact on society.