Policy-Induced Technical Inefficiency

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Canada's Dairy Policy

- Canada has been implemented supply management policies for milk, chicken, eggs and turkey productions since the late 1960s.

- In the dairy industry, a national production quota is allocated to provincial marketing which are responsible for the marketing of milk within provinces.

- Individual producers must purchase production quotas to be allowed to produce and sell milk. Production quotas are traded on provincial exchanges. Foreign competition is controlled with restrictive TRQs for milk and dairy products.

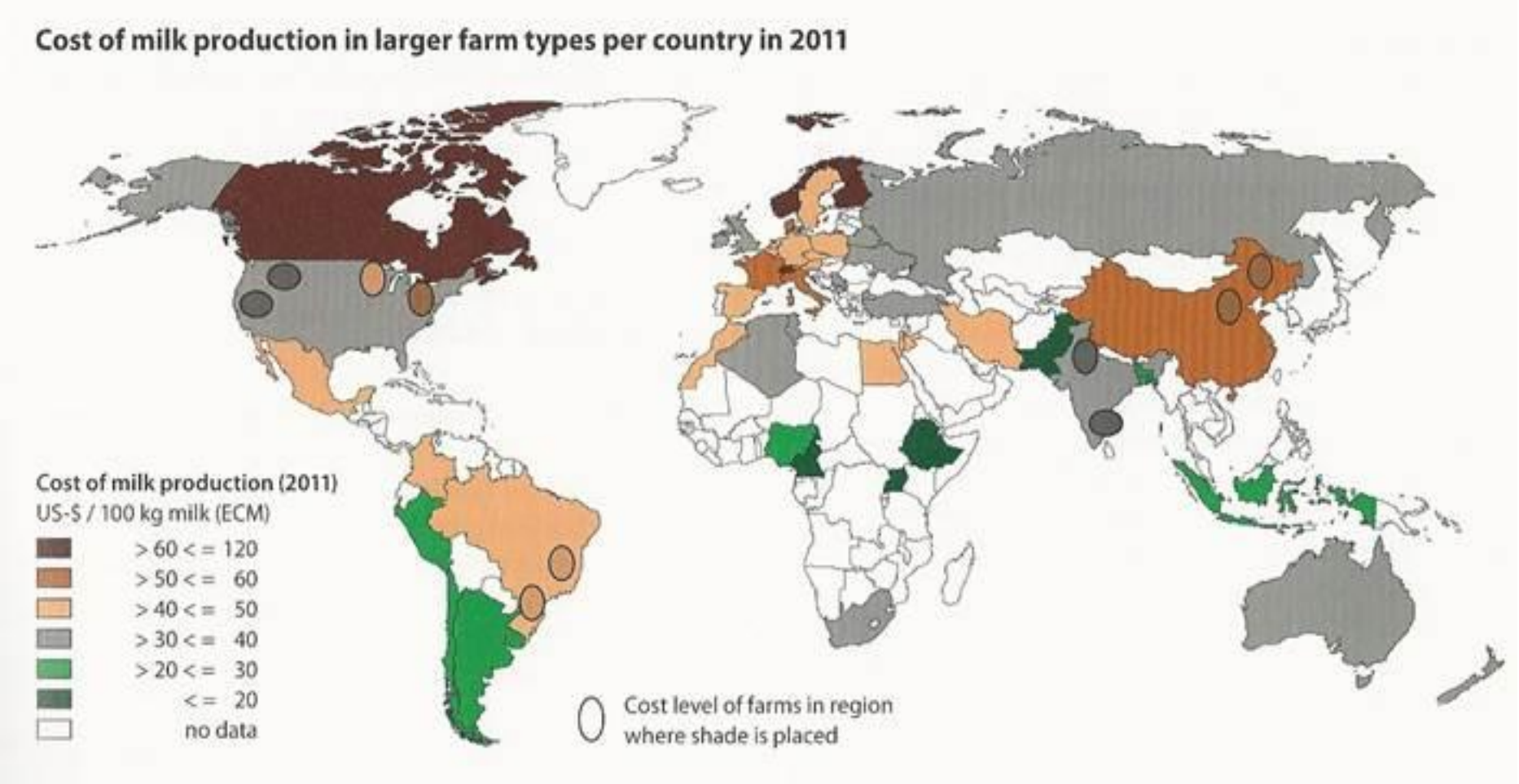
- In the past, Canada has been successful in shielding its dairy industry from regional and multilateral trade liberalization initiatives, but it has agreed to enlarge its cheese TRQ in the negotiations of the Canada-European Union Trade Agreement (CETA). What concessions will be made in the TransPacific Partnership?

Two visions of supply management

- **Margins are high and stable along SM supply chains. As a result, there is a strong consensus within the industry and amongst politicians over SM.**

- **Agricultural economists tend to be critical. Early studies focussed on deadweight losses and the regressive nature of the transfers** (e.g., Loyns, 1974; Barichello, 1981; Veeman, 1982,1988; Van Kooten and Spriggs, 1984; Larue, 1994).
- **Others have focussed on trade liberalization issues** (e.g., Vercammen and Schmitz, 1982; Alston and Spriggs, 1998; Larue et al. 2007; Pouliot and Larue, 2012)**, or regulations** (Felt et al., 2010)**, or on forgone export opportunities** (Carter and Steinbach, 2013).

Canadian milk production costs are high



Canadian Dairy Farms at a Glance

Province	Tie stall		Free stall		Robotic system		Total farms*
	% of farms	Herd size	% of farms	Herd size	% of farms	Herd size	
BC	3.7	56.3	87.4	163.9	8.8	113.0	**300**
AB	9.7	79.7	81.0	148.2	9.2	136.3	**417**
SK	10.9	77.2	82.2	192.8	6.9	144.1	**103**
MB	34.6	78.3	49.2	186.5	16.2	168.7	**191**
ON	68.0	57.4	26.4	127.3	5.6	101.7	**2951**
QC	**88.9**	**54.6**	**6.4**	**112.2**	**4.7**	**98.1**	**4825**
NB	43.3	57.4	51.2	117.1	5.5	72.6	**142**
NS	45.0	54.5	52.3	109.1	2.8	110.3	**142**
PEI	59.1	64.2	37.5	104.0	3.4	194.3	**104**
NL	20.0	103	60.0	161.3	20.0	106.0	**7**
CAN	71.7	-	22.7	-	5.6		**9429**

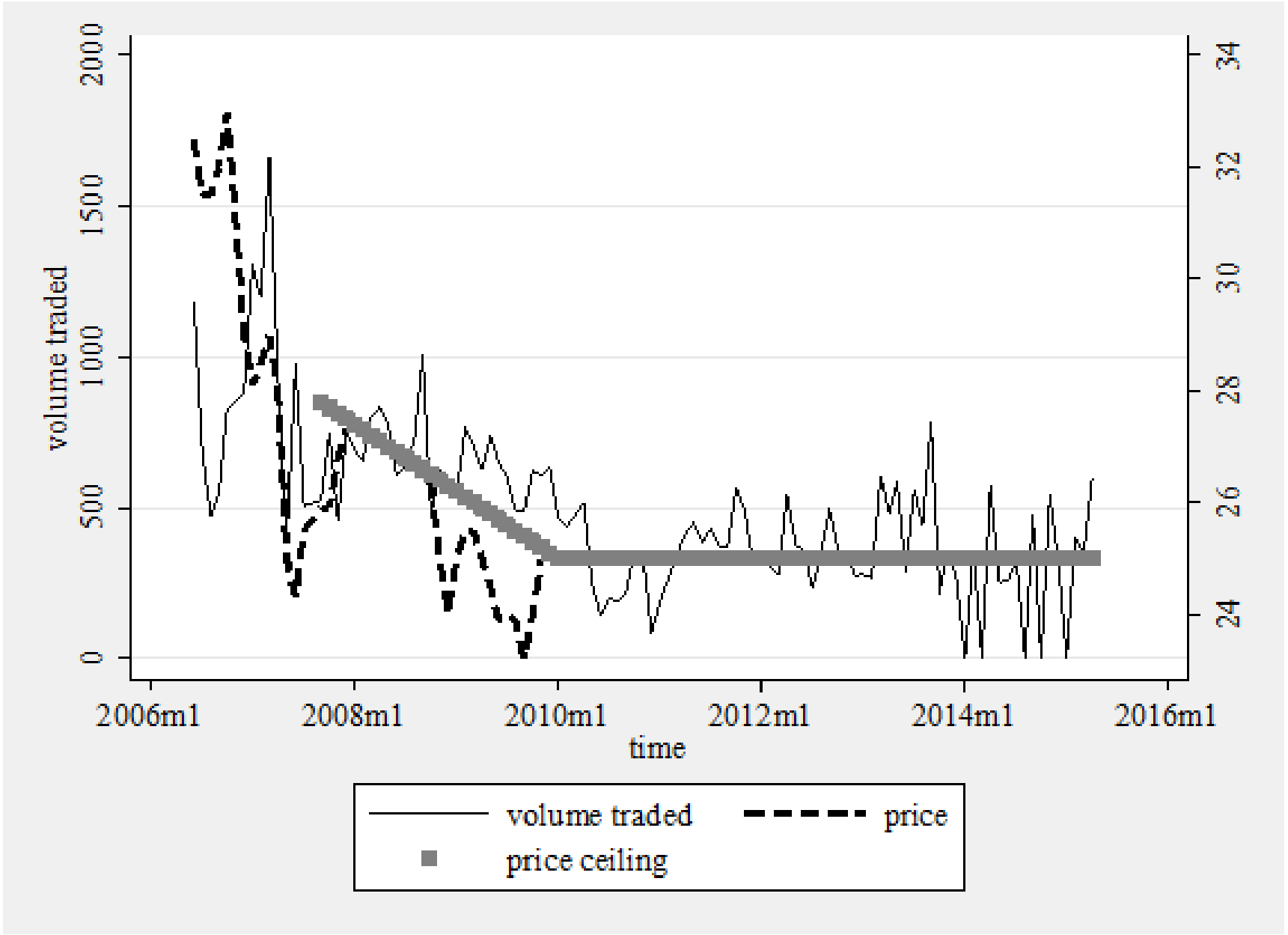
Supply management and farm performance

- **Canadian dairy farms are small, particularly in Quebec and in Ontario.**
- **Several studies have shown that there are economies of scale in dairy production** (Mosheim and Lovell, 2009)**, including in Canada** (Moschini, 1988; Singbo and Larue, 2015)**.**
- **Several studies have shown that Canadian dairy farms operate at very high levels of technical efficiency** (Weersink et al.,1990; Mbaga et al., 2003; Hailu, 2005; and Yélou et al., 2010).
- **Why are QC dairy farms staying small?**

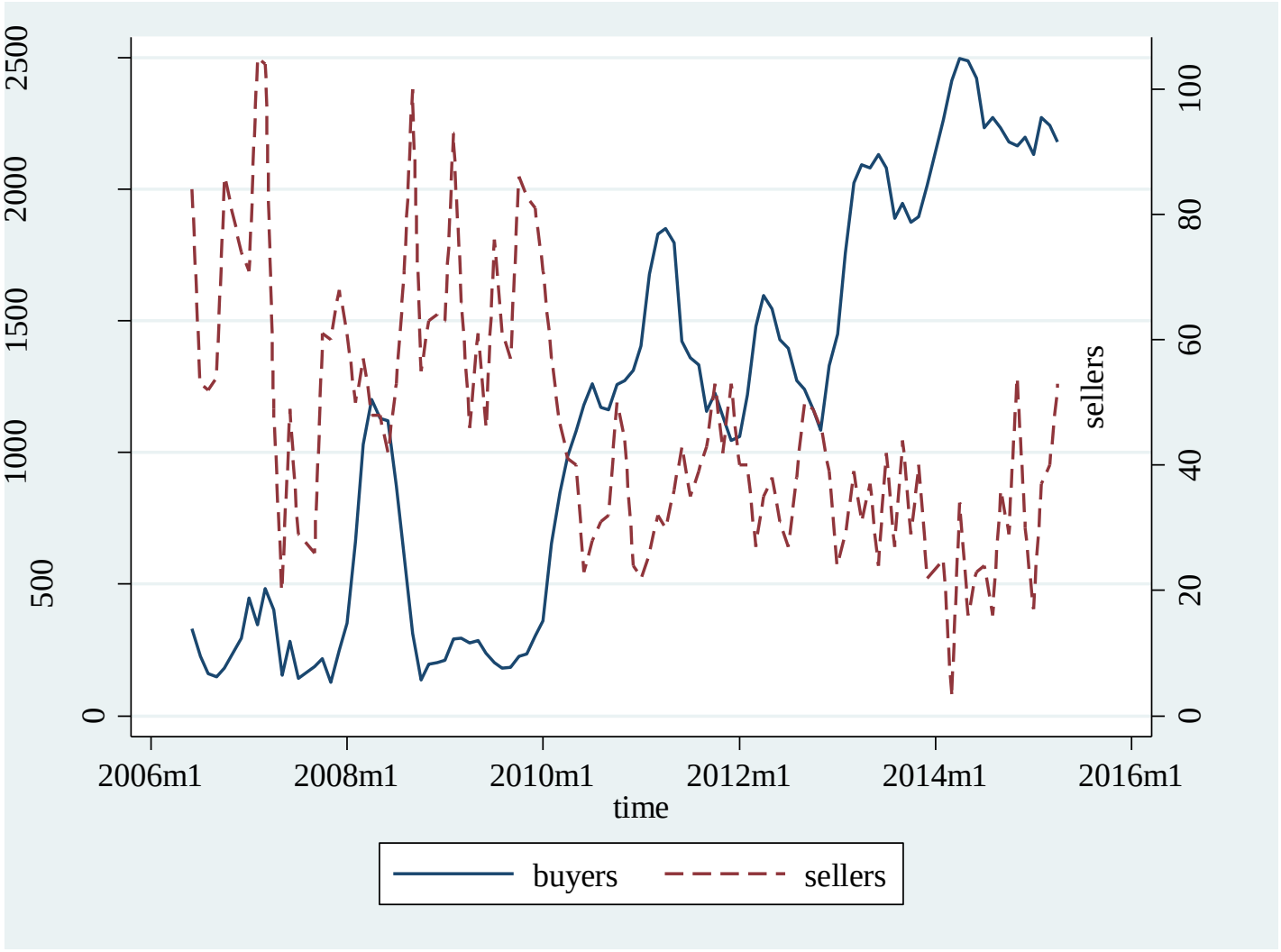
Regulations about the trading of production quotas

- Production quota prices are constrained by a price ceiling;
- Part of the production quota put out for sale is retained by the marketing board for the building of a quota reserve to help beginning farmers;
- Production quotas are tied to locations;
- Production quotas cannot be traded interprovincially.

Production quotas traded and prices in Quebec



Rationing and Expected Rationing



How big a barn? What output per cow?

$n \in (0, \bar{n}]$: # of cows /barn size constraint;

$n\ y_c \in (0, \bar{y}]$: production quota;

$$Max.\Im = pny_c - r_n n - n\sum_{j=1}^{J} r_j x_j + \lambda_1 \left(y_c - f\left(\mathbf{x}\right)\right) + \lambda_2 \left(\bar{n} - n\right) + \lambda_3 \left(\bar{y} - ny_c\right)$$

$$\frac{\partial \Im}{\partial n} = py_c - r_n - \sum_{j=1}^{J} r_j x_j - \lambda_2 - \lambda_3 y_c = 0; n \le \bar{n}$$

$$\frac{\partial \Im}{\partial x_k} = -nr_k - \lambda_1 \frac{\partial f}{\partial x_k} = 0; \text{allocative efficiency}$$

$$\frac{\partial \Im}{\partial y_c} = pn + \lambda_1 - n\lambda_3 = 0$$

If $\lambda_3 > 0, \lambda_2 > 0, n = \bar{n}\ y_c = \bar{y} / \bar{n}$;

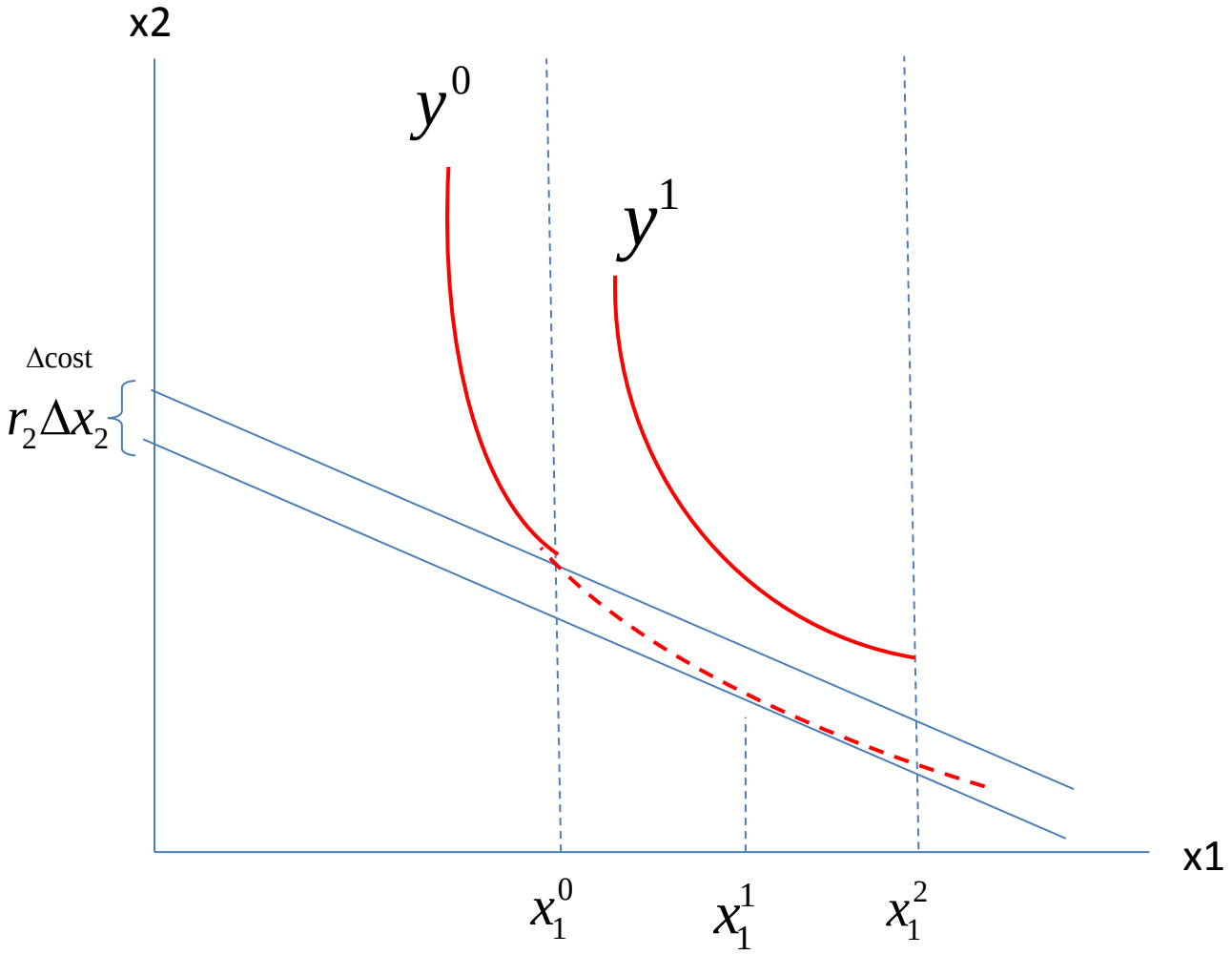
$$if\ \lambda_3 = \lambda_2 = 0, p = \left(y_c\right)^{-1} \left(r_n + \sum_{j=1}^{J} r_j x_j\right) (\text{scale efficiency}),\ r_k = p\frac{\partial f}{\partial x_k}\ (\text{alloc.eff.})$$

$$\text{If}\ \lambda_2 = 0 < \lambda_3, p = \left(y_c\right)^{-1} \left(r_n + \sum_{j=1}^{J} r_j x_j\right) + \lambda_3$$

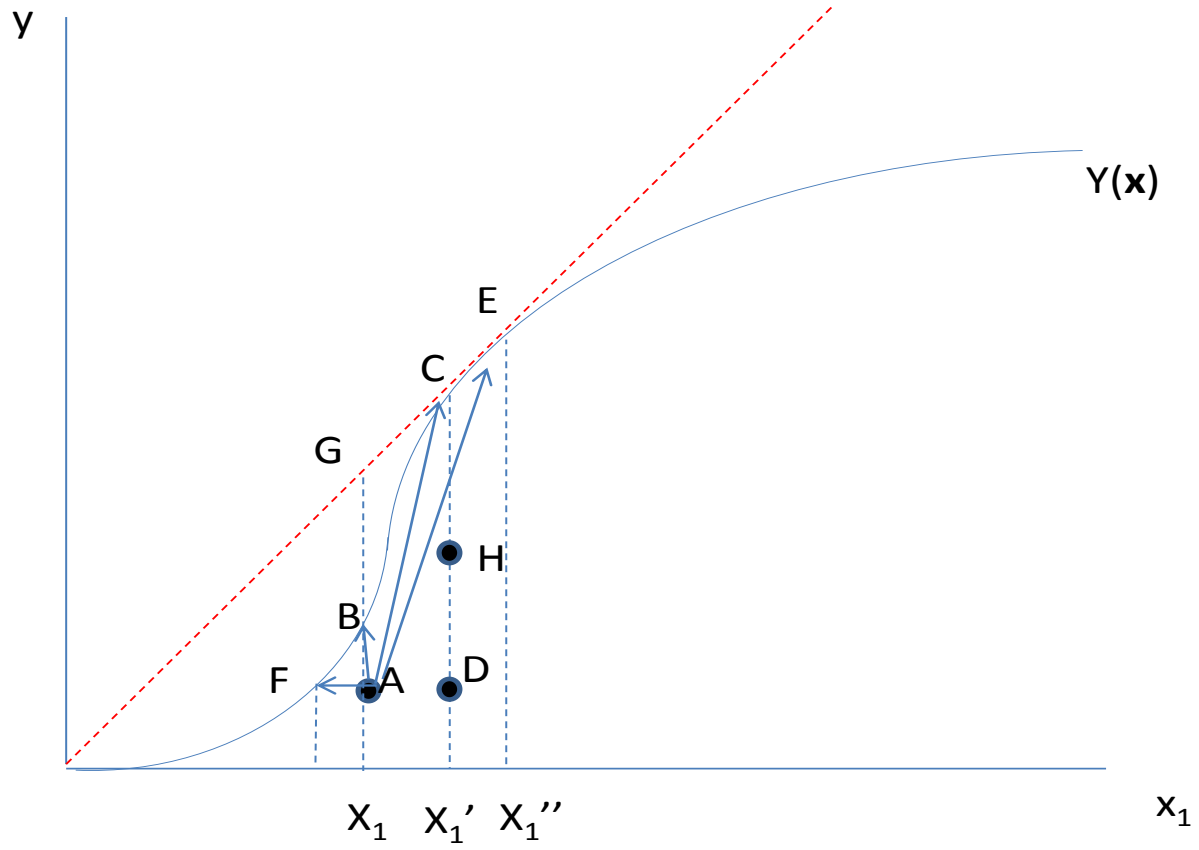
What are the implications of quota rationing and input lumpiness on inefficiencies?

- The rationning by itself only impacts on scale inefficiency;
- Some inputs are lumpy, but lumpiness by itself generally entails only allocative and scale inefficiencies;
- Production quota rationing + input lumpiness can induce technical inefficiency;
- H0: Price-ceiling had no effect on technical efficiency versus HA: Price-ceiling induced a jump in inefficiency followed by a gradual reduction

Lumpy Input and Allocative and Scale Inefficiencies



Regulation/policy-Induced Inefficiencies



Empirical validation

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- **Estimate technical inefficiency scores from a distance function that handles multi-product (milk & beef, other)multi-input (feed, labor, land, machinery, other capital) technologies as in Rasmussen (2010) and Singbo and Larue (2015) ; Given production adjustment constraint, input orientation is better suited than output orientation;**

- **Data is an unbalanced panel (2002-2010, 1495 farms) with farms only in the pre-price ceiling period , farms only in the price-ceiling era and farms in both periods, but with possible years missing;**
- **Why is the panel unbalanced? Entry and exit of farms and data cleaning;**
- **In looking for a pattern in technical inefficiencies, we need to account for the possibility that farms that are in either period have different average scores;**
- **Hypothesized pattern is a "jump" in inefficiency in the price-ceiling period , stemming from the purchase of a larger quantity of one or more lumpy inputs combined with the inability to buy production quota, followed by a "gradual" decrease in inefficiencies as some production can be purchased by a sequence of very small purchases.**

The econometric model

$$-\ln\left(x_{3it}\right)=\alpha_0+\sum_{n\neq 3}^{N}\alpha_n \ln x_{nit}^{*}+\frac{1}{2}\sum_{n\neq 3}^{N}\sum_{k\neq 3}^{N}\alpha_{nk}\ln x_{nit}^{*}\ln x_{kit}^{*}$$

$$+\sum_{m=1}^{M}\beta_m \ln y_{mit}+\frac{1}{2}\sum_{m=1}^{M}\sum_{l=1}^{M}\beta_{ml}\ln y_{mit}\ln y_{lit}+\sum_{m=1}^{M}\sum_{n\neq 3}^{N}\gamma_{mn}\ln y_{mit}\ln x_{nit}^{*}$$

$$+\sum_{n\neq 3}^{N}\delta_{tx_n} t\ln x_{nit}^{*}+\sum_{m=1}^{M}\delta_{ty_m} t\ln y_{mit}+\sum_{s=2}^{T}\tau_s C_s+\theta_1 t+\theta_2 t^2+v_{it}-u_{it}$$

$$u_{it}=u_i\exp\left(-\eta\left(t-T\right)\right)$$

$$\mu_i=\sum_{k=1}^{K}\omega_k A_k \qquad TE_{it}=E\left[\exp\left(-u_{it}\right)\middle| v_{it}-u_{it}\right]$$

south	0.0161	0.0218	0.0240	0.0240
	(0.0155)	(0.0145)	(0.0144)	(0.0144)
north	-0.0123			
	(0.0149)			
Off-farm work	0.0300	0.0279	0.0246	0.0246
	(0.0181)	(0.0183)	(0.0182)	(0.0182)
d2007	0.6414***	0.6193***	0.5946***	0.5946***
	(0.1463)	(0.1449)	(0.1451)	(0.1451)
t2007	-0.1063***	-0.1029***	-0.0988***	-0.0988***
	(0.0230)	(0.0228)	(0.0228)	(0.0228)
dbefore	0.0393			
	(0.0265)			
dafter	-0.0446*	-0.0497*	-0.0414*	-0.0414*
	(0.0203)	(0.0209)	(0.0209)	(0.0209)
old			-0.0330*	-0.0330*
			(0.0130)	(0.0130)
_cons	-0.1281**	-0.1231**	-0.1493***	-0.1493***
	(0.0495)	(0.0470)	(0.0387)	(0.0387)

Conclusions

1) The QC exchange for production quotas is no longer performing as it should to allow dairy producers that can profit more from production quotas to buy them from producers who can profit less;
2) Chernoff estimated that the real value of quota in Quebec in 2010 was not $25000/kg butterfat per day, but close to $31k.
3) Many dairy production inputs are lumpy (ex. milking robots, barn extension, cows…) and given that production quota can be obtained in very small increment over time, theory predicts a jump in inefficiency scores followed by a gradual decline in inefficiency as small increments of production quotas can be purchased. The « jump » can be particularly large given that Quebec farms face important economies of scale.
4) Empirical evidence confirm that SM regulations create not only scale inefficiency, but also technical inefficiency.