Information feedback mechanism and market dominance in a percolation model of innovation diffusion.

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Empirical findings

-the diffusion of new technologies is often delayed

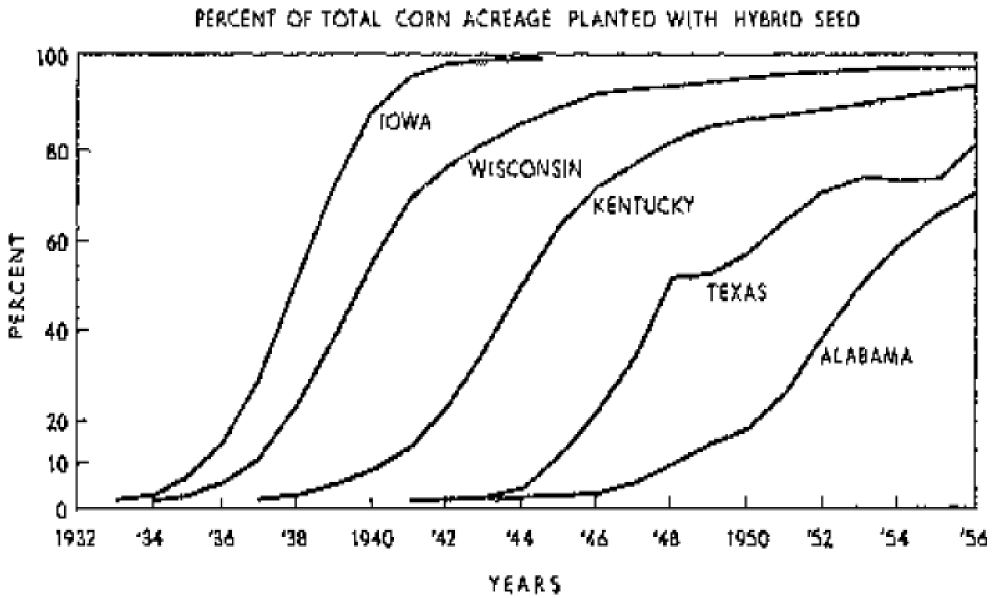


FIGURE 1.—Percentage of Total Corn Acreage Planted with Hybrid Seed.
Source: U.S.D.A., *Agricultural Statistics*, various years.

- new technologies often exhibit price decrease and quality improvement

Theoretical findings

The delay of adoption has been explained by 'retardation factors', like high up-front costs, uncertainty and lack of information about the new technology, the time and costs involved in learning and the often proprietary nature of the new technology.

Models of the diffusion of stand-alone technologies

Epidemic Models
Probit or Rank Models
Stock and Order Models
Evolutionary Models

Probit models

$$D = \int_{S^c}^{\infty} f(S_i) dS_i = 1 - F(S^c).$$

Stoneman and Ireland, 1983

Features: heterogeneity of agents that differ size Si and threshold level S*, (exogenous drivers of diffusion and learning, search and switching costs). Limitations: It neglects the network structure between agents.

Epidemic models

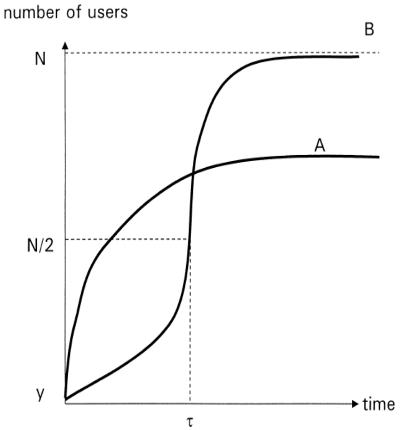


Fig. 1. Plots of the modified exponential (A) and logistic (B) diffusion functions.

Features: Information contagion and the diffusion of a new technology, (common source and prime movers). Limitations: homogeneity of population

Models of multiple technologies diffusion

Complementary, partial and total substitution (Stoneman, 2000)

The demand of one technology is also dependent on the price of other technologies that serve similar functions (complementary inputs, network externalities, the adoption of previous technologies etc.). There is strong empirical evidence on cross technology effects.

Information Feedbacks (Lane and Arthur, 1993)

Searching for information from experienced buyers is certainly reasonable, however it creates information feedbacks that possibly drive one technology to market dominance

Diffusion Policy

Innovation policies are mainly directed towards R&D

Neo-classical justifications for governmental intervention

Market failures responsible for inefficiencies linked to technological diffusion: imperfect information, imperfect competition and externalities

Environmental needs and urgencies

We might want to investment in eco-innovations diffusion despite the high up-front costs of the technology

The Model

We provide a theoretical analysis of the delayed path of technology diffusion by explicitly including in our model two retardation factors, namely localized information and learning. Furthermore we allow for a multinomial decision mechanism rather than the traditional choice on only one technology.

We do this by combining a percolation model of technology diffusion with a model of heterogeneous agents (ABS). We thus capture the influence of both localized spread of information, not accounted for by probit models, and heterogeneous rationality, disregarded by epidemic models.

Our aim is to investigate the effect of variety in the process of diffusion and the influence of demand-pull public interventions.

The rules of the model

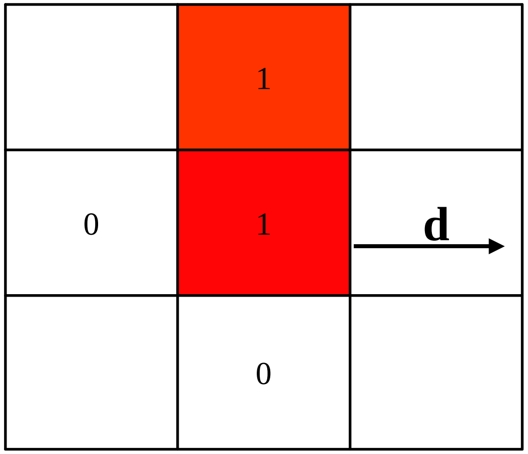
Diffusion as a process of spreading news: consider the new technology if your neighbours have already bought it

Diffusion as a process of heterogeneous rationality: compare your reservation price to the market price of the new technology

Buy if your reservation price is higher than the market price

The definition of neighbourhood

$$w_i \in \left\lfloor f\left(d=n\right)=\left\lfloor\left(2d+1\right)^2-1\right\rfloor\right\rfloor < N$$



if d = 1, w = 8
if d = 2, w =24

Equations of the model

Reservation price $\theta_k \in [0,+\infty] \quad \Theta \approx LogN(\mu,\sigma)$

Initial market price $p_{0,i} \in [0,+\infty]$

Agent *i* buys in period *t* if at least one neighbour has bought in period *t-1* and $p_{t,i} < \theta_{k,i}$

Learning economies and subsidies

$$p_{t,i} = p_0 \left(\frac{N_0}{N_{t-1,i}} \right)^{\alpha_i} (1 - s_i)$$

Initial number of adopters

$$N_{0,i}$$

Cumulative number of adopters

$$N_{t-1,j} = \sum_{j=0}^{t-1} n_{j,i}$$

The wheel mechanism

Technology Options Set $T = [p_1, p_2, p_3]$

Level of attractiveness $A_1 = w_1 e^{\beta(-p_1)}$ etc.

Wheel mechanism probability

$$\pi_i = \frac{A_i}{\sum_j A_j}$$

$$\pi_i \geq 0$$

Set of parameters

Bi-dimensional lattice = 100x100

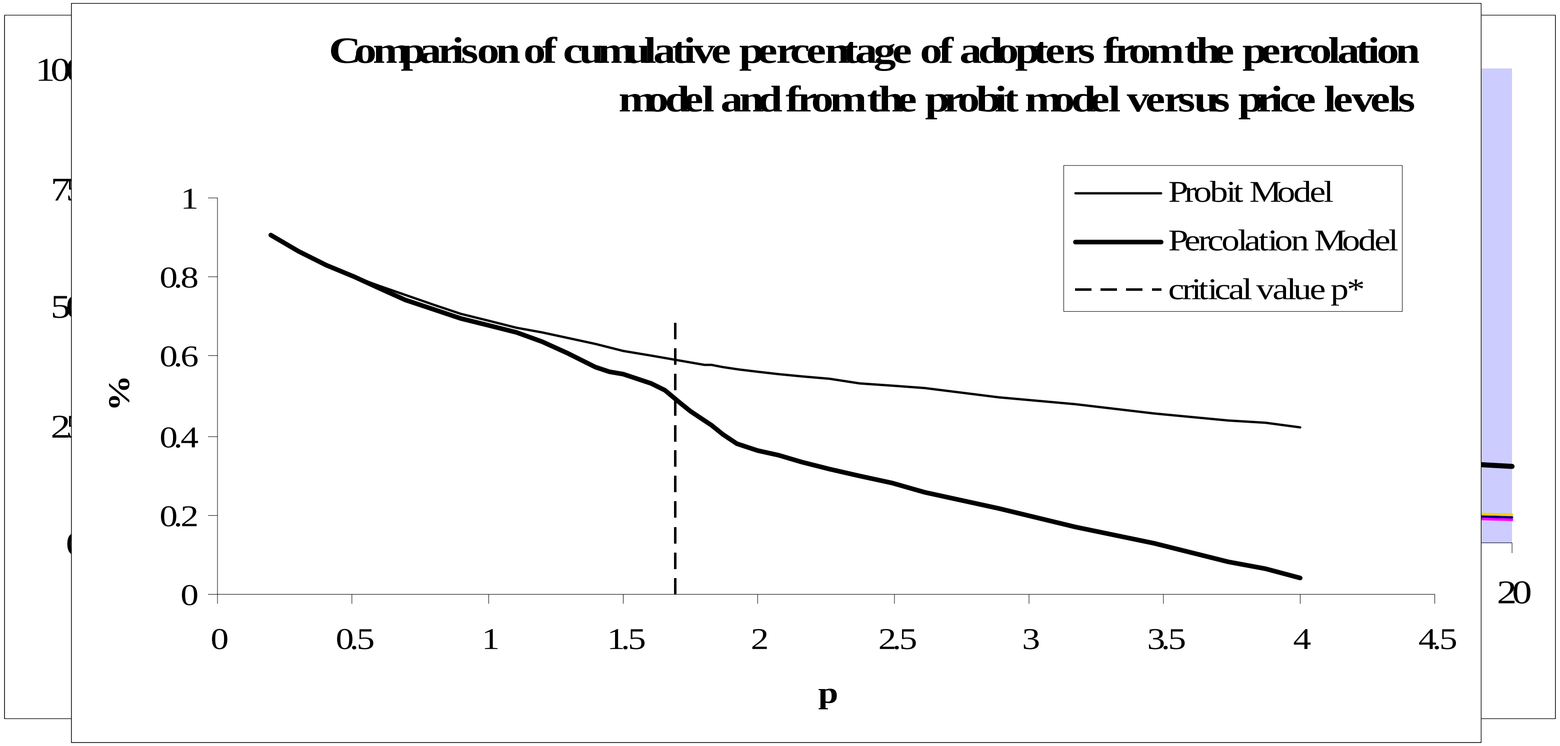
n. of early birds = 1 for each technology, randomly distributed on the lattice

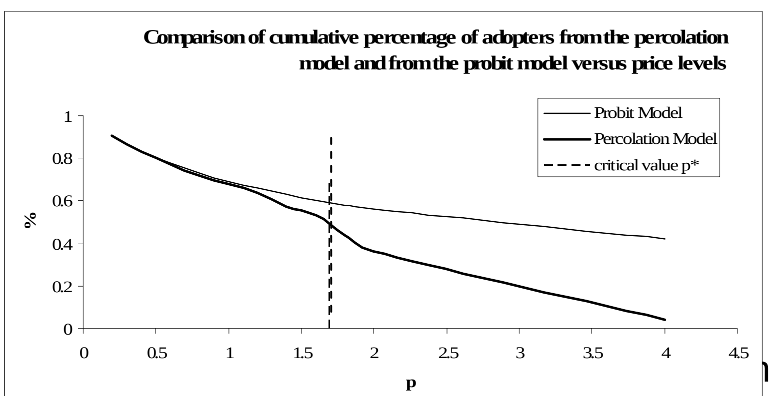
n. of technologies = 3

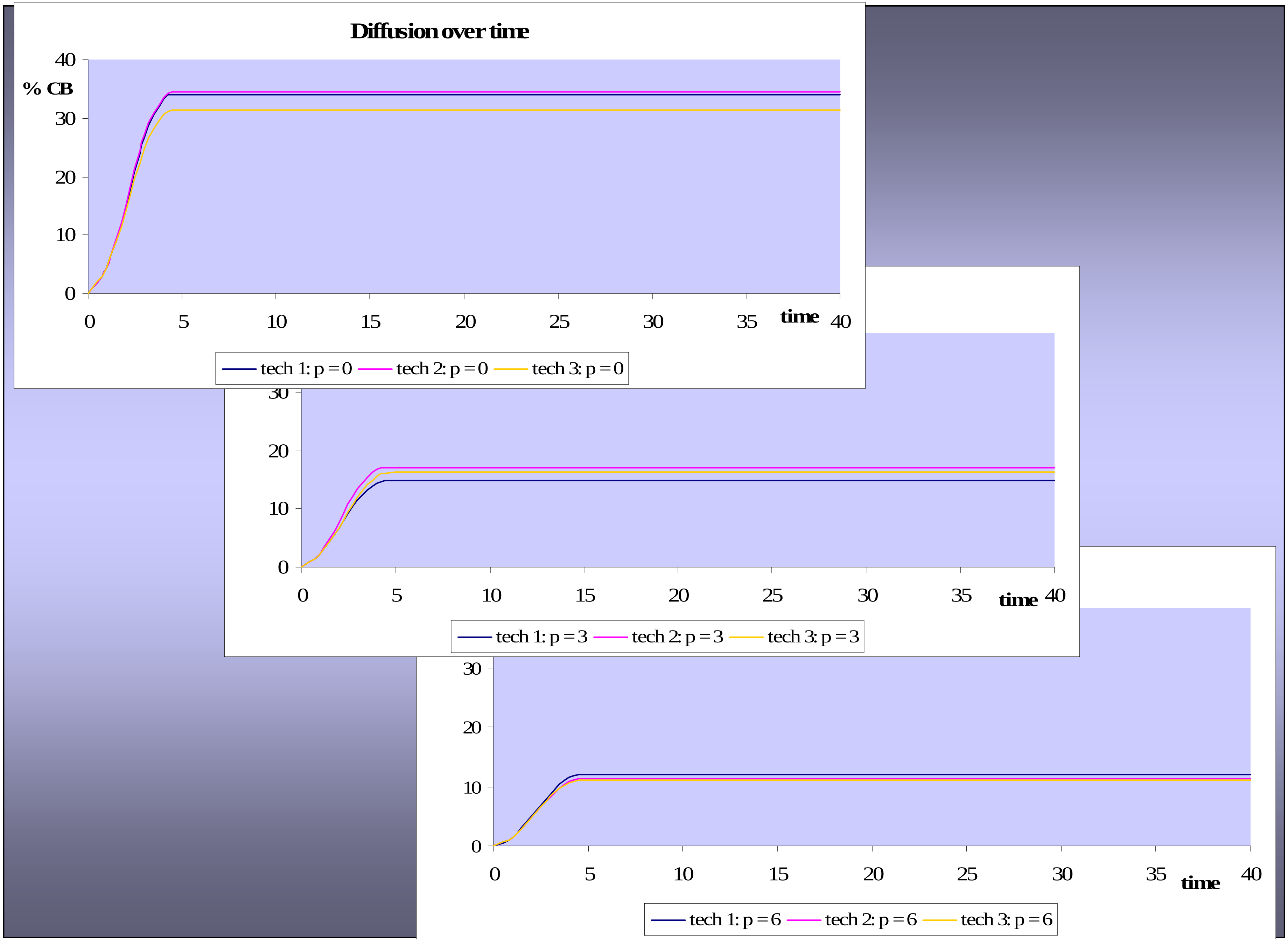
Beta = 0.1, high chance of information feedbacks

tMax = 4 simulation time-steps, long-term subsidy policy

Diffusion versus price



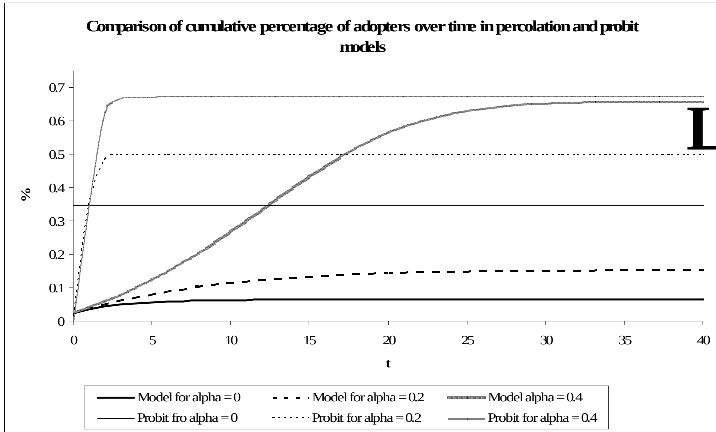


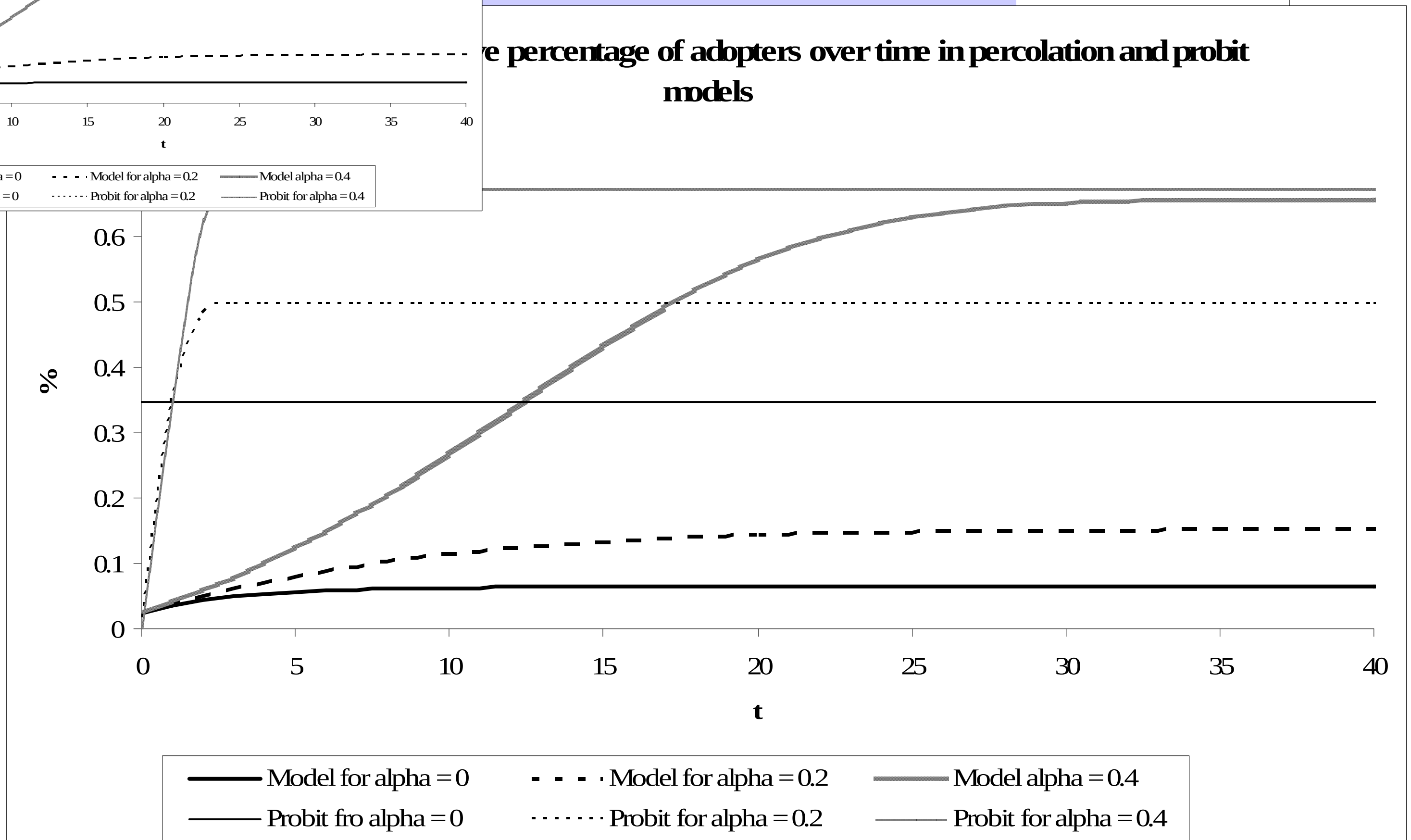

Diffusion over time
% CB
time
tech 1: p = 0
tech 2: p = 0
tech 3: p = 0
time
tech 1: p = 3
tech 2: p = 3
tech 3: p = 3
time
tech 1: p = 6
tech 2: p = 6
tech 3: p = 6

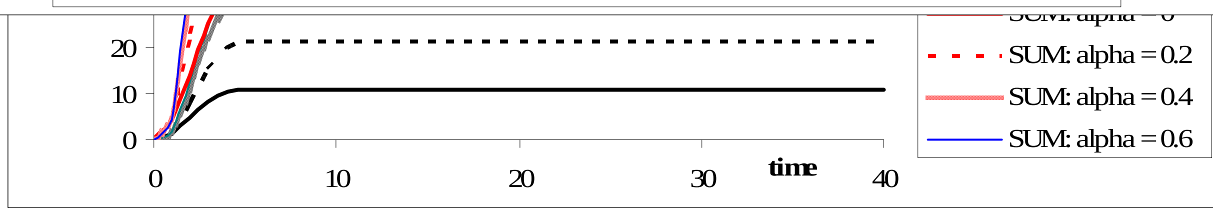
Set of initial prices = [6, 6, 6]

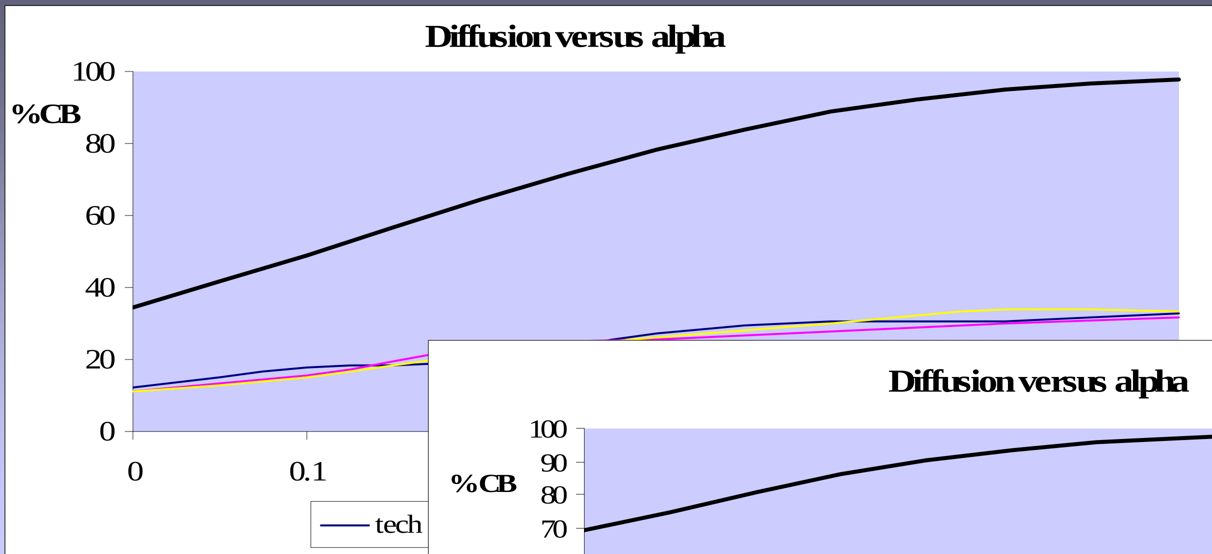
Learning economies

Tech 3: diffusion

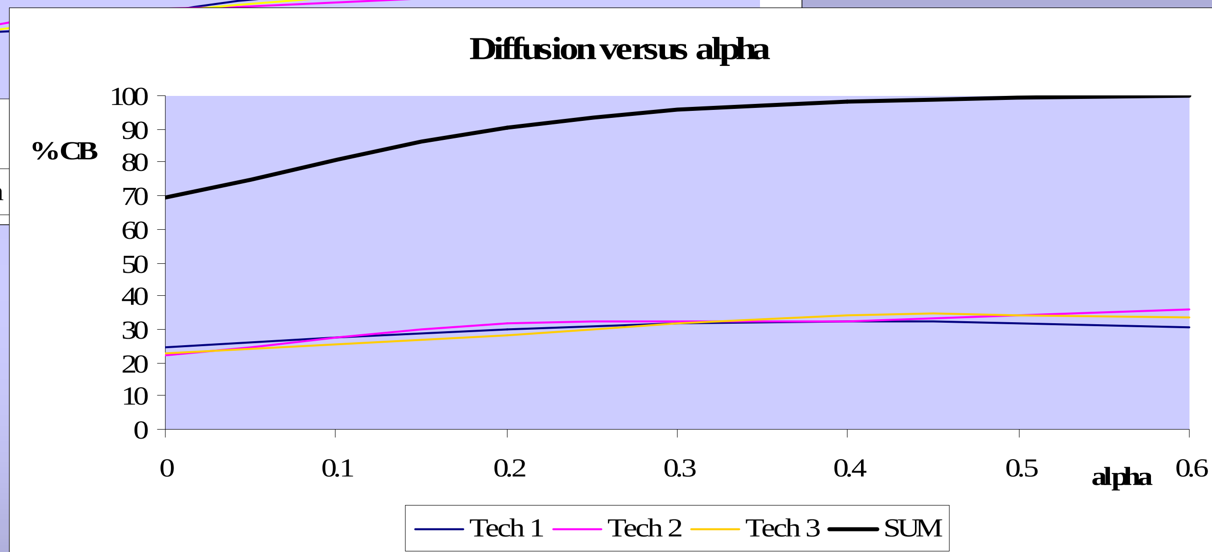




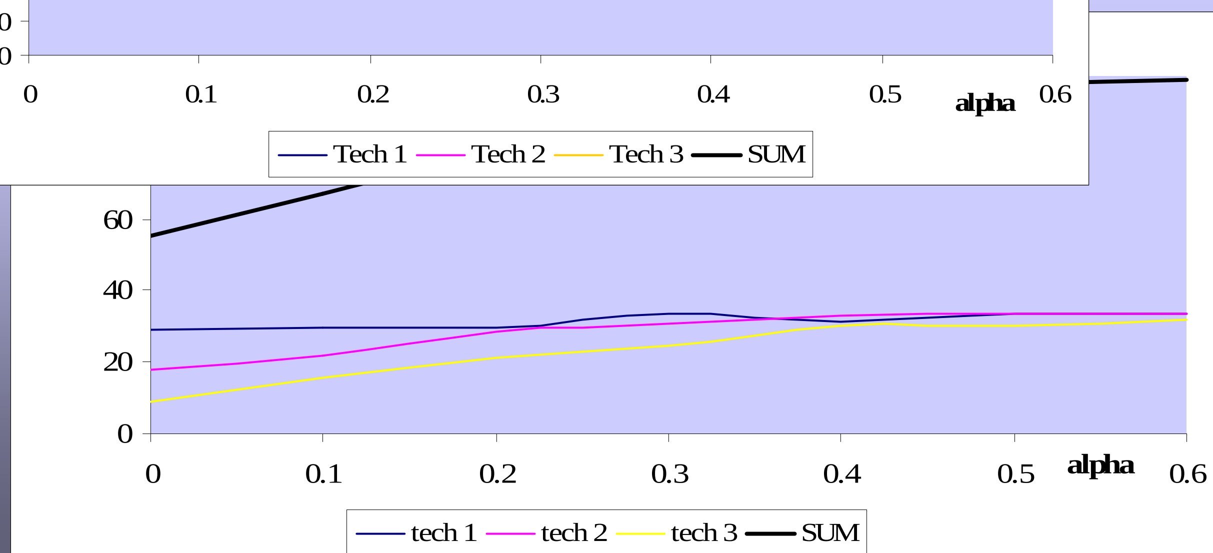




P = [6, 6, 6]



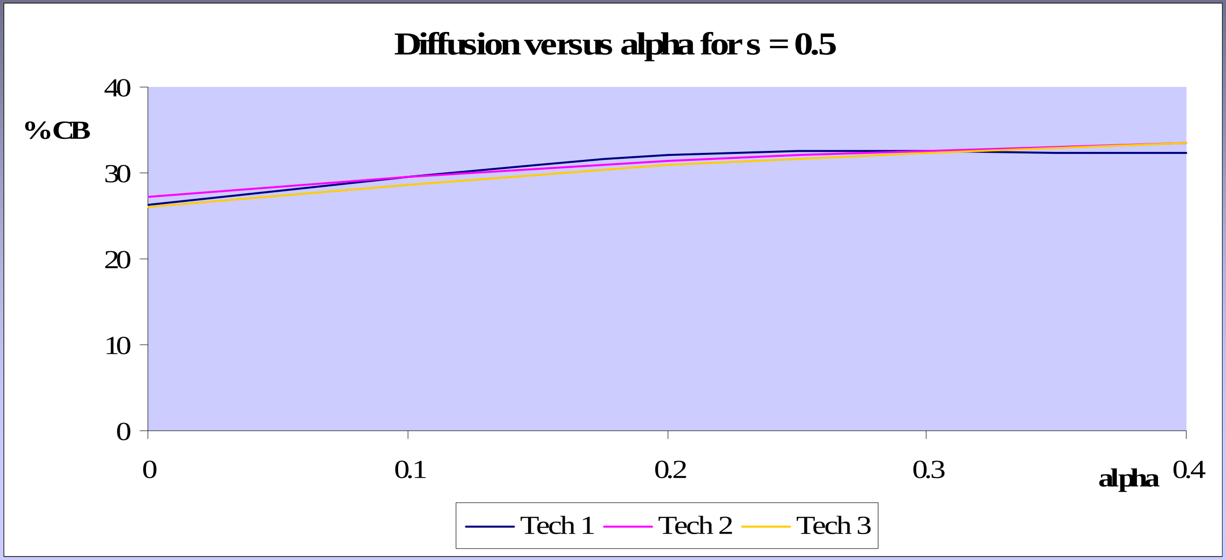
P = [1, 1, 1]

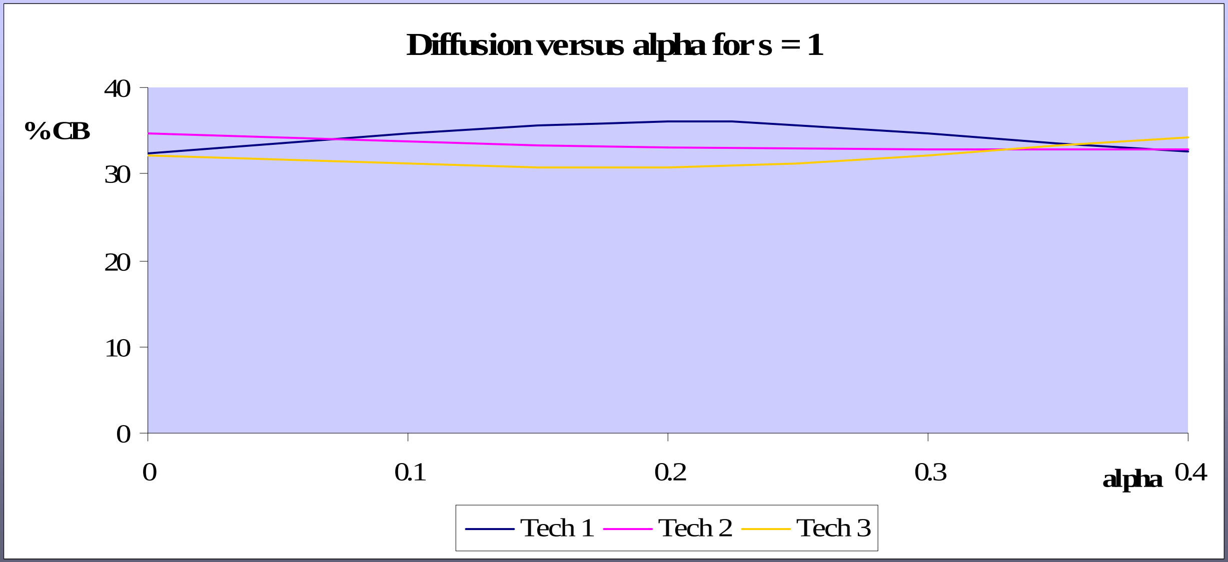


P = [1, 3, 6]

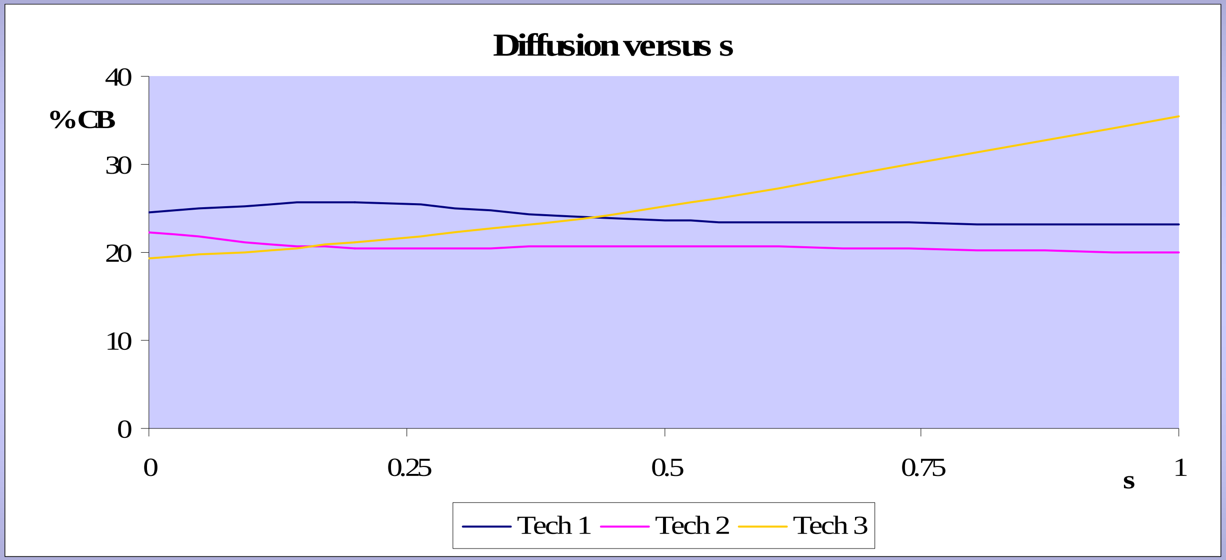
Policy Implications

Set of initial prices = [1, 1, 1]





An application: alpha =[0, 0.1, 0.2]
Subsidy Policy applied only to Tech 3
Set of price p =[1,3,6]



Preliminary Conclusions

In a bi-dimensional lattice each technology follows a similar path of diffusion: information feedbacks do not seem to drive a certain technology to market dominance (is it because there are others factors involved or is it a combination of information feedbacks and others factors?)

The effect of demand-pull policies on technology diffusion: subsidies do not play a relevant role in enhancing market dominance when technologies have a similar price. However they might consistently trigger the diffusion of a technology with high up-front costs (if the spread of that technology is characterized by learning economies).

Further Research

Including variable costs and consumers' behaviour in order to analyze the combined effects of subsidies and taxes

Changing the structure of the network: sampling (Lane and Arthur, 1973)

Combining the model with a supply model of diffusion
Analysing diverse market structure (oligopoly)

Comparing the model with a rational model of technology adoption

Thank you for your attention

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