



3 e 4 de Setembro
BRASÍLIA/DF
2015



UFABC - EMBRAPA - BOLDNESS
UFABC - EMBRAPA - BOLDNESS

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Instituto Alberto Coimbra-COPPE/UFRJ

MODELS: WHAT ARE THEY
GOOD FOR?

THE DIFFUSION APPROACH

BROWNIAN MOTION, FICK, EINSTEIN, SMOLUCHOWSKI, BOLTZMANN

Applications

- **Mass transfer: Diffusion in gases**
- **Energy propagation: Heat conduction**
- **Population dynamics: Fishes**
- **Epidemiology: malaria spreading**
- **Social context**
 - **Knowledge transfer**
 - **Economics**

The celebrated Black & Sholes equation

$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS \frac{\partial V}{\partial S} - rV = 0.$$

THE DIFFUSION APPROACH

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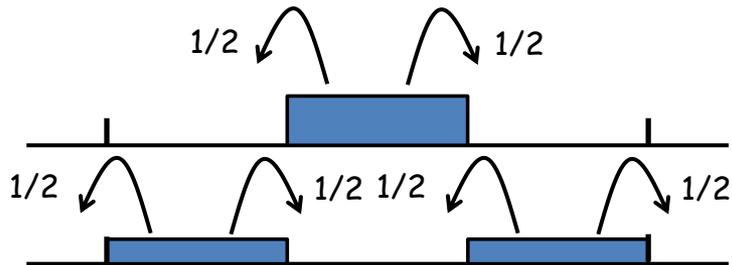
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The celebrated Black & Sholes equation

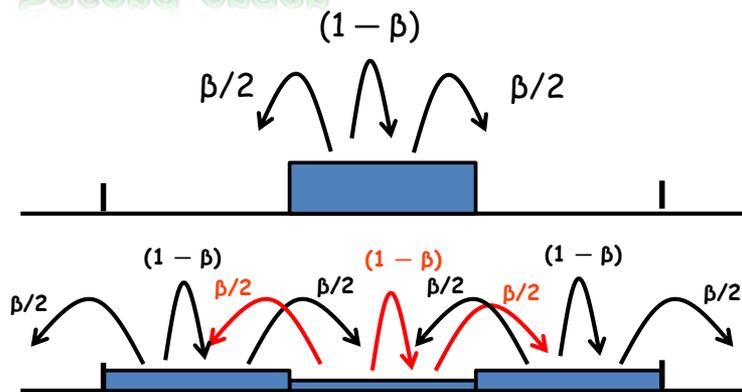
$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS \frac{\partial V}{\partial S} - rV = 0.$$

THE DISCRETE APPROACH TO THE DIFFUSION PROCESS

Classical

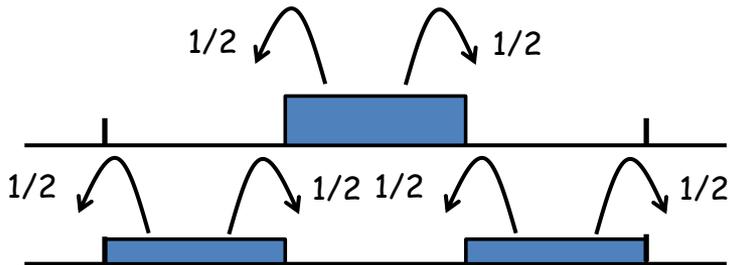


Second order



THE DISCRETE APPROACH TO THE DIFFUSION PROCESS

Classical

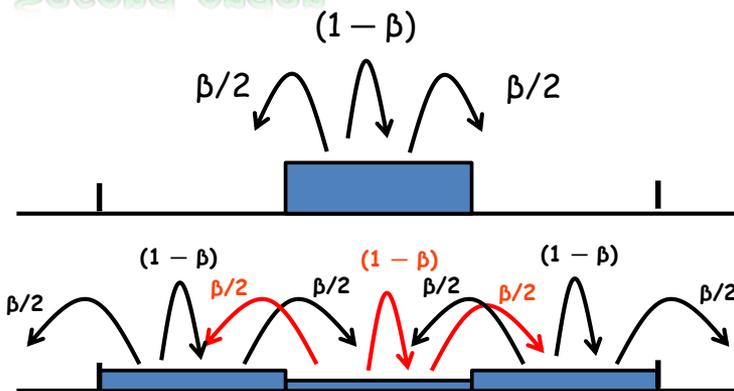


$$\frac{\partial q}{\partial x} = D \frac{\partial^2 q}{\partial x^2}$$

$$q_n^t = (1 - \beta)q_n^{t-1} + \frac{1}{2}\beta q_{n-1}^{t-1} + \frac{1}{2}\beta q_{n+1}^{t-1}$$

$$q_n^{t+1} = (1 - \beta)q_n^t + \frac{1}{2}\beta q_{n-1}^t + \frac{1}{2}\beta q_{n+1}^t$$

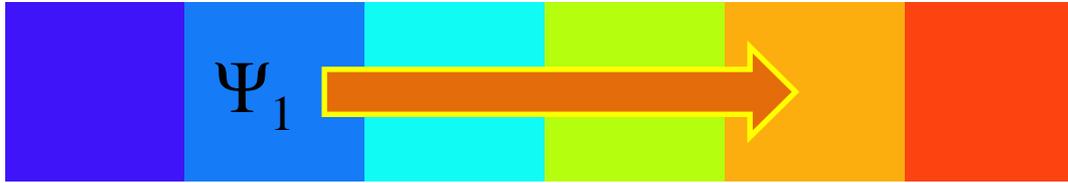
Second order



$$\frac{\partial q}{\partial x} = \beta D \frac{\partial^2 q}{\partial x^2} - \beta(1 - \beta)R \frac{\partial^4 q}{\partial x^4}$$

SINGLE FLUX AND BI-FLUX DIFFUSION

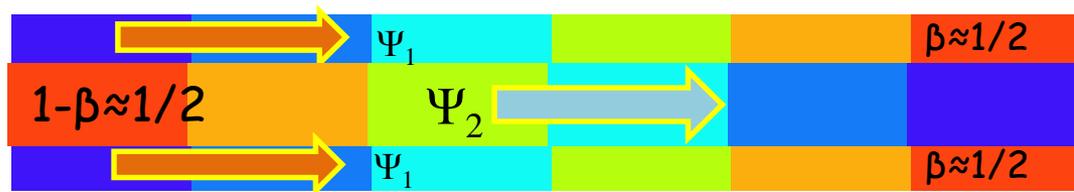
First order theory - Single flux Classical Theory



$$\Psi_1 = -D \frac{\partial q}{\partial x}$$

Single parameter D

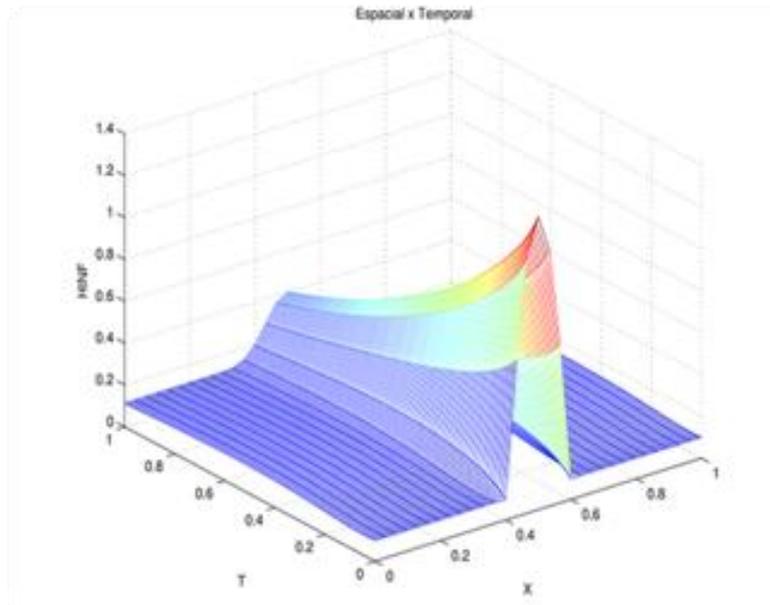
Second order theory - Bi-flux New Theory



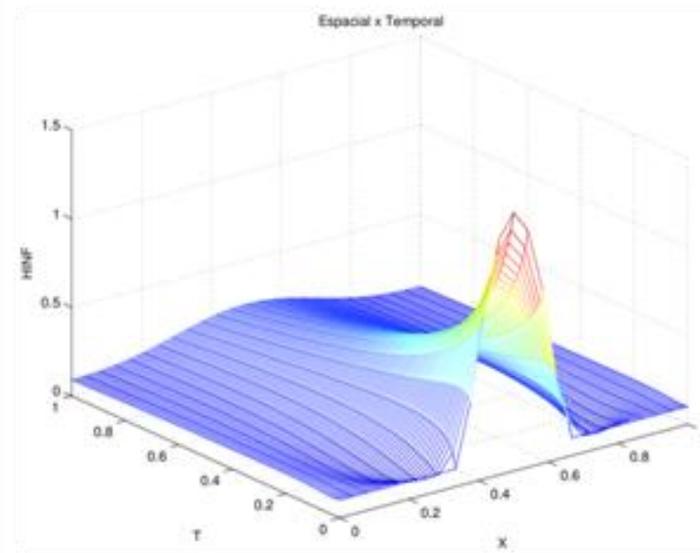
$$\Psi_1 = -D \frac{\partial q}{\partial x} \quad \Psi_2 = \beta R \frac{\partial^3 q}{\partial x^3}$$

Three parameters D, R, β

FIRST ORDER AND SECOND ORDER THEORIES



First order

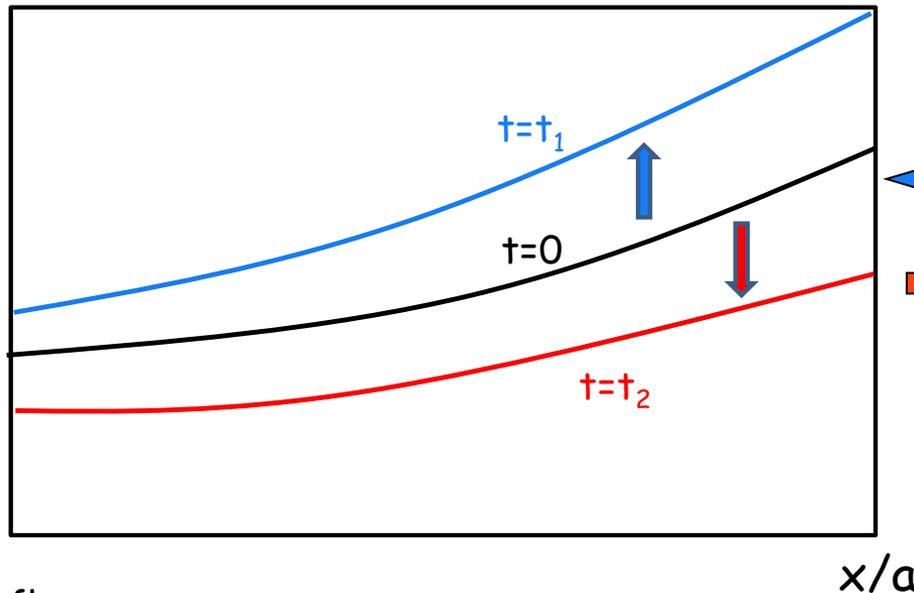


Second order

Fig.1. Response to a concentrated distribution at $x=0.5$. (a) Single flux diffusion process, classical solution; (b) bi-flux diffusion process, fourth order PDE .

AGGREGATED MONEY FLUX IN AN ECONOMIC CHAIN

$p(x,t)$



No flux

The initial distribution
($t=0$) could go up
(growth, $t=t_1$) or
down (recession $t=t_1$)
depending on the
values of D, R, β and a

Parameter controlling the
evolution of the process

$$\rho = \frac{D\beta}{a^2} \left(1 - (1-\beta) \frac{R}{Da^2} \right)$$

$\rho > 0$ GROWTH
 $\rho < 0$ RECESSION
 $\rho = 0$ STAGNATION

COMMENTS ON THE KEY PARAMETERS

D : represent the tools to encourage (discourage) investments, high values of D correspond to intensification of the capital inflow rate

R : represents regulations to reduce (increase) the spending time rate, low values of R correspond to contention in the outflow rate that is it tends to decrease the cash outflow rate.

β : this is a very important parameter regulating the distribution between the volume of investments and expenditures. It also controls the outflow rate, if β is small the expenditure rate will fall in the same proportion. It means that if there is no money available payment becomes impossible.

x : may be considered as the set of the connected activities composing the economic chain.

VARIATION OF ρ AS FUNCTION OF β AND R

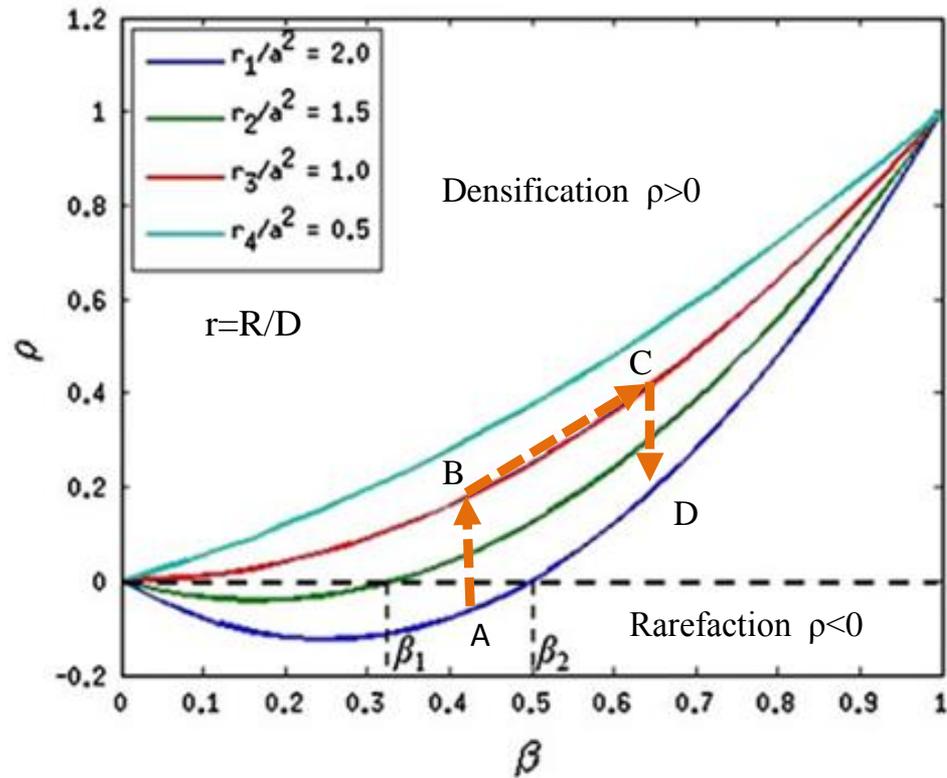


Fig.8. Variation of the evolution control parameter ρ with the mass fraction distribution β

Strategies to recover from a recession scenario with the initial constraint $\beta = \text{constant}$

From A to B relax regulations and outflow rate. Reduce R

From B to C with a promising growth attract more capital, increase inflow rate β

From C to D if necessary may return to the original restraints and continue growing

VARIATION OF ρ AS FUNCTION OF β , R AND THE SOURCE INTENSITY α

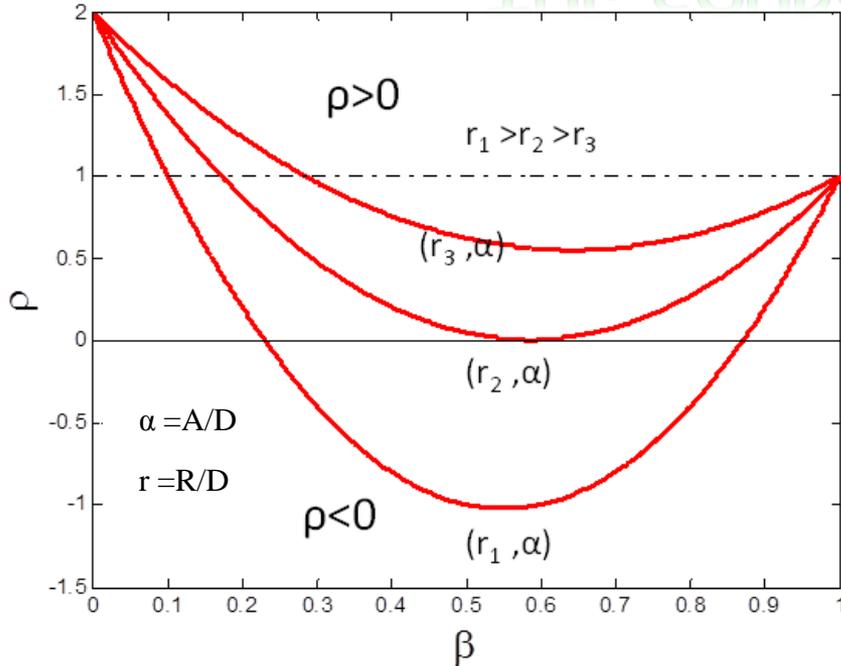


Fig.9. Influence of the parameter r on the evolution of an economic chain for a given source $\alpha=2.0$. $r_1 = 10$, $r_2 = 5.8$, $r_3 = 3.5$.

Parameter controlling the evolution of the process

$$\rho = D(\beta^2 r + \beta(1-r-\alpha) + \alpha)$$

THE SOURCE TERM COMPENSATE THE OUTFLOW VOLUME PROPORTIONAL TO $(1-\beta)$

$$\frac{\partial q}{\partial t} = \beta D \frac{\partial^2 q}{\partial x^2} - \beta(1-\beta)R \frac{\partial^4 q}{\partial x^4} + A(1-\beta)q$$

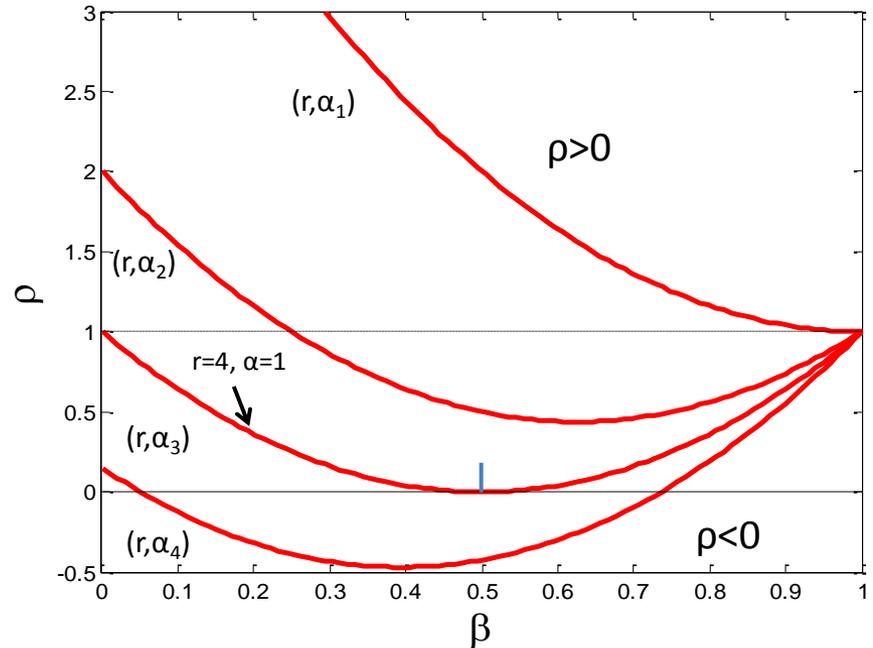
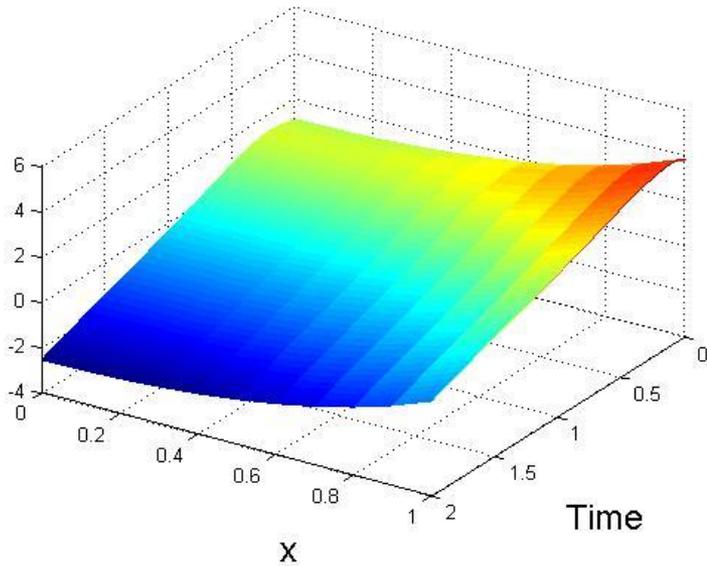


Fig 10. Influence of the source intensity on the evolution of an economic chain for (a) $r=4$; $\alpha_1=5$, $\alpha_2=2$, $\alpha_3=1$, $\alpha_4=0.1$;

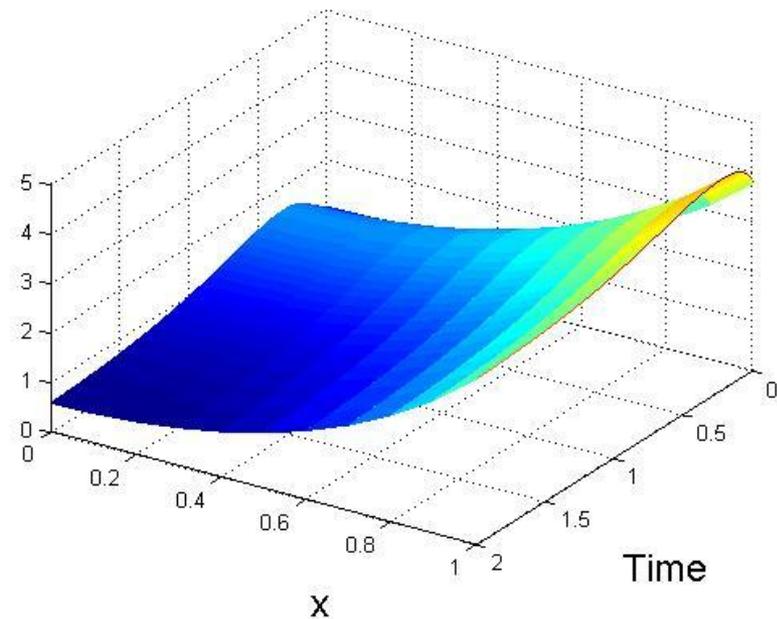
VARIATION OF q AS FUNCTION OF x AND t

β IS FUNCTION OF TIME

$D=1, R=1, dt=0.001, a=0.5, p_0=1, A=2, \beta=0.7-0.68 \cdot \exp(-2t)$



$D=1, R=1, dt=0.001, a=0.5, p_0=1, A=2.569, \beta=0.7-0.68 \cdot \exp(-2t)$



VARIATION OF ρ AS FUNCTION OF β , R AND THE SINK INTENSITY γ

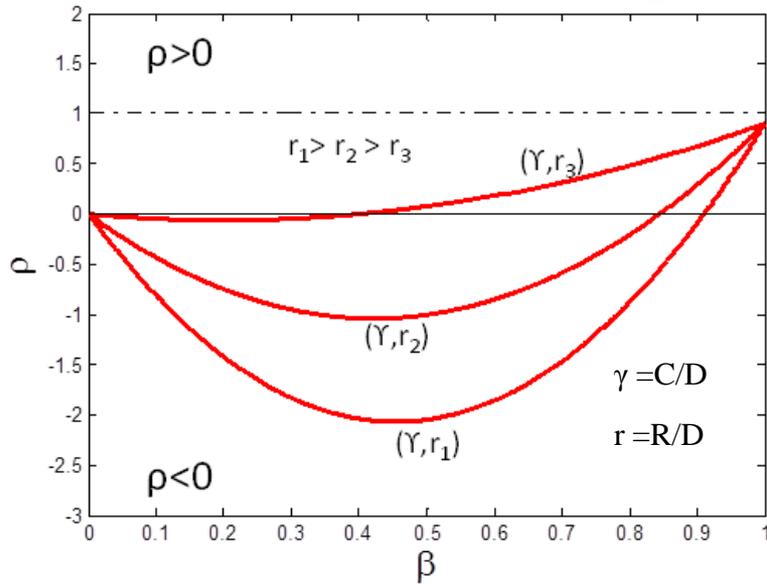


Fig.11. Influence of the parameter r on the evolution of an economic chain for a given sink $\gamma=0.1$; $r_1 = 10$, $r_2 = 5.8$, $r_3 = 1.5$.

Parameter controlling the evolution of the process

$$\rho = D\beta(\beta r - r - \gamma + 1)$$

THE SINK TERM EXTRACTS A FRACTION OF THE INFLOW VOLUME PROPORTIONAL TO β

$$\frac{\partial q}{\partial t} = \beta D \frac{\partial^2 q}{\partial x^2} - \beta(1-\beta)R \frac{\partial^4 q}{\partial x^4} - C\beta q$$

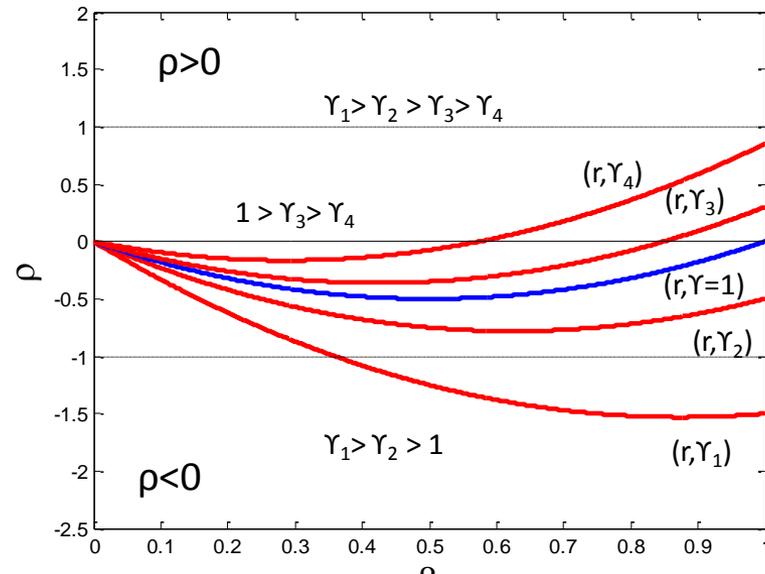
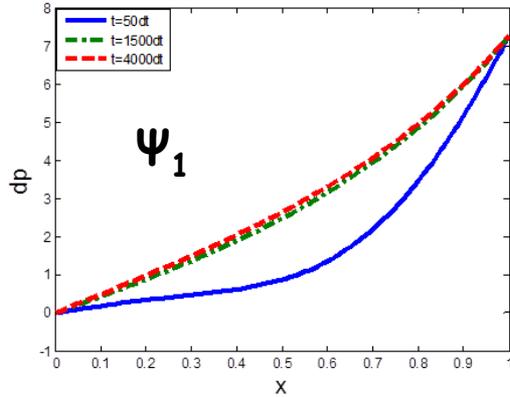


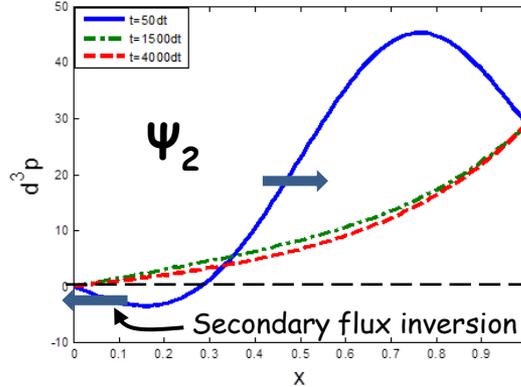
Fig.12. Influence of the parameter γ on the evolution of an economic chain for a given $r=2$; $\gamma_1=2.5$, $\gamma_2=1.5$, $\gamma_3=0.7$, $\gamma_4=0.15$.

INFLUENCE OF THE BOUNDARY CONDITIONS ON THE BEHAVIOR OF THE FLUXES

$D=0.1, R=0.05, \beta=0.75, dt=0.001, a=0.5, p_0=0.5,$

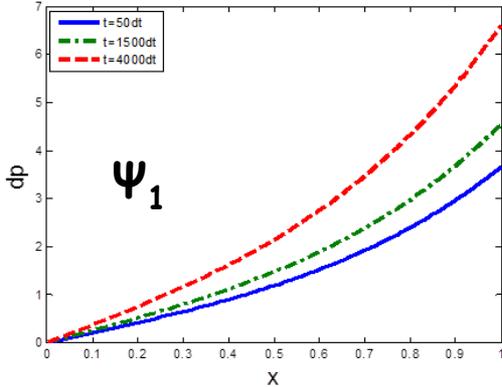


$D=0.1, R=0.05, \beta=0.75, dt=0.001, a=0.5, p_0=0.5,$

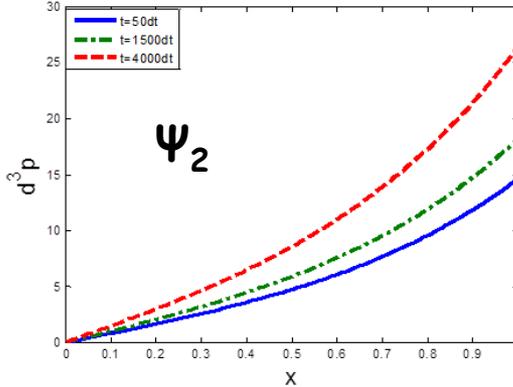


TIME INDEPENDENT
FIXED BOUNDARY
CONITIONS

$D=0.1, R=0.05, \beta=0.75, dt=0.001, a=0.5, p_0=0.5,$



$D=0.1, R=0.05, \beta=0.75, dt=0.001, a=0.5, p_0=0.5,$



TIME DEPENDENT
ADAPTATIVE BOUNDARY
CONITIONS

SUGGESTIONS FOR FUTURE RESEARCH WORK

Development of the capital flow model. The questions raised by the previous examples could only be answered through a deeper analysis of the significance of the coefficients D, R, β and a . Therefore it is necessary to select some cases, initially simple cases, to be reviewed under the light of the fourth order theory. Particular attention should be given to the following items:

- Establish a methodology to associate concrete economic data basis with the variables and coefficients introduced in the theory.
- Selection of some cases with reliable data, available and free to be used to test the model.
- Perform a detailed analysis with β as function of time and examine the influence on the answers given by the solution of the equation.
- A key question is to investigate the possibility of the resistivity R to be a function of β . If there is strong evidence supporting this hypothesis the behavior of the solution could be substantially modified to match real cases of economic evolution.
- Explore the significance of sources and sinks, probably associated with loans and debts.

SUGGESTIONS FOR FUTURE RESEARCH WORK

Mathematical analysis. Given that it is crucial to investigate the behavior of the fundamental equation with the parameters R , D and β as functions of x and t it is inevitable to devote part of the attention to mathematics. Also the addition of sinks and sources and the respective influence on the response is essential. Therefore we envisage the following topics to be considered:

- Development of numerical methods for nonlinear equations of the form:
- Analysis of the behavior of the linear fourth order equation with $\beta=\beta(t)$, function of time. Particular attention should be given to the term that for some particular conditions could lead to chaotic behavior.
- Analysis of the stability conditions of the solution for D and R functions of x . Anisotropic media. Influence of sinks and sources on the stability of the solutions.
- Behavior of particular cases with $R=R(\beta)$ as suggested by the input from the research line 2 above.
- If it is possible to associate capital inflow and outflow with two distinct "energy states" a new notion of "entropy" could be introduced in the economy dynamics.

VALIDATION OF A
CASE

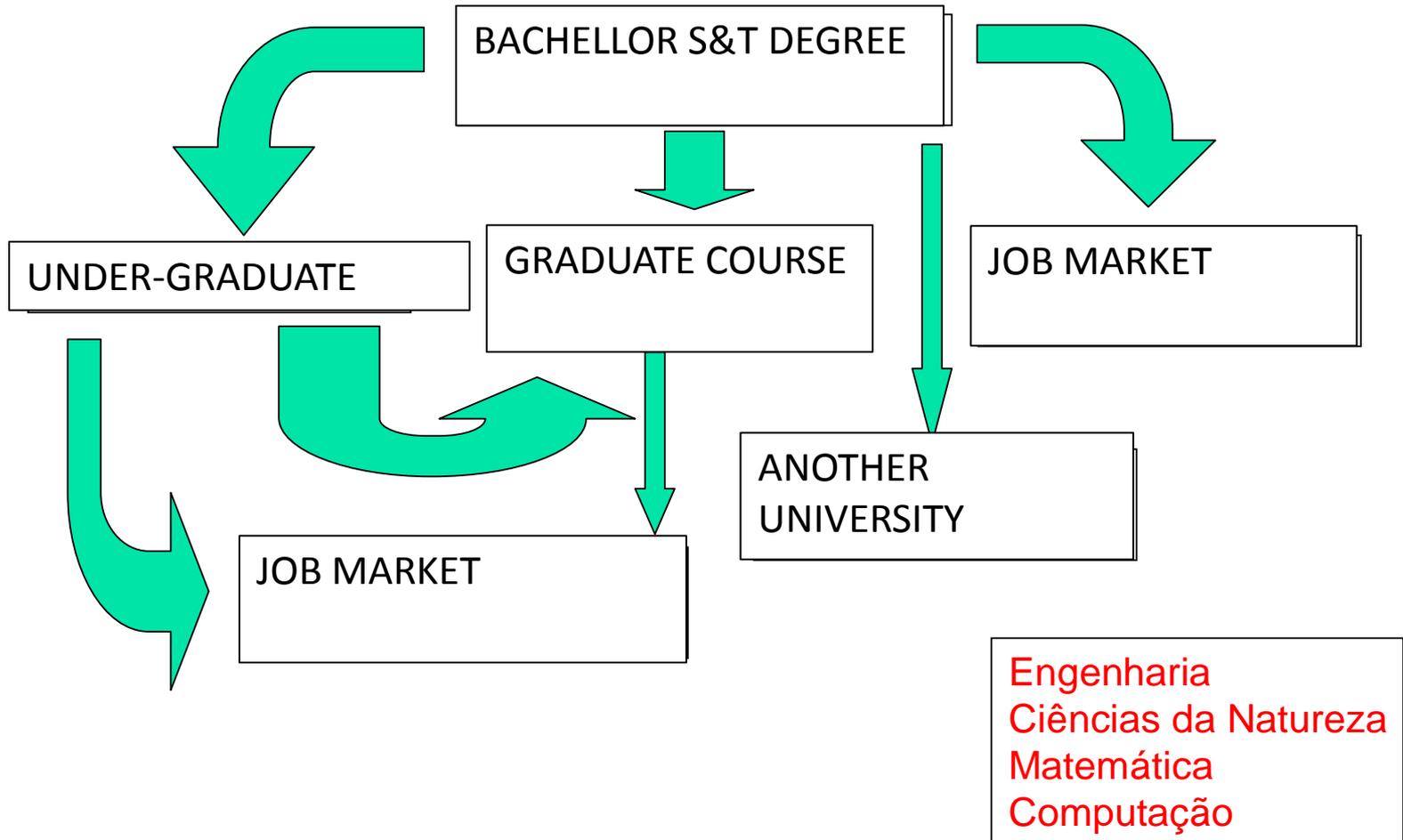
DOESN'T GUARANTEE
VALIDATION OF A
PHENOMENON

THE UFABC PROJECT

ACADEMIC STRUCTURE

- Abolition of the departmental organization
- Three Schools:
 - **Natural Sciences and Humanities**
 - **Mathematics and Cognition**
 - **Engineering and Social Sciences**
- Challenging new topics offered in courses under the supervision of the Undergraduate Studies Division
- Competence prevailing over diploma
- More freedom to select courses and professional options
- Students are admitted to the University not to a specific course

THE TRAJECTORIES



THE NEW SCIENTIFIC FRAMEWORK

- *Structure of Matter*
- *Energy*
- *Transformation Processes*
 - *Mechanically and physically driven*
 - *Life sciences*
- *Communication and Information*
- *Representation and Simulation
(Mathematics)*
- *Humanities and Social Sciences*

EDUCATION

- Fostering creativity - More individual work and less classes - Think.
- Building self-confidence - To dare and to reduce aversion to risk.
- Learning to take decisions and to take initiatives - Less complaints and more solutions.

EDUCATING FOR THE FUTURE THE UFABC ETHOS

The main commitment of the UFABC toward society is to **recover the appreciation for scientific learning**, to show the beauty inherent in the mysteries of nature and hidden in a mathematical object. It was founded on the assumption that knowledge is not only a means to response to market demands but **above all to the enlightenment of the human spirit.**

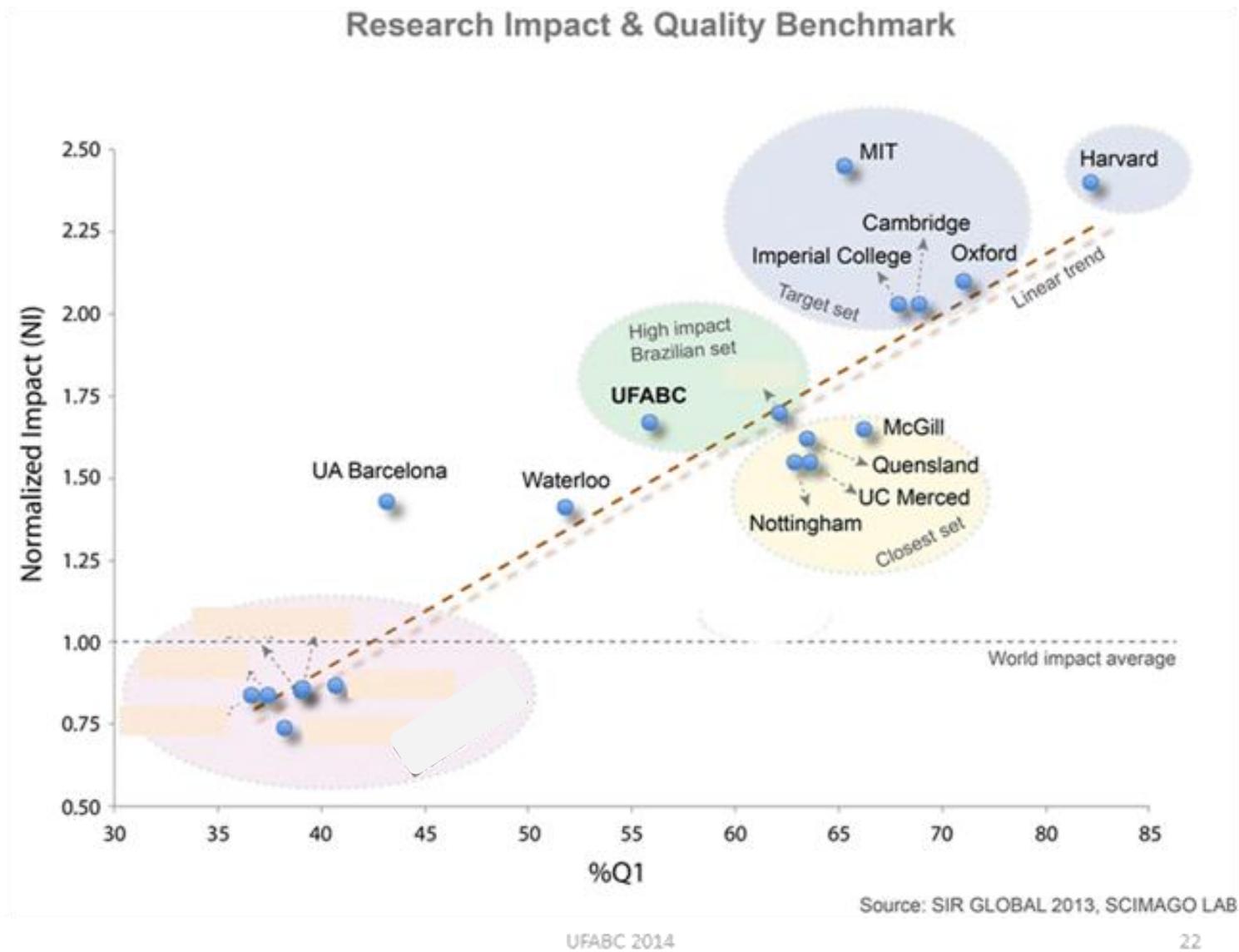


Fig. 1. Produção científica da UFABC, qualidade dos periódicos vs impacto, SIR GLOBAL 2013, SCIMAGO LAB

CLASSIFICAÇÃO IGC-2013

Índice Geral de Cursos

GERAL: IGC: 5 (4200 pontos) Ranking 2º

Conceito Preliminar de Curso:

Primeiro lugar: Química (Bacharelado e Licenciatura), Matemática (Bacharelado e Licenciatura), Engenharia Ambiental e Urbana, Engenharia de Materiais

FOLHA DE SÃO PAULO

PRIMEIRO LUGAR NO QUESITO INTERNACIONALIZAÇÃO

IEEE PRIZE 2014



Gostaria de dedicar este prêmio (anexo) aos senhores professores e compartilhar essas experiência dos últimos anos mostrando o quando eu considero o BC&T o grande diferencial e divisor de águas na minha formação não apenas do ponto de vista científico e profissional, mas também pessoal, além das diversas portas que este curso pioneiro e ousado abriu na minha vida.

.....
Thiago Alencar.

THE GUARDIAN (MAY 2015)

[The Federal University of ABC \(UFABC\)](#)

UFABC is proving the shining example of what public higher education in Brazil can become

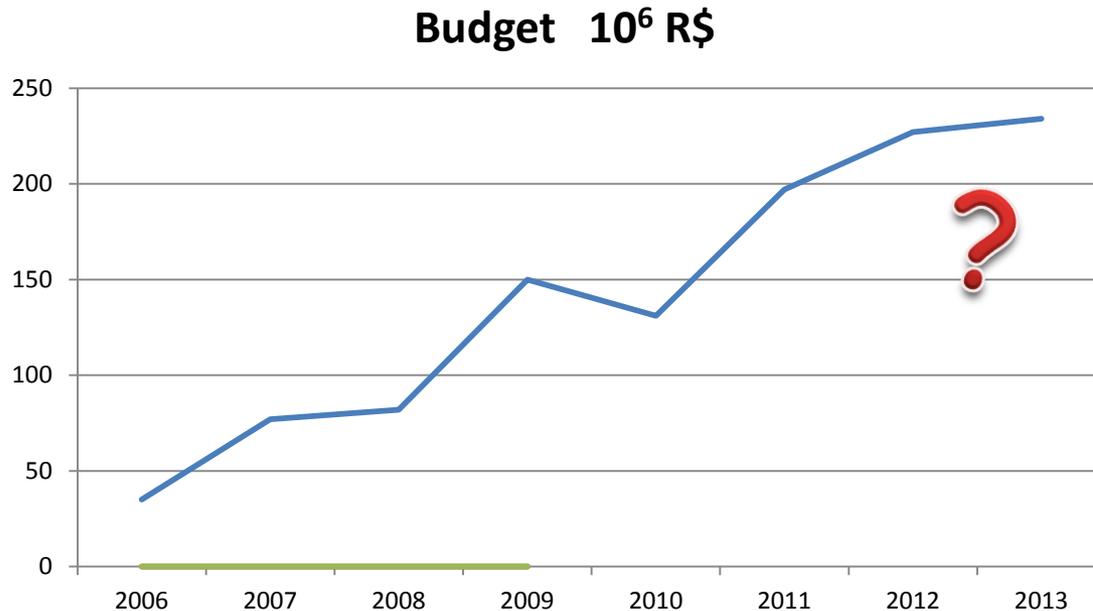
THEGUARDIAN.COM

The Federal University of ABC (UFABC)

President Lula may have drawn much of his power base from the unions he represented in local industry, but in the creation of the ABC region's Federal University he has paid back that loyalty. Shaking off the image of closed-off laboratories, conservative approaches and reluctance to change, UFABC is proving the shining example of what public higher education in Brazil can become

UFABC BUDGET EVOLUTION

UFABC BUDGET EVOLUTION



562 professores, todos Drs.
> 12.000 alunos
27 graduações
23 pós-graduações (13 com dout)

EMBRAPA

Embrapa: its origins and changes **Geraldo B. Martha Jr, Elisio Contini and Eliseu Alves'**

The government's response to the challenge of creating a new era in agriculture resulted in the creation in **1973** of the Brazilian Agricultural Research Corporation, Embrapa, a "research arm" of the Ministry of Agriculture, Livestock and Food Supply. This institution was given the mission of coordinating the Brazilian Agricultural Research System, composed of state agricultural research organizations, universities (agricultural colleges) and Embrapa itself.

RESEARCH IN EMBRAPA

Dr. Johanna Döbereiner played a decisive role in EMBRAPA development with her contribution to adapt soybeans in the northeast of Brazil. This was possible with her breakthrough contribution showing that nitrogen fixation could be done introducing [Azospirillum](#) and other bacteria that could be useful to Brazilian soil. Dr. Döbereiner proved that science is extremely useful to push technological development. Appreciation for science has always been one of the most important of the EMBRAPA's priorities.

In a interview for BC Brazil researchers in the field of agriculture were unanimous to declare that the most important contribution of EMBRAPA was the development of technologies that allowed for the correction of the soil acidity in the Northeast Brazil making possible the adaptation of plants coming from different biome. Before 1970 the Northeast region was irrelevant as a player in the agribusiness, nowadays this region contributes with almost 50% of the country's production.

RESEARCH IN EMBRAPA

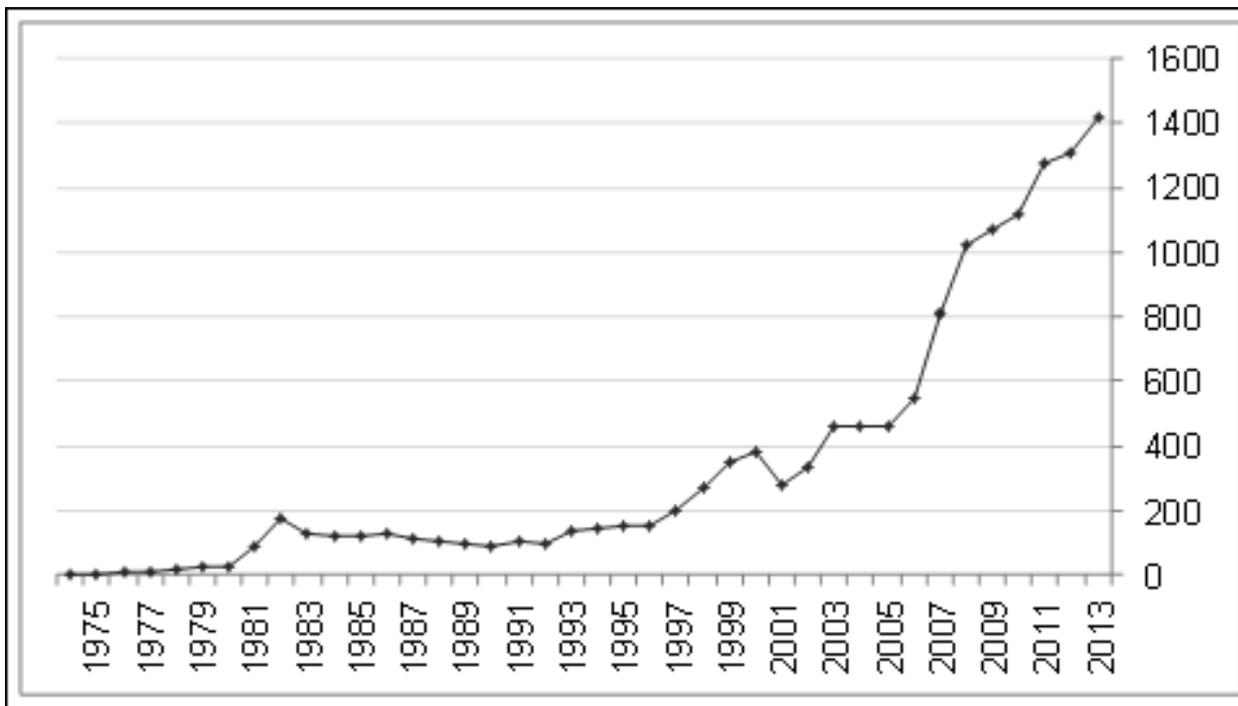


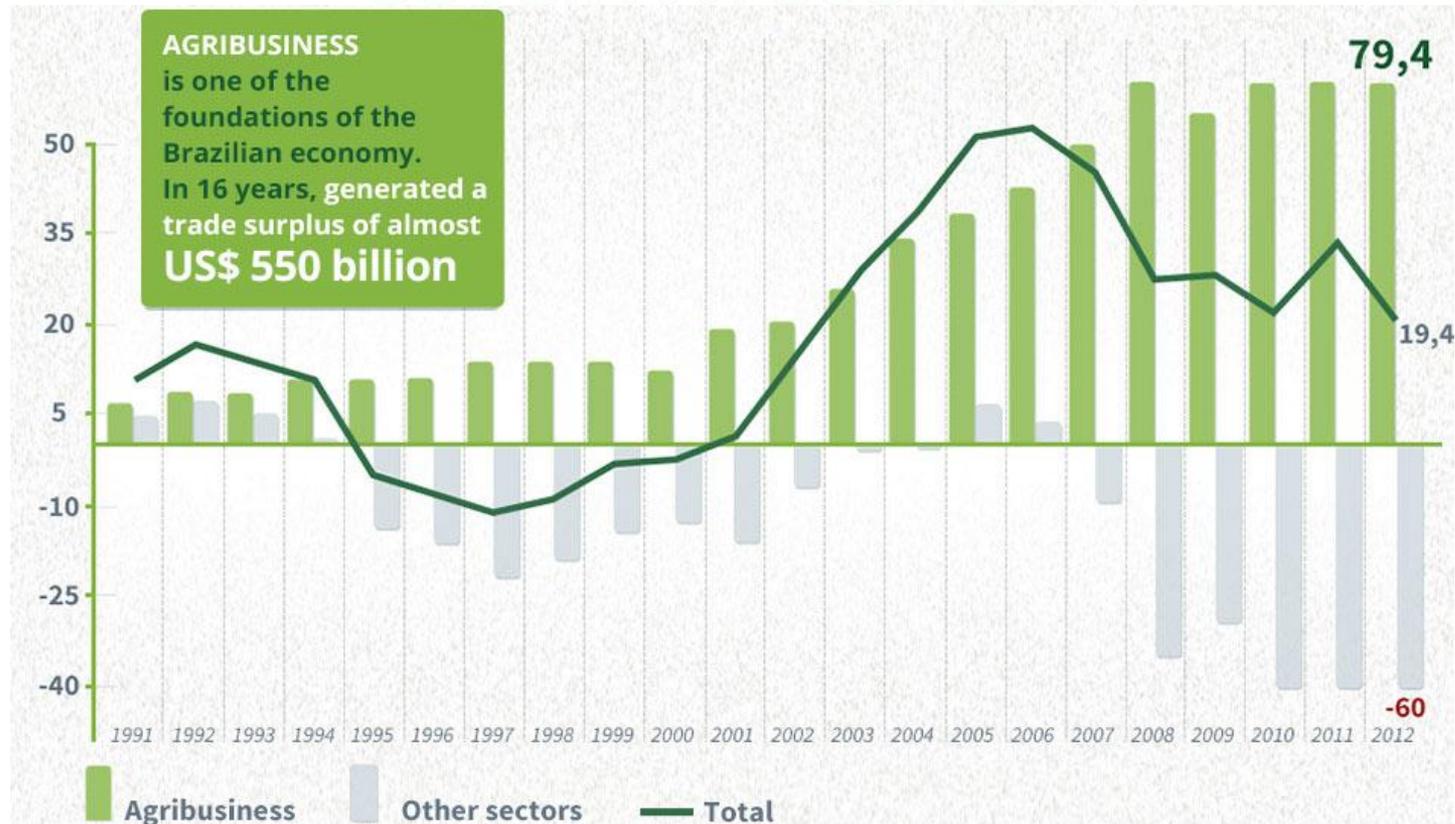
Figura 1. Produção de artigos científicos pela Embrapa em periódicos indexados na Web of Science de 1974 a 2013.

SOCIAL RETURN

Investing in technology is really worth it. The Social Profit/Net Revenue ratio in 2014 was of 8.53. In other words, each Brazilian real invested was returned to Brazilian society multiplied by 8.53. The returns from Embrapa's investment in the 106 technologies monitored and assessed since 1997, the year of the Social Report's inception, also indicate high yield and an average internal rate of return (IRR) of 39.4%.

In 2014, 66,255 new jobs were created. This is a baseline figure, as it refers to new jobs generated by the 106 technologies assessed in this report. Since Embrapa has developed and transferred thousands of technologies, products, and services to Brazilian society throughout the course of its history, such impact on the number of jobs created each year is certainly much higher.

AGRIBUSINESS CONTRIBUTION TO THE BRAZILIAN ECONOMY



Source: [Agrostat \(MAPA\)](#)

PRODUCTION AND ENVIRONMENT

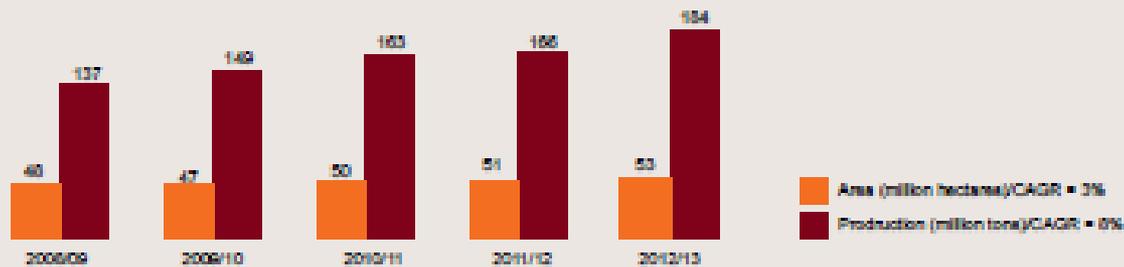
Agribusiness in
Brazil: an overview

pwc

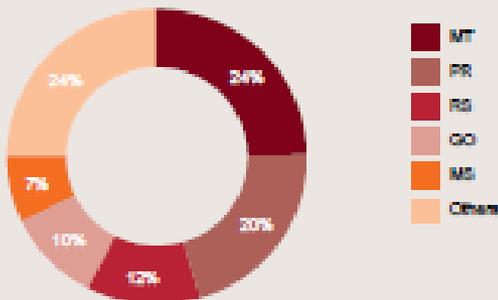


Oilseed & Grains complex

Grain production and planted area



Grain production by state
Harvest 2012/13*



*projection

Key grains by production and total area

Item	% of grain total production	% of total planted area
Soybean	45%	52%
Corn	42%	29%
Rice	7%	5%
Wheat	2%	4%
Beans	2%	6%
Cottonseed	1%	2%
Others	1%	2%

RECENT PROGRAMS

1. Controle de Pesca do Mato Grosso do Sul - SCPesca/MS), which enabled the management and the conservation of fish stocks in Pantanal.
2. Technology reduces deforestation and guarantees milk production in the Amazon region
3. App Suplementa Certo helps farmers decide on cattle feed during draughts
4. INPE-Embrapa Partnership in land monitoring in Amazonia extended to Cerrado
5. Booroola mutation expands sheep meat production in Southern Brazil
6. Draught-resistant cashew clone generates wealth in Piauí semiarid
7. New gene bank broadens Embrapa's contribution to food security in the planet
8. Embrapa's new website potencializes technology transfer

Recognition from society: 70 awards and honours in 2014

EMBRAPA- BUDGET EVOLUTION

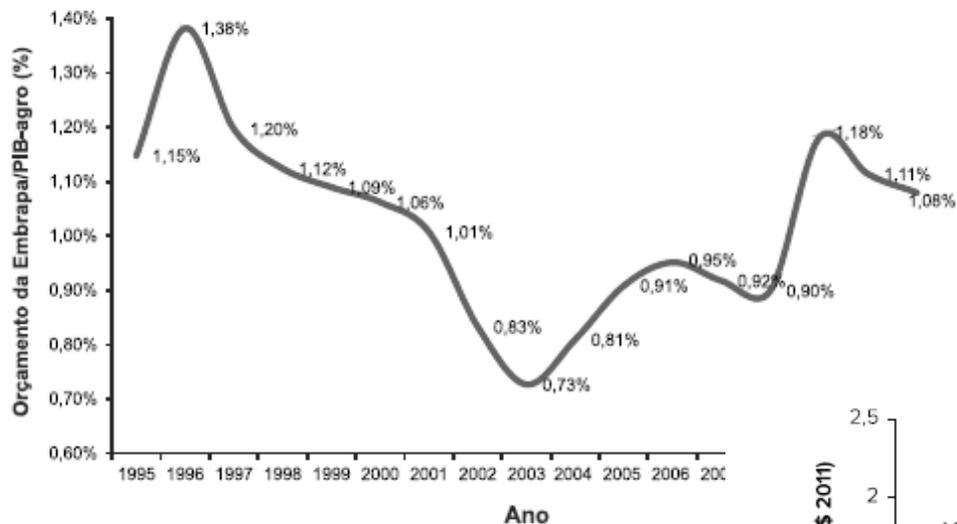


Figura 3. Evolução do orçamento da Embrapa, expresso em produto interno bruto do setor agropecuário (PIB-agro).

Fonte: Embrapa (2013) e IBGE (2013).

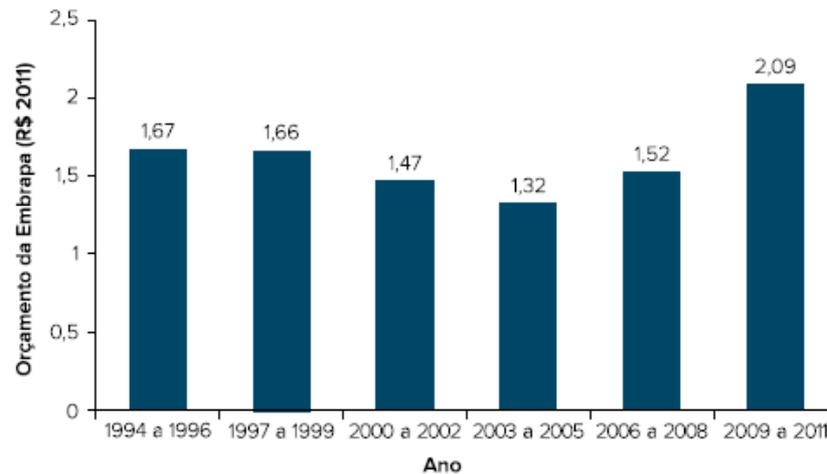


Figura 2. Evolução do orçamento da Embrapa, em termos reais, no período de 1994 a 2011. Valores médios do triênio, em bilhões (R\$) de 2011; valores deflacionados pela média anual do IGP-DI/FGV.

Fonte: Embrapa (2013).

THNAXKS FOR YOUR ATTENTION