Potential Net Benefits of Adopting Bt Cotton in Pakistan

By

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Background

- The cotton crop is highly susceptible to several pests, insects and mites during the entire growing season.

- Evidence indicates that Bt cotton reduces pesticide expenditure, improves yield

- Bt technology is IPR protected, commercial adoption is conditional on a per acre fee (technology fee) paid to the owners of the gene – high seed price
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- Among the top four cotton producers in the world, Pakistan is the only country which is yet to commercially adopt Bt cotton.

- The cultivation of Bt cotton, although unapproved and unregulated, increased rapidly after 2005 in Pakistan (PARC, 2008)

Background

- The government of Pakistan has been negotiating with Monsanto since May 2008 to allow the commercial production and distribution of the latest GM cotton seed in the regulated market.

- These negotiations have remained inconclusive due to a disagreement over the size of the technology fee.

- The government of Pakistan argues that the technology fee demanded by Monsanto is too high and that it will transfer the entire benefit of this technology to the innovator and not to cotton growers of Pakistan.

Research Gap and Objectives

- Strong perception that buying Bt technology by paying technology fee will not benefit farmers (GoPunjab, 2009)
  - Lack of empirical research on estimates of the potential benefits and expected costs of adopting Bt cotton

- Research question
  - What might be the size and distribution of potential benefits among farmers, cotton consumers seed companies, and technology innovators?

- Objectives
  - Measure the potential welfare implications of commercial adoption of Bt cotton among different stakeholders

Analytical Framework

- Economic surplus model – perfectly competitive input market
- IPR protection – violation of the assumption of perfectly competitive input market
- Adjusted Economic Surplus Model (Falck-Zepeda et al., 2000)

$$\Delta TS_t = \Delta PS_t + \Delta CS_t + MB_t$$

$$MB_t = SB_t + IB_t$$

- Five hypothetical scenarios are developed and simulated
- The component of risk is incorporated by applying probability distributions for selected parameters

Five Hypothetical Scenarios

1. Adoption of unapproved Bt varieties (the current situation)
2. Commercial adoption of varieties developed domestically in Pakistan
3. Commercial adoption of Bt hybrid seed imported from India
4. Commercial adoption of latest Bt technology
5. Irregular adoption of the latest Bt technology

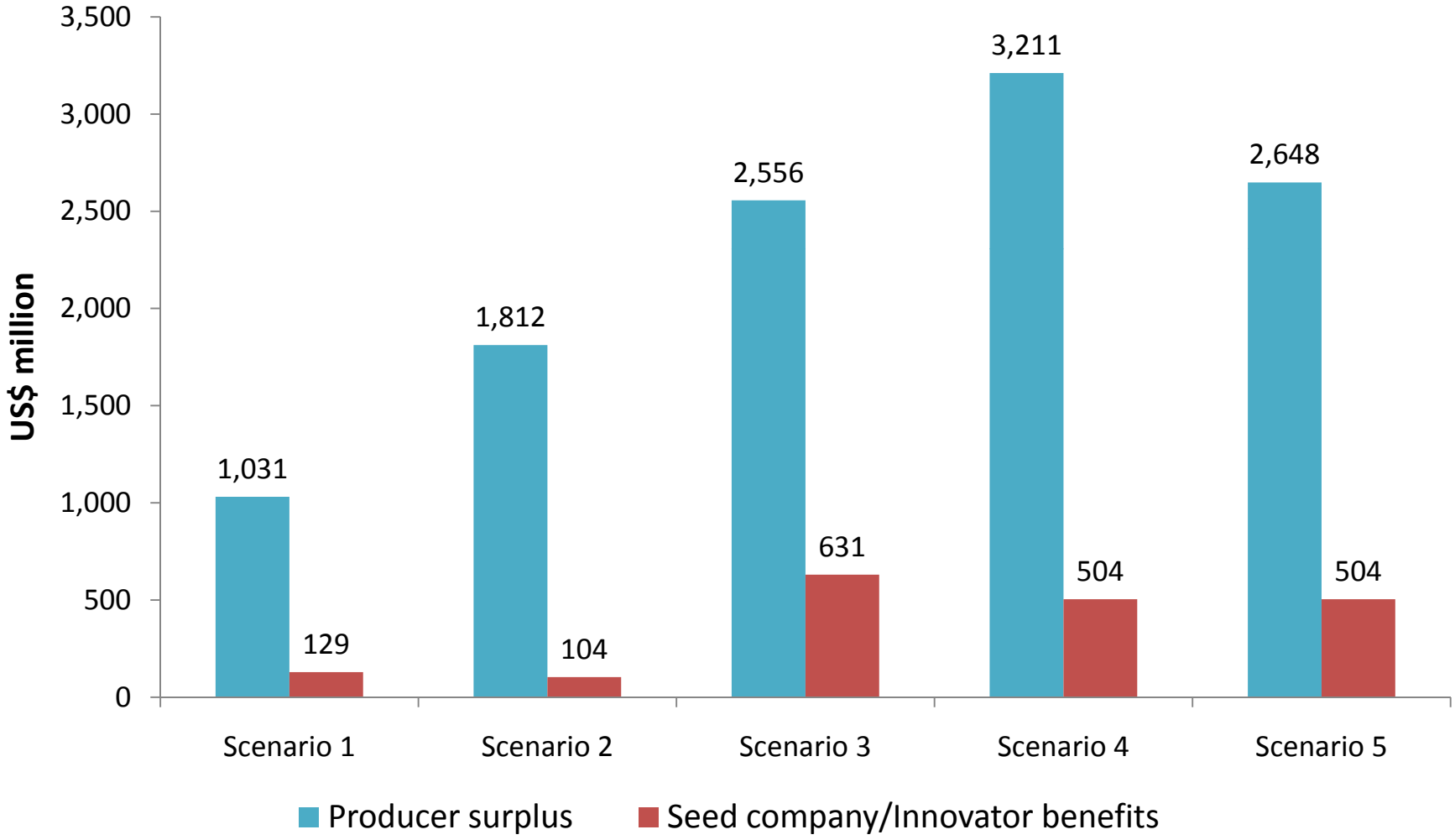
Data: Assumptions and Probability Distributions

Variables	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Yield gain (%)	Δ(0, 0.10, 0.20)	Δ(0, 0.15, 0.25)	Δ(0, 0.22, 0.35)	Δ(0, 0.30, 0.40)
Decline in Pest expenditure (%)	Δ(0, 0.07, 0.15)	Δ(0, 0.10, 0.15)	Δ(0, 0.13, 0.30)	Δ(0, 0.20, 0.35)
Seed premium (US$/hectare)	Δ(5, 10, 20)	Δ(6, 8, 10)	-	-
Technology fee	-	-	Δ(33, 40, 53)	Δ(27, 32, 42)
Adoption rate (%)	Δ(0.50, 0.60, 0.70)	Δ(0.50, 0.65, 0.80)	Δ(0.50, 0.70, 0.90)	Δ(0.50, 0.70, 0.90)
Supply elasticity	Δ(0.3, 1, 1.5)	Δ(0.3, 1, 1.5)	Δ(0.3, 1, 1.5)	Δ(0.3, 1, 1.5)
Diffusion path (yrs)	17	21	21	22
R&D cost (US$)	150,000	200,000	90,000	1,200,000

Area (million hectares)= 3,032,
Cost of production (US$/hectare) = 570.12
Yield of raw cotton (kg/hectare) ~ N(1962, 204)
Price of raw cotton (Rs/40kg) ~ N(1034, 226)

Results: Potential Benefits and Expected Costs:

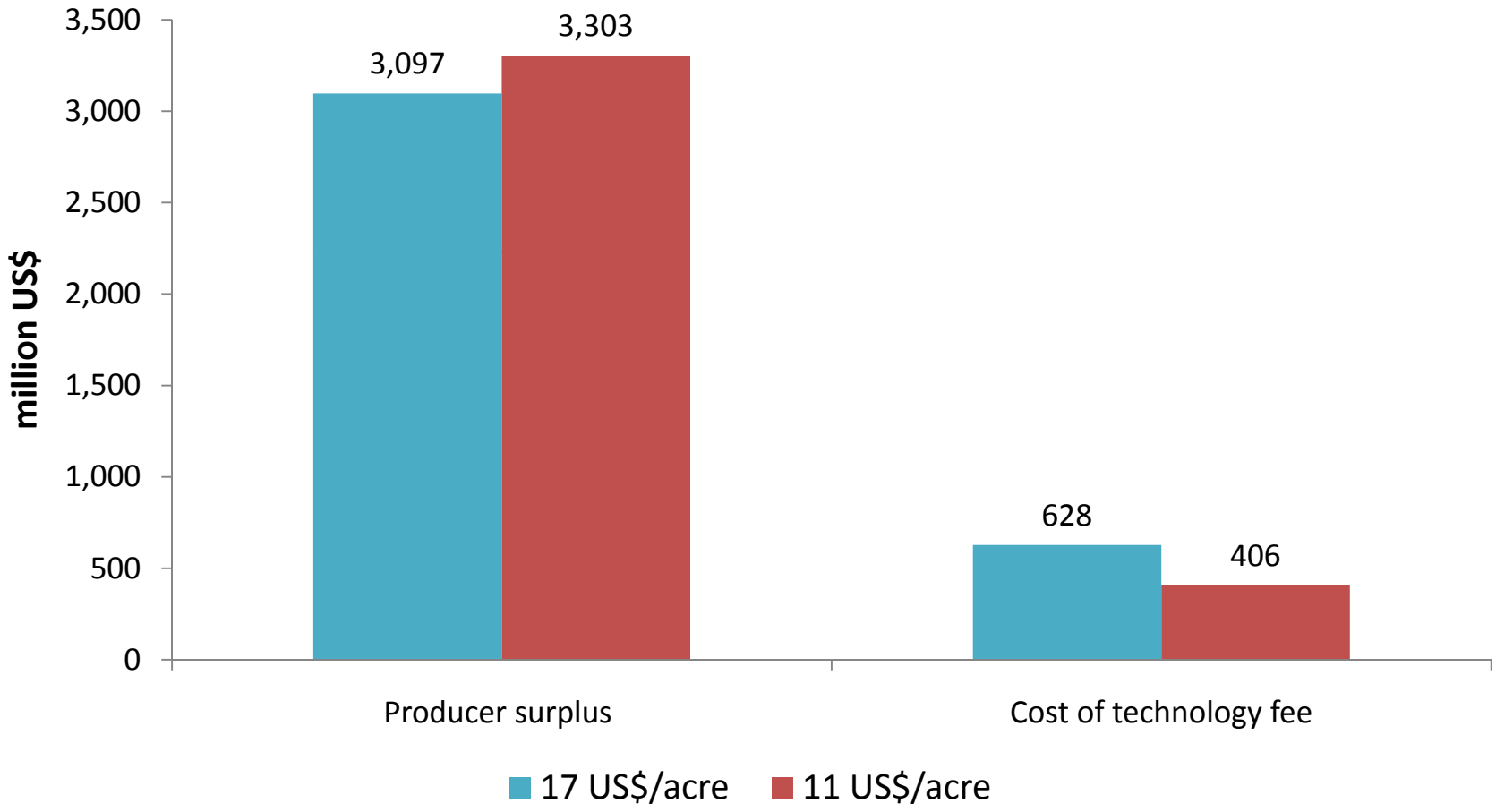
Mean values of 10,000 iterations – 5 Scenarios



Note: Open economy case

Results: Potential Benefits and Expected Costs:

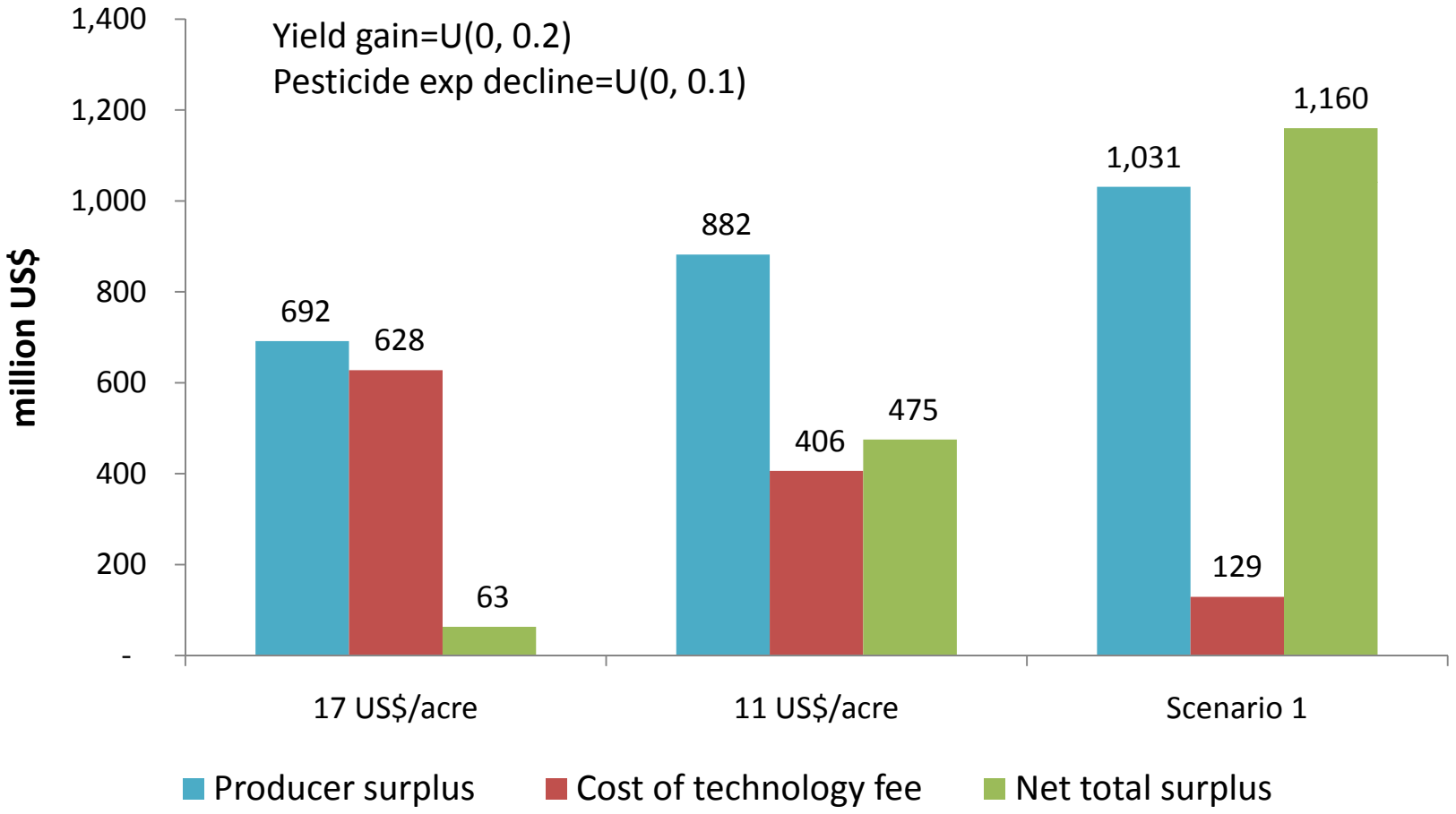
Impact of Technology Fee on Economic Surplus



Country can save 428 million, 19 million/year, but losing 141 million/year

Results: Potential Benefits and Expected Costs:

Low Effectiveness and Benefits and Costs of Bt Cotton Adoption under Scenario 4



Conclusions

- The commercial adoption of Bt cotton can bring substantial benefits
- Producer surplus is much higher than the benefits to seed companies and innovators
- Fluctuating adoption rate can reduce the economic benefits
- Latest Bt technology is not a viable option if its effectiveness is low

Policy Implications

- Domestically produced Bt cotton varieties should be released in a regularized seed market and latest Bt technology should be acquired

- But consider the effectiveness of Bt technology before making a decision of paying a technology fee

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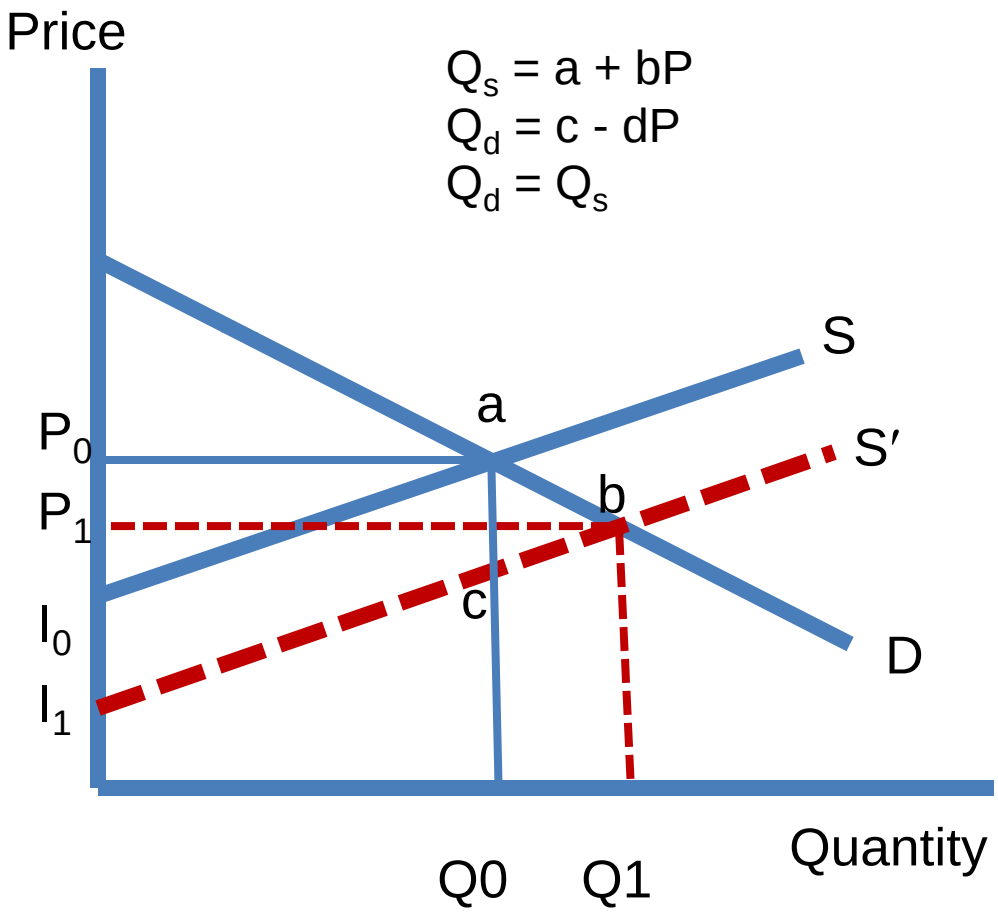
Economic Surplus Model



Cost saving at initial quantity = I_0acI_1

Economic gains:

$abc = Q_0abQ_1 - Q_0cbQ_1$

Q_0abQ_1 = increment in consumption

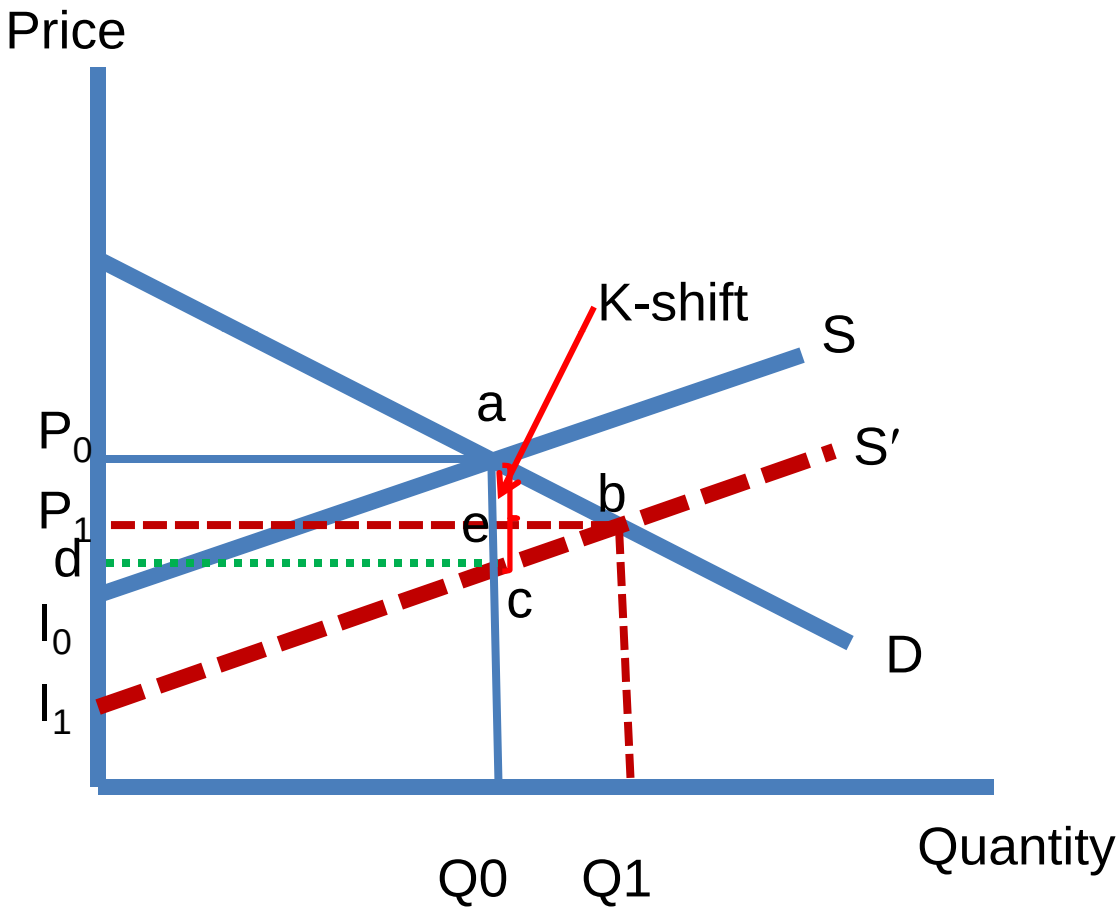
Q_0cbQ_1 = total cost of increment to production

$\Delta CS = P_0abP_1$

$\Delta PS = P_1bI_1 - P_0aI_0$

$\Delta TS = I_0abI_1$

Economic Surplus Model



Let

$K = (P_0\text{-}d)/P_o = k/P_o$

$$Z = -\left(\frac{P_1 - P_o}{P_o}\right) = \frac{\varepsilon_s k}{\varepsilon_s + \varepsilon_d}$$

Measuring ΔPS

$\Delta PS = P_1 b I_1 - P_0 a I_0$

$= P_1 bcd + dcI_1 - P_0 a I_0$

$dcI_1 = P_0 a I_0$

$\Delta PS = P_1 bcd = P_1 ecd + ebc$

$P_1 ecd = (P_1 - d)Q_0$

$ebc = 0.5*(P_1 - d)(Q_1 - Q_0)$

$P_1 - d = (P_0 - d) - (P_0 - P_1)$

$= k - P_0 Z$

$= K P_0 - P_0 Z = P_0(K-Z)$

$\Delta PS = P_0(K-Z) Q_0 + 0.5* P_0(K-Z)(Q_1 - Q_0)$

$\Delta PS = P_0 Q_0 (K-Z)[1 + 0.5*(Q_1 - Q_0)/Q_0]$

$\Delta PS = P_0 Q_0 (K-Z)[1 + 0.5*e_d*Z]$

Change in Economic Surplus

- $\Delta PS = P_0 Q_0 (K-Z)[1 + 0.5*e_d*Z]$
- $\Delta CS = P_0 Q_0 Z[1 + 0.5*e_d*Z]$
- $\Delta TS = KP_0 Q_0[1 + 0.5*e_d*Z]$

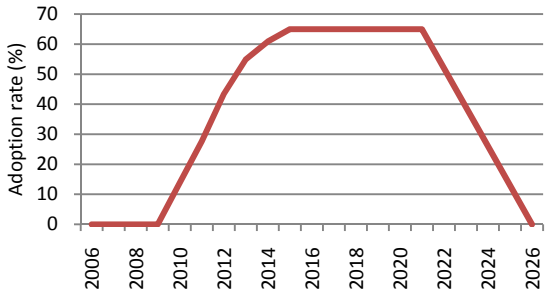
- How to measure K

$$K_i = \left[\frac{E(Y)}{g_i} - \frac{E(C)}{1 + E(Y)}\right] p A_i (1 - \delta_i)$$

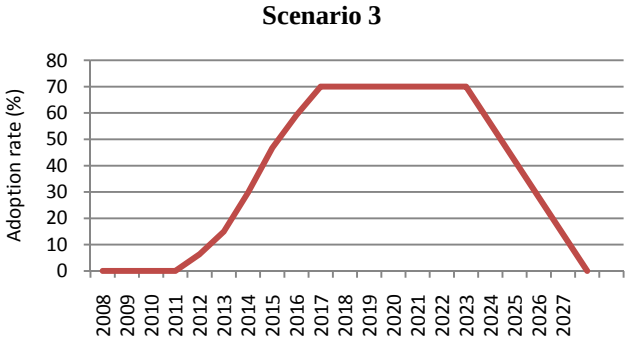
Adoption Profile

Scenario 1

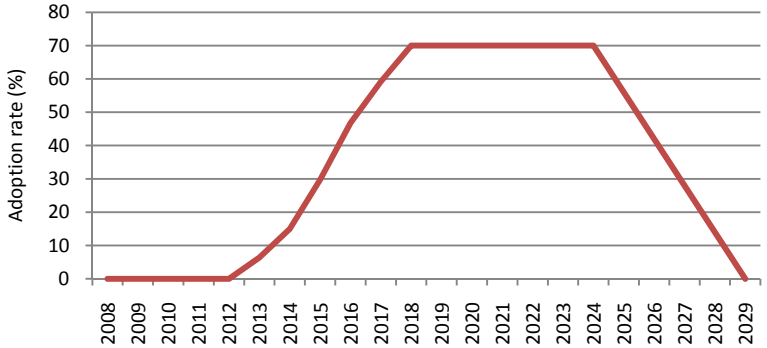
Scenario 2



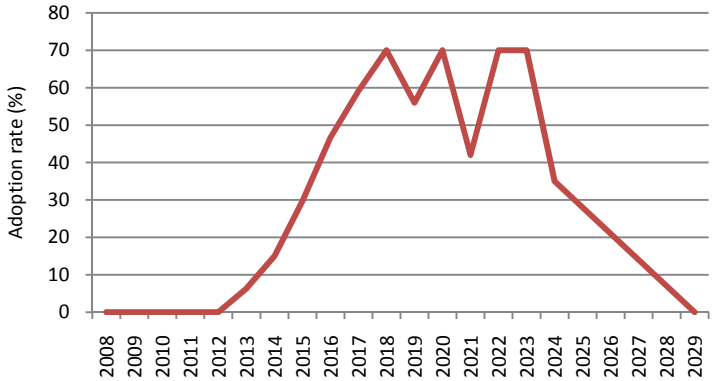
Scenario 3



Scenario 4



Scenario 5



The Probability of Negative Economic Surplus is Zero