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Do Canadian Food Processing and Beverage and Tobacco Industries Minimize Average Costs?

Presentation to SPAA Workshop

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March 8, 2013

Canada

Why might we be concerned if average costs are not minimized?

- A large average cost “gap” may imply there that existing production technologies could be utilized more efficiently.

- Rapid changes in input prices may challenge the ability to minimize average costs

- There may be a relation between an average cost gap and incentives to invest/disinvest in capital stock.

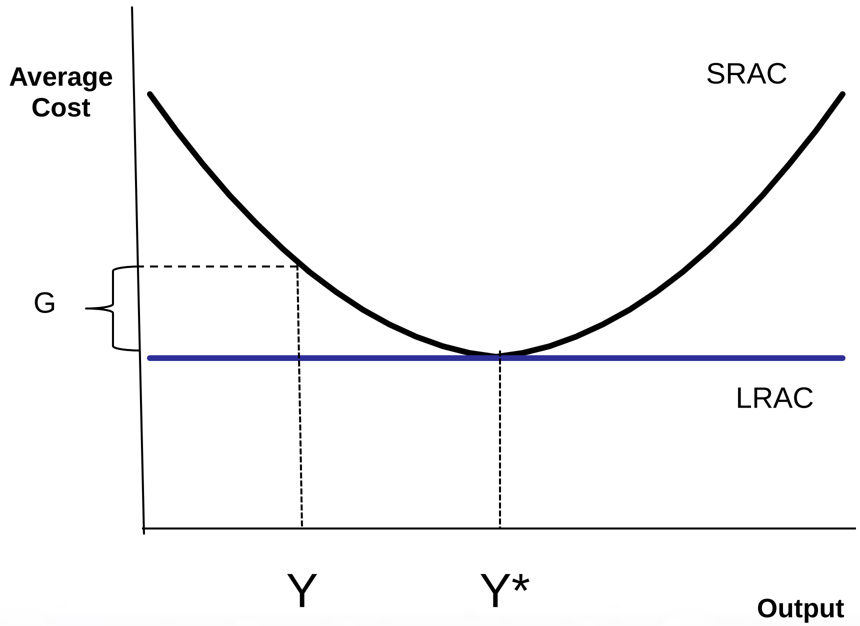
- A gap may also have implications for Canadian industry competitiveness.

Capacity Utilization as an Indirect Measure of the Average Cost Minimization

- Assume industries minimize average costs under the constraint of fixed capital inputs
- Also assume industries compensate for this through their decisions over levels of other inputs (ie, labour and intermediate inputs) to meet demanded levels of output.
- Then there may be a gap between actual average costs and their theoretical minimum levels. Minimum average costs are defined in the long run when all inputs, including capital, are free to vary.
- There are levels of output associated with actual average costs and theoretical minimums
- The ratio of actual output to optimal output gives an indirect measure of the average cost gap. This measure is referred to as Capacity Utilization

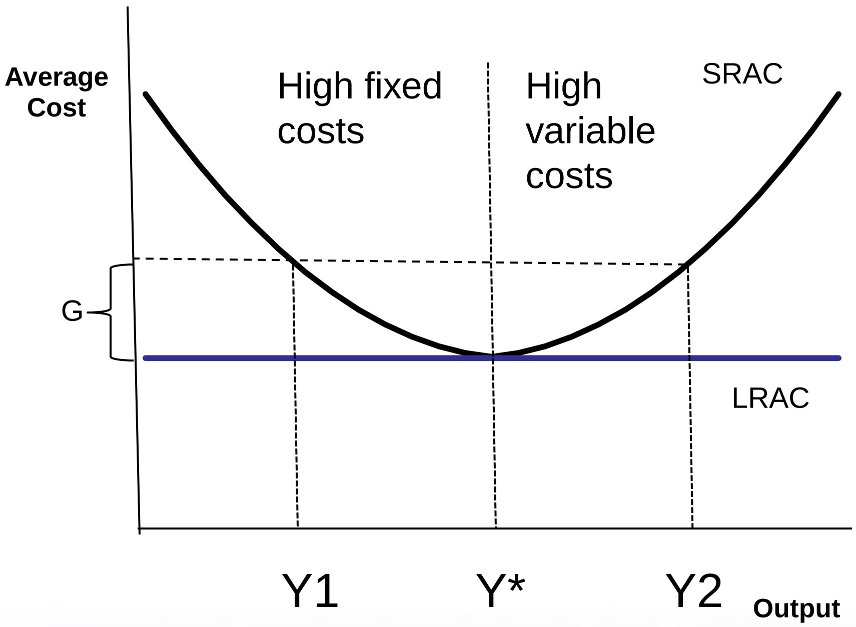
Defining Capacity Utilization

- Under assumption of long-run constant returns to scale (CRTS), LRAC curve is a straight line.
  - Minimum point on SRAC curve is also the point of tangency with LRAC curve
- CU=Y/Y* implies average costs are $G above minimum level.
- This definition comes at the expense of a more general picture between cost and scale



Determining Reasons for Average Cost Gap

- When CU<1 (Y<Y*), higher fixed costs of capital more than offset lower variable costs
  - Incentives to shed capital to lower average costs
  - Shedding capital shifts SRAC curve to the left to Y1
- When CU>1 (eg. Y>Y*), higher variable costs more than offset lower fixed costs of capital
  - Incentives to invest in capital to lower average costs
  - Investing in capital shifts SRAC right to Y2



Measurement Strategy

- Specify industry-level variable cost function which treats capital as a quasi-fixed input (Eg, Berndt and Hesse, 1986).
  - Also specify variable input cost share equations and other equations representing cost-minimizing optimization behavior.
  - These equations share same parameters as variable cost function.

- Estimate system using Seemingly Unrelated Regressions (SUR)

- Use estimated parameters to derive optimal levels of output using numerical methods. Capacity utilization is ratio of observed output to optimal output

- With proper restrictions in place, we can relate capacity utilization to the average cost scenario presented in previous slides

Estimation Procedure

- The short-run cost function includes prices of variable inputs labour (P_L) and intermediates (P_I), levels of fixed capital (K), levels of output (Y) and time (t):

$$lnVC = \alpha_o + \alpha_Y lnY + \alpha_L lnP_L + \alpha_I lnP_I + \beta_K lnK + \alpha_t t + 0.5\alpha_{tt} t^2 + 0.5\gamma_{yy}(lnY)^2 + 0.5\gamma_{LL}(lnP_L)^2 + \gamma_{LI} lnP_L lnP_I + 0.5\gamma_{II}(lnP_I)^2 + 0.5\gamma_{KK}(lnK)^2 + \rho_{YL} lnY lnP_L + \rho_{YI} lnY lnP_I + \rho_{YK} lnY lnK + \rho_{KL} lnK lnP_L + \rho_{KI} lnK lnP_I + \rho_{tY} t lnY + \rho_{tK} t lnK + \rho_{tL} t lnP_L + \rho_{tI} t lnP_I$$

- Input demand equations use same parameters and increase degrees of freedom:

$$\frac{P_L L}{VC} = \alpha_L + \gamma_{LL} lnP_L + \gamma_{LI} lnP_I + \rho_{YL} lnY + \rho_{KL} lnK + \rho_{tL} t$$

- Restrictions to ensure:
  - homogeneity of degree one in prices (eg: $\alpha_L + \alpha_I = 1$)
  - long-run constant returns to scale (eg: $\alpha_Y + \beta_K = 1$) ←Flat LRAC curve

Estimation Procedure

- The cost function parameters can also be used in the estimation of a “shadow value” equation for capital:
  - $\frac{-R_K K}{VC} = \beta_K + \gamma_{KK} lnK + + \rho_{YK} lnY + \rho_{KL} lnP_L + \rho_{KI} lnP_I + \rho_{tK} t < 0$

Where,

- -$R_K K = P_Y Y - VC$ is the gross operating surplus, the best industry can do in the short run
- The shadow price, R_K, is negative because it indicates the potential reduction in variable costs from an increase in the level of capital.

Determining Cost Minimizing Level of Output (Y*)

- After estimation, rearranging the shadow value equation gives a value for the shadow price:
  - $-R_K = \frac{VC(Y)}{K}(\beta_K + \gamma_{KK} lnK + +\rho_{YK} lnY + \rho_{KL} lnP_L + \rho_{KI} lnP_I + \rho_{tK} t)$ (A)

- Under CRTS, in a long-run equilibrium, the user cost of capital, P_k, coincides with the shadow value of capital, such that:
  - $P_k = -R_K$

- Search for an optimal level of output, Y*, in (A) such that $P_k = -R_K$.

- Y* is defined by the point where the horizontal LRAC curve and the SRAC curve are tangent

Data and Construction of Variables

- Data on Canadian food processing and beverage and tobacco processing are obtained from Statistics Canada's Canadian Productivity Accounts

- Published industry-level variables include nominal values and quantity indexes for:
  - Gross output (all produced output: sales, intermediate inputs and inventories)
  - Capital services (aggregated stocks of productive capital weighted by user costs)
  - Labour services (aggregation of multiple types of workers)
  - Intermediate inputs (aggregation of energy, materials and services)

- Implicit price indexes for variable inputs are constructed by dividing the total value of the variable by the relevant quantity indexes.
- Data on Canadian and US aggregated FBT industries are obtained from WorldKLEMS database
  - Some methodological differences

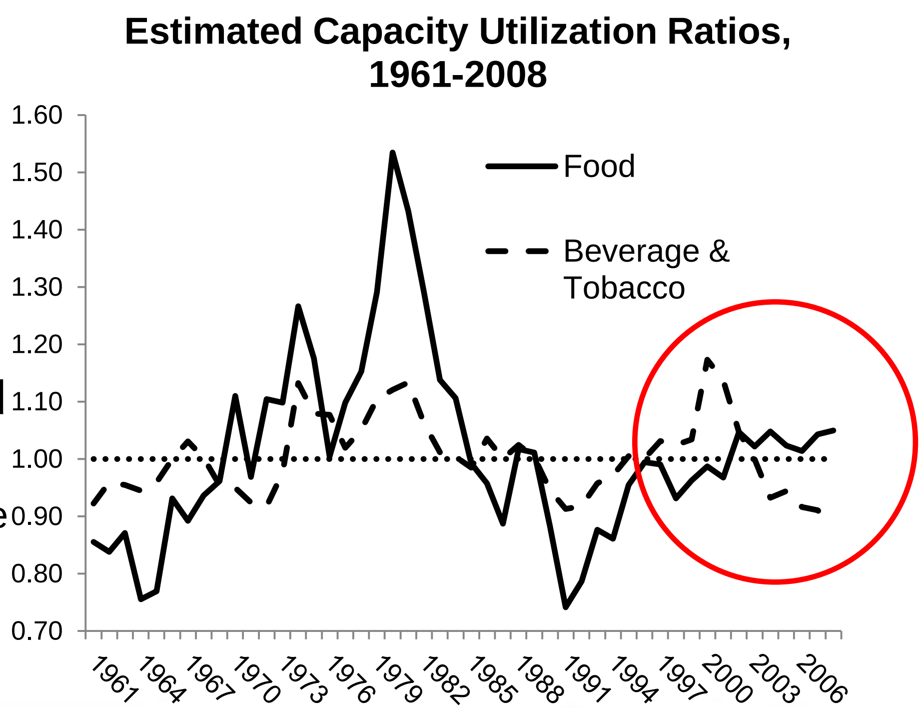
Estimated Parameters

Canada Food			Canada Beverage and Tobacco		
Parameter	**Estimate**	**T-Stat.**	**Parameter**	**Estimate**	**T-Stat.**
Constant	0.8809	31.7280	**Constant**	0.8793	14.1990
PL	0.4422	19.5050	**PL**	0.3387	6.9877
PI	0.5578	24.6020	**PI**	0.6614	13.6460
T	-0.0083	-13.9750	**T**	-0.0070	-3.2388
Y	1.0633	37.0110	**Y**	0.9863	17.0370
K	-0.0633	-2.2044	**K**	0.0137	0.2375
PLPL	0.1151	11.9990	**PLPL**	0.0703	3.3728
PLPI	-0.1151	-11.9990	**PLPI**	-0.0703	-3.3728
PLT	-0.0020	-12.1370	**PLT**	-0.0007	-1.5361
PLY	-0.0053	-0.4284	**PLY**	-0.1967	-11.6170
PLK	0.0053	0.4284	**PLK**	0.1967	11.6170
PIPI	0.1151	11.9990	**PIPI**	0.0703	3.3729
PIT	0.0020	12.1370	**PIT**	0.0007	1.5361
PIY	0.0053	0.4284	**PIY**	0.1967	11.6170
PIK	-0.0053	-0.4284	**PIK**	-0.1967	-11.6170
KT	-0.0019	-8.1223	**KT**	-0.0050	-5.4663
KY	0.0261	0.7090	**KY**	-0.3105	-3.6498
KK	-0.0261	-0.7090	**KK**	0.3105	3.6498
TT	0.0001	5.7917	**TT**	0.0001	1.0373
TY	0.0019	8.1223	**TY**	0.0050	5.4663
YY	-0.0261	-0.7090	**YY**	0.3105	3.6498
VC	R-Squared	0.9997	**VC**	R-Squared	0.9974
L	R-Squared	0.6161	**L**	R-Squared	0.8885
K	R-Squared	0.7824	**K**	R-Squared	0.6530

Estimated Measures of Capacity Utilization for Canadian Industries

- From mid 1990s, food processing capacity utilization remained close to one, suggesting average costs are being minimized.

- Capacity utilization for beverage and tobacco declined over a period of five years to 0.88 in 2008.
  - Fixed costs may have been high relative to average variable costs.
  - Persistence may also suggest that incentives exist for the industry to shed capital.

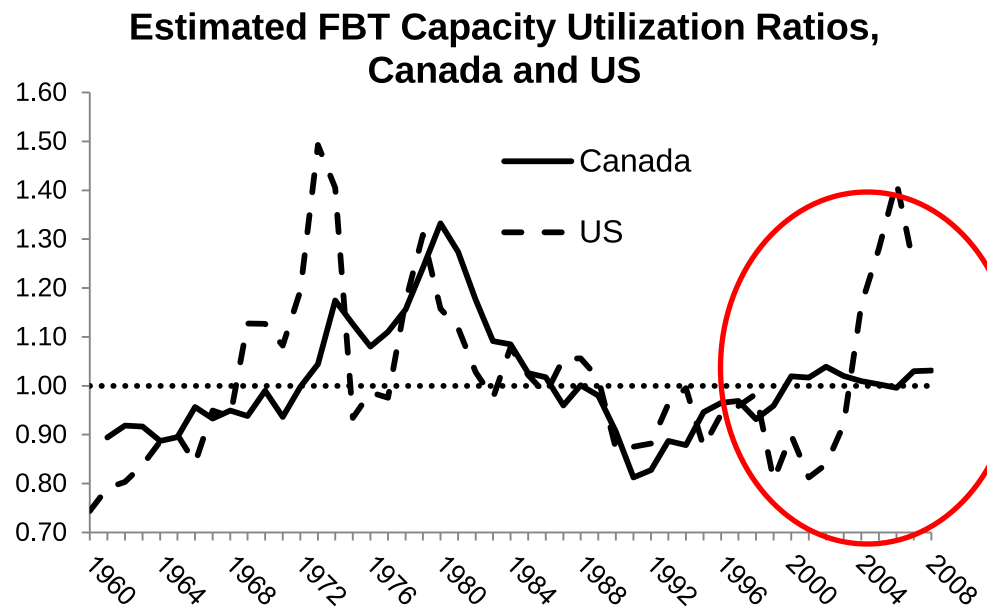


Estimated Parameters

Canada FBT			US FBT		
Parameter	**Estimate**	**T-Stat.**	**Parameter**	**Estimate**	**T-Stat.**
Constant	0.8479	35.3960	**Constant**	0.7196	20.5800
PL	0.4569	20.4710	**PL**	0.3346	11.4800
PI	0.5431	24.3340	**PI**	0.6655	22.8300
T	-0.0105	-15.9660	**T**	-0.0078	-8.2500
Y	1.0448	46.1630	**Y**	1.1357	54.6600
K	-0.0448	-1.9787	**K**	-0.1357	-6.5300
PLPL	0.1224	11.2190	**PLPL**	0.0858	6.5720
PLPI	-0.1224	-11.2190	**PLPI**	-0.0858	-6.5720
PLT	-0.0028	-13.8620	**PLT**	-0.0012	-5.7970
PLY	-0.0211	-1.9224	**PLY**	0.0336	4.4130
PLK	0.0211	1.9224	**PLK**	-0.0336	-4.4130
PIPI	0.1224	11.2190	**PIPI**	0.0858	6.5720
PIT	0.0028	13.8620	**PIT**	0.0012	5.7970
PIY	0.0211	1.9224	**PIY**	-0.0336	-4.4130
PIK	-0.0211	-1.9224	**PIK**	0.0336	4.4130
KT	-0.0028	-8.0660	**KT**	-0.0016	-3.7770
KY	-0.0350	-1.0336	**KY**	0.0127	0.6006
KK	0.0350	1.0335	**KK**	-0.0127	-0.6006
TT	0.0002	8.3453	**TT**	0.0002	7.8210
TY	0.0028	8.0661	**TY**	0.0016	3.7770
YY	0.0350	1.0336	**YY**	-0.0127	-0.6006
VC	R-Squared	0.9996	**VC**	R-Squared	0.9996
L	R-Squared	0.7658	**L**	R-Squared	0.5866
K	R-Squared	0.6936	**K**	R-Squared	0.7990

Estimated Capacity Utilization Measures for Canadian and US FBT

- CU trends for Canadian and US aggregated food, beverage and tobacco processing were similar until late 1990s
- But from roughly 1998 onwards, the pictures diverge.
- CU suggests US FBT average costs were not minimized due to:
  - High fixed costs in late 1990s-early 2000s
  - High variable costs in mid- to late-2000s



Summary

- Preliminary results suggest that the Canadian food processing industry was relatively cost efficient over 1999-2008.

- Capacity utilization in Canadian beverage and tobacco processing saw a sustained period of decline over the mid-2000s
  - suggests that high fixed costs associated with capital boosted average cost above minimum levels.

- For US FBT, minimum average costs do not appear to have been met, although the reasons differ across various points in the 2000s

Limitations of this Framework and Future Work

- Simply meeting minimum average cost does not necessarily ensure cost competitiveness in relation to industries in other countries.
- Hard to gauge size of gap. A direct measure would take shape of SRAC curve into account.
- With less-aggregated industry (eg, 4-digit NAICS) data, it may be possible to identify industries that have trouble meeting minimum average costs.
- Timeliness is an issue. CPA only runs to 2008. Can Statcan survey-based measures be linked to economic measures of Capacity Utilization?
- Suggesting policy options likely requires more precision in results, possibly starting with refinements to the shadow value equation