

Investing in Vertical Integration

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OF COMPETITION AND REGULATION

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 - ▶ When will the firm do this? What factors encourage/inhibit this.

- ▶ Begin with an equilibrium model of electricity market.



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- ▶ Market participants may have forward positions (QC).



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$$S_{it}(p_t, QC_{it}, \vec{W}_t) = -\frac{a(K-2)}{b(K-1)} + \frac{K-2}{b(K-1)} p_t + \frac{1}{K-1} QC_{it} \\ + \frac{m_i}{K-1} D_t - \frac{(K-2)}{b(K-1)} \sum_{j=1}^L \rho_j w_{jt}.$$



Clearing the market, cont'd

Firm's profit & prices

$$\pi_i = p^c S_i^*(p^c) - C(S^*(p^c)) + (PC - p^c)QC_i + m_i(p^R - p^c)D.$$

$$p_t^c = A - B \sum_{i=1}^K QC_{it}^* + \sum_{j=1}^L C_j W_{jt}$$

Where

$$A = a + b \frac{(c - \kappa_o p^R) \left(K - (1 + \sum_{i=1}^K m_i) \right)}{K(K-2)}$$

$$B = \frac{b}{K(K-2)}$$

$$C_j = \rho_j + b \frac{\left(K - (1 + \sum_{i=1}^K m_i) \right)}{K(K-2)} \kappa_j$$



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- ▶ We then solve the ODE

$$\frac{1}{2}\sigma^2 D^2 F''(D) + \mu D F'(D) - rF(D) = 0$$

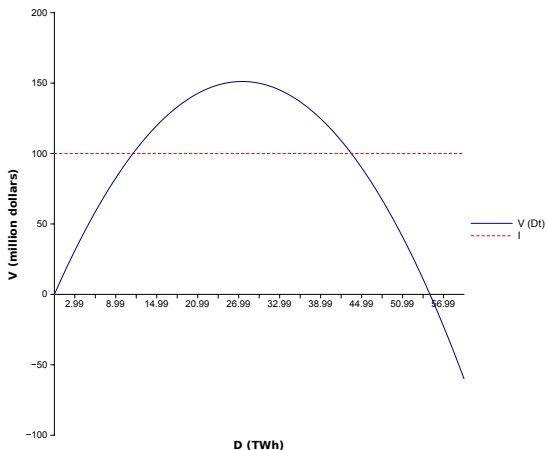
subject to $F(D) \geq V(D)$ with smooth pasting conditions.

Numerical example

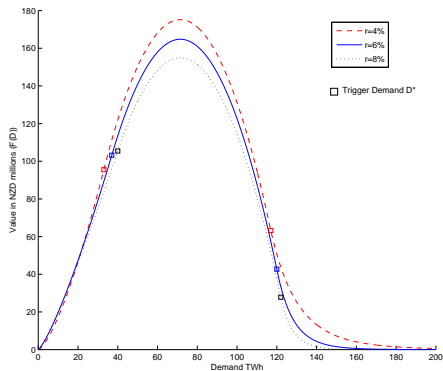
- ▶ $K = 5$, $M = 0.5$, $m_i = M/K$.
- ▶ $I = 100$, $\Delta m_i = 2\%$, $h = 4$, $\omega = 60\%$.
- ▶ $QC = 10$, $a = 50$, $b = 3$.
- ▶ This gives a price of \$72.5/MWh for 37.5TWh output (NZ 22/1/2004-30/11/2010).



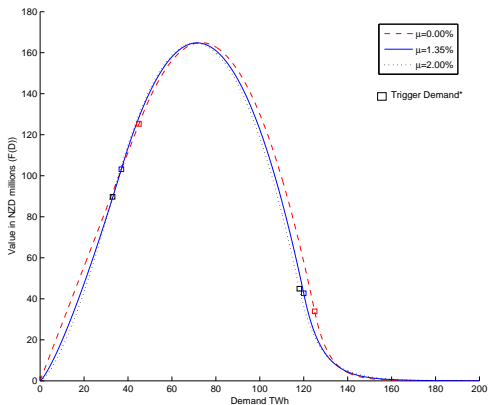
Concavity of $V(D_t)$



Project value and investment policy (different risk free rates)

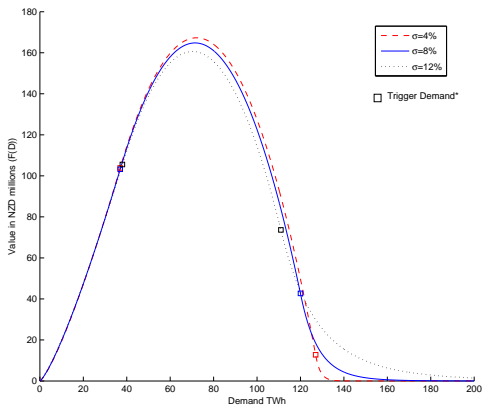


Project value and investment policy (different drifts)



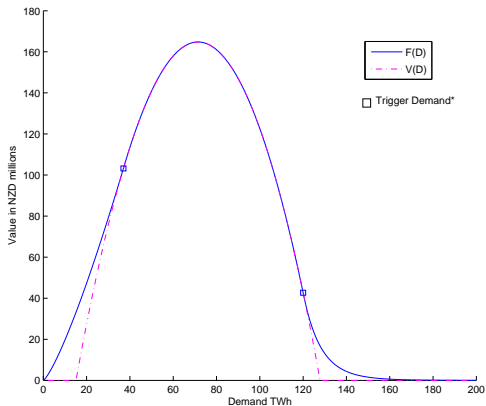
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Project value and investment policy (different volatilities)



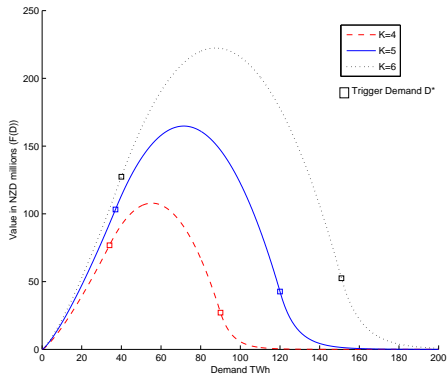
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Concavities of $F(D)$ and $V(D)$

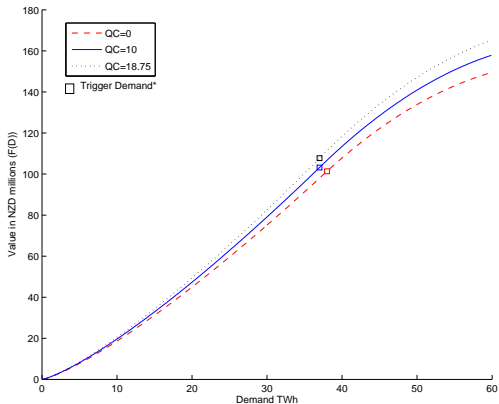


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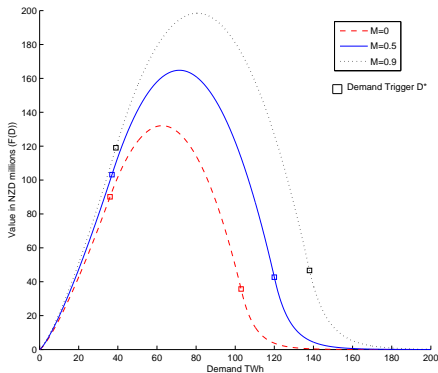
Project value and investment policy (different number of firms)



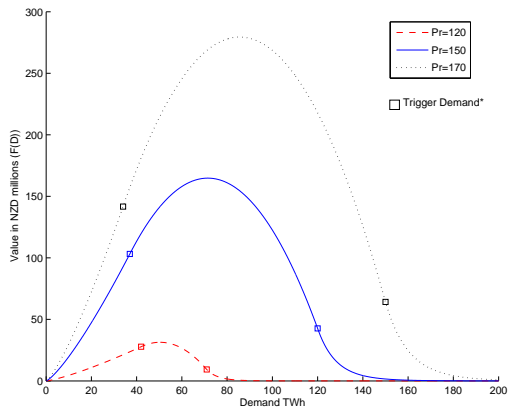
Project value and investment policy (quantity contracted)



Project value and investment policy (degree of vertical integration)



Project value and investment policy (Retail prices)



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Final thoughts

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- ▶ Extending vertical integration can be profitable for a firm (increased market power, reduced risk).
- ▶ Overextending can be risky.
- ▶ Extension: updating contract prices (similar qualitative results).

