The New (Commercial) Open Source: Does It Really Improve Social Welfare?

Sebastian v. Engelhardt*   Stephen Maurer**

*Friedrich-Schiller-University Jena

**University of California, Berkeley

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Commercial Open Source Software

Open Source Software (OSS):

- Source code is open
- Right to read, modify, improve, redistribute and use it
- $\rightarrow$ de facto a public good

Closed Source Software (CSS):

- Source code is secret
- Right to use software

▶ OSS is jointly developed by non-commercial and *commercial* agents
▶ OSS business models: combine OSS with complementary product
▶ Rising role of commercial OSS (Deshpande and Riehle 2008)

Most OSS-CSS models without commercial OSS

Only a few models with commercial OSS:

- Duopoly: *Baake & Wichmann (2004), Verani (2006), Henkel (2006), Casadesus-Masanell & and Llanes (2009), Lambardi (2009)*

- Oligopoly: *Schmidtke (2006)*, only OSS firms

- Users with idiosyncratic preferences and binary demand: *Llanes & de Elejalde (2009), Casadesus-Masanell & and Llanes (2009)*

Our contribution

- General oligopoly with OSS and CSS firms, both developing software

- Free market entry and exit: endogenous proportion of OSS firms

- Welfare (effects of quantity vs. quality competition and cost sharing)

- Discussing government interventions

The model

- $n \geqslant 2$ firms
- Products: software (x) + complementary good/service
- differentiated products (γ)
- Software (x) determines quality of products: $\alpha = 1 + x$
- Software is OSS or CSS

Two stage game

Stage I: Decision on quality (software)
Stage II: Decision on quantity

Backward induction:
Stage II: $\rightarrow$ stand. result of a horizontally and vertically diff. Oligopoly
Stage I: *see next slides...*

Pure CSS industry

- CSS firm:

$$\pi_i = \frac{\left(\alpha_i + \theta \sum_{j \neq i} \alpha_i - \alpha_j\right)^2}{h^2} - \frac{1}{2}\phi x_i^{\mathsf{cs}\,2}$$

$$\alpha_i = 1 + x_i^{\mathsf{cs}}$$

$$x^{\mathsf{cs}*} = \frac{1 + (n-1)\,\theta}{\frac{1}{2}h^2\phi - (1 + (n-1)\,\theta)}$$

- Quality competition (θ) increases software-output
- Quantity competition (h) decreases software-output

$h = 2 + \gamma(n-1)$

$\theta = \gamma/(2-\gamma)$

$\gamma \in [0,1]$: inverse measure of horizontally product differentiation

Pure OSS industry

- OSS firm:

$$\pi_i = \frac{\alpha_i^2}{h^2} - \frac{1}{2}\phi X^{\text{os}2} \frac{x_i^{\text{os}}}{X^{\text{os}}}$$

$$\alpha_i = 1 + X^{\text{os}}$$

$$x^{\text{os}*} = \frac{1}{\frac{1}{4}\phi h^2 (1+n) - n}$$

  - Shared code: no quality competition ("cartel effect")
  - Quantity competition (h)
  - Shared code: pro rata costs

$h = 2 + \gamma(n-1)$

$\theta = \gamma/(2-\gamma)$

$\gamma \in [0,1]$: inverse measure of horizontally product differentiation

Mixed industry (OSS and CSS firms) I

- CSS firm:
    - Profit function of CSS firms remains the same
    - Quality competition with CSS rivals and OSS rivals

- OSS firm:
    - Quality difference between OSS firms remains zero
    - Quality difference between OSS firm and its CSS rivals is *not* zero

$\Rightarrow$ Quality competition by CSS firms weakens cartel effect!

Mixed industry (OSS and CSS firms) II

Ratio of CSS firms $\uparrow$:

1. $x_i^{os} \uparrow$ because quality competition increases (weakened cartel effect)
2. Number of OSS firms who jointly produce X^{os} decreases

$\Rightarrow$ net effect: inverted U-shaped $X^{os} = \sum x_i^{os}$

3. Total costs increase (CSS firms $\rightarrow$ duplicated costs)

Welfare: OSS and CSS firms

- Average quality highest if *very few* OSS firms
- Average costs lowest if *only* OSS firms

- Mixed industries better than pure states
- Welfare maximized if *a few* OSS Firmen

- Consumer surplus highest if *very few* OSS firms
- Producer surplus highest if *only* OSS firms

Market outcome versus welfare optimum

- Pure case: lock in possible
- Mixed case: too many OSS firms
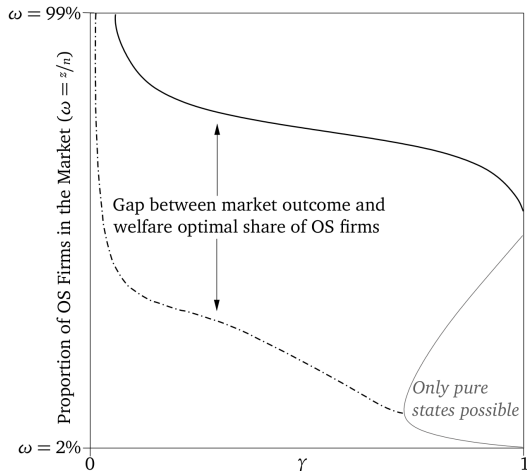
Government interventions

Pure states

- Lock in: maybe support market entry of the other type

Mixed states

- Tax policy: optimal would be a lump-sum tax for OSS firms and lump-sum tax-breaks for CSS firms
- Government provision of OSS: $+$
- Government procurement: preferences for OSS products: $-$

Summary

- General oligopoly model
- Industries with OSS and CSS firms
- CSS: duplication of costs — OSS: cartel effect $\rightarrow$ mix!
- No theoretical justification for "pro OSS firms" interventions

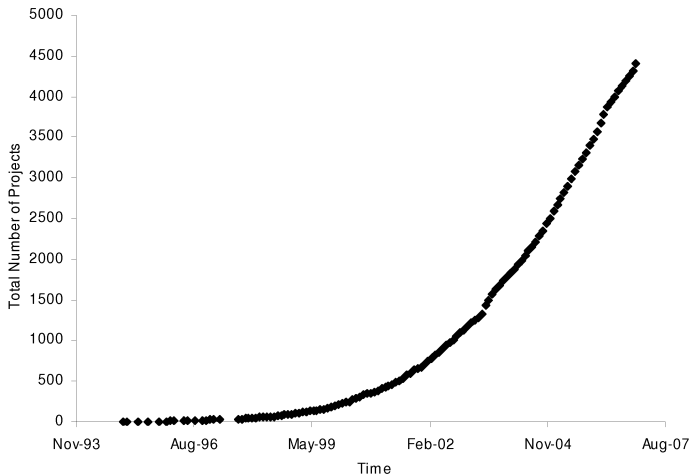# The New (Commercial) Open Source: Does It Really Improve Social Welfare?

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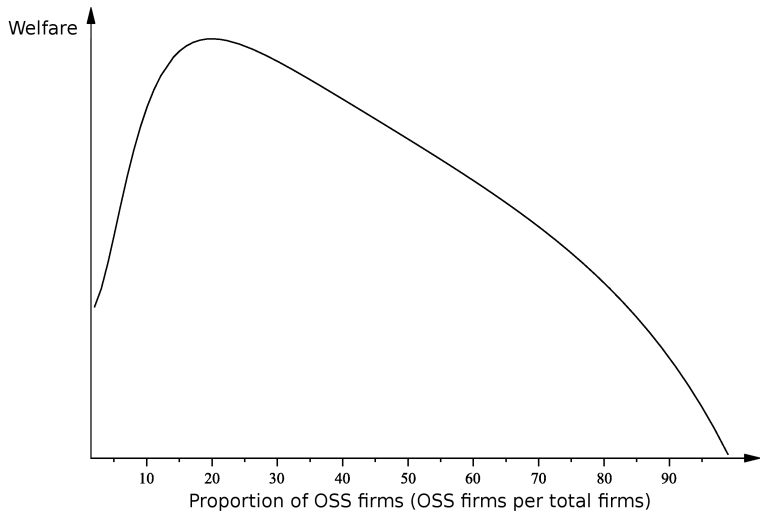
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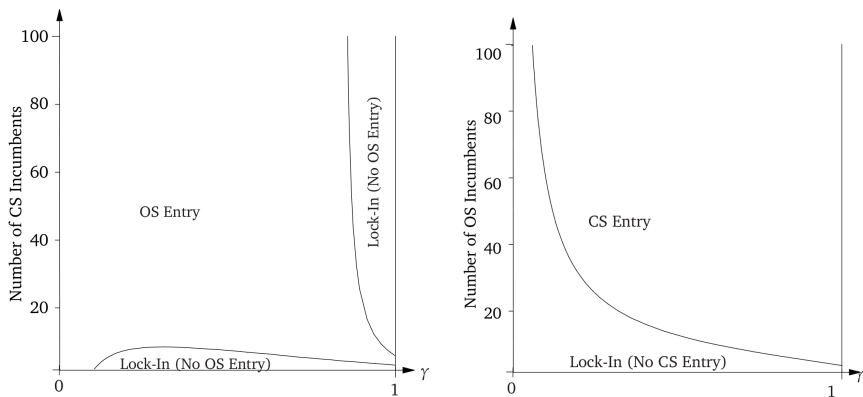January 13, 2011

Figure: Total Number of Open Source Projects

(Source: Deshpande and Riehle 2008)

Figure: Welfare of a mixed industry (example)

Market outcome versus welfare optimum

Figure: CS and OS lock in ($\phi = 2$)

$$x^{\text{cs}} = \frac{(1 + (n-1)\,\theta)\,(1 - z^2\theta x^{\text{os}})}{\frac{1}{2}h^2\phi - (1 + (n-1)\,\theta)\,(1 + z\theta)}$$

$$x^{\text{os}} = \frac{(1 + r\theta)\,(1 - \theta r x^{\text{cs}})}{\frac{1}{4}\phi h^2\,(1 + z) - z\,(1 + r\theta)^2}$$
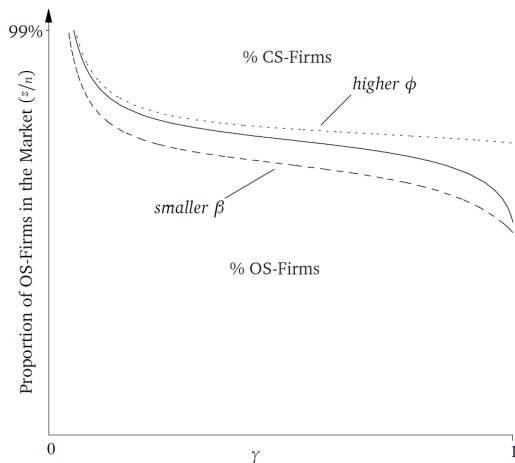
$n = r + z$

z: number of OSS firms

r: number of CSS firms

Parameters and Results

Figure: Parameters and Proportion of OSS Firms

Market Shares

Figure: Market Shares of OSS- and CSS-based Products