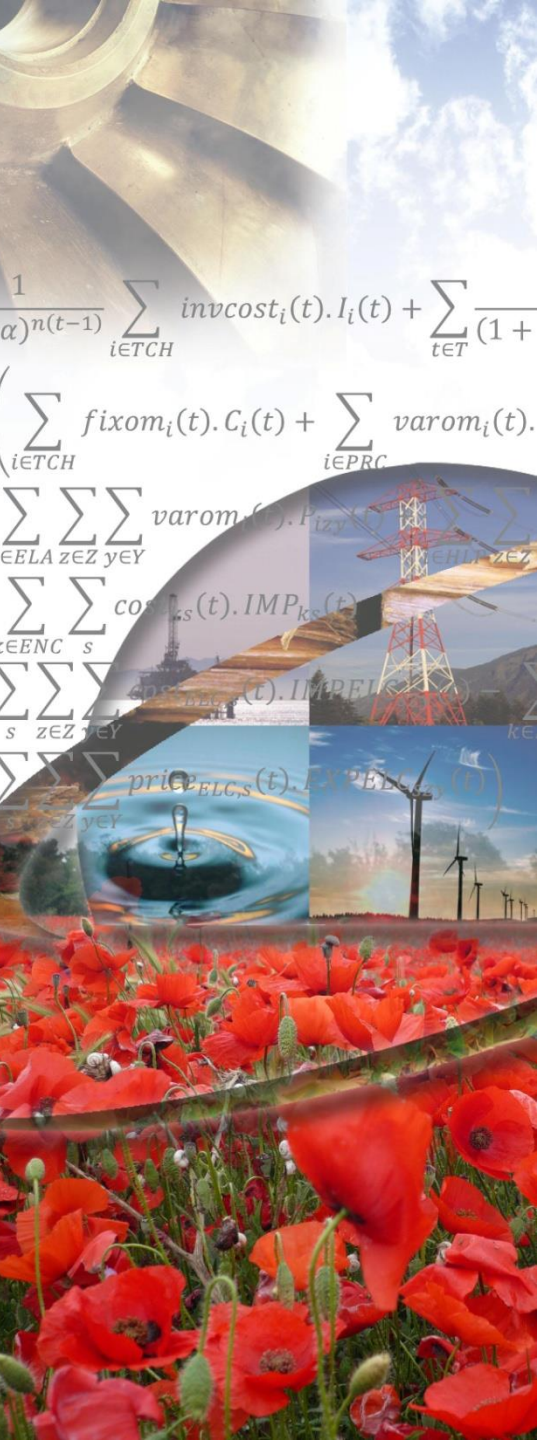
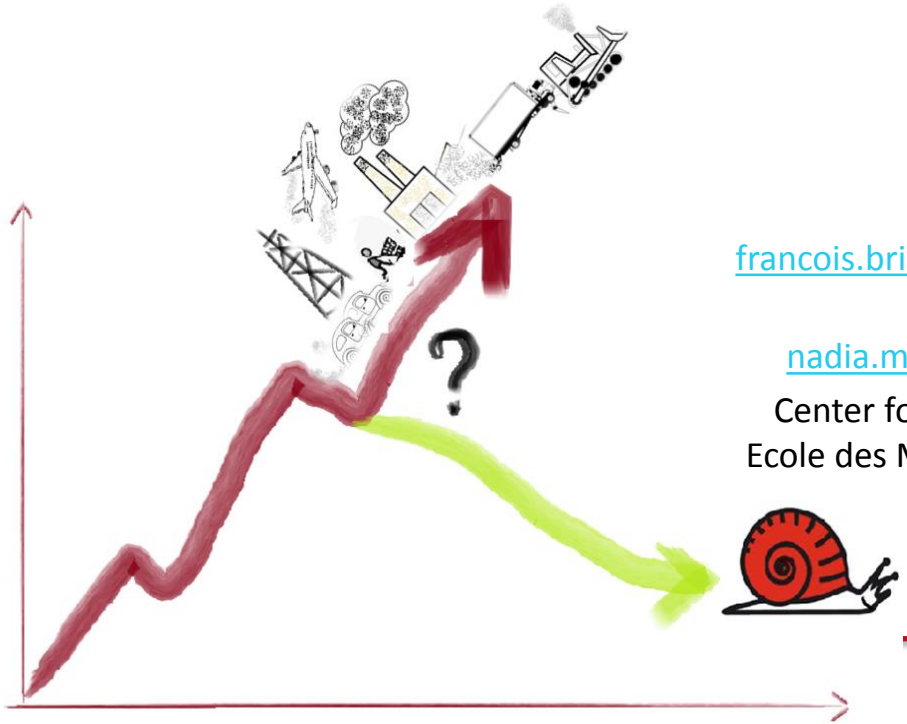


Centre for Applied Mathematics

Prospective modeling for Degrowth

Investigating macroeconomic scenarios for France



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04/09/2014

CONTENT

- Some challenging issues for the 21st century:
  - *Environment and Climate Change*
  - *Energy and Material Ressources*
  - *Financial and Economic unstability*
  - *Inequalities and Social disruption …*

=> A multi-dimensionnal Crisis…

- Different perspectives:

« *Sustainable Development* » and « *Green Growth* »

or

«Sustainable Degrowth »

?

« *Degrowth* »?

⇒ **A project of transition toward a society of « *frugal abundance* » (S.Latouche)**

⇒ A « *matrix* » for multiple alternatives, « *R -oriented* »

relocating, reevaluating, reconceptualizing, restructuring, redistributing, reducing, re-using, recycling,…

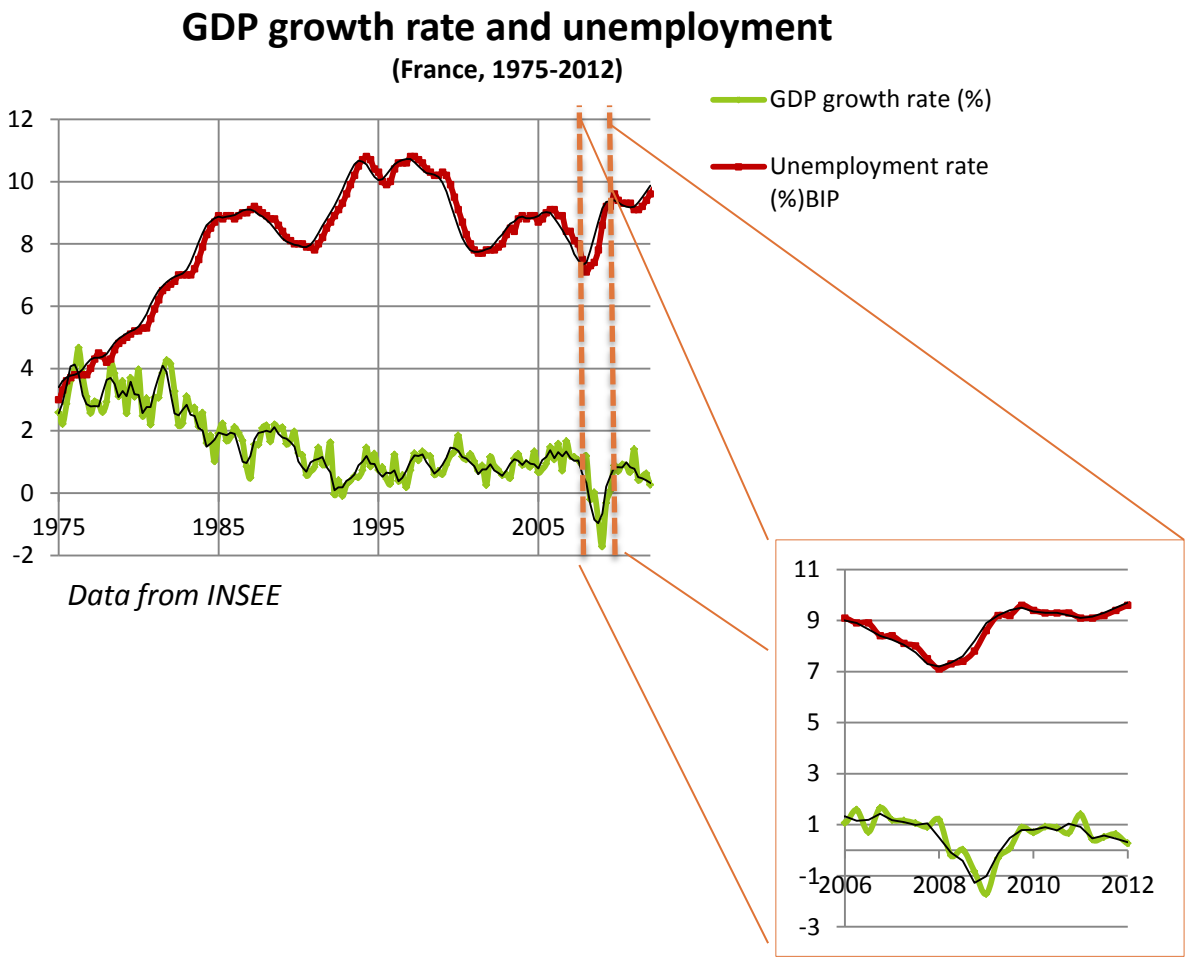
➢ **Ambition:**

A *voluntary* , *democratic*, *socially sustainable*, *equitable, smooth* **downscaling of production and consumption** for high consumption countries, to an *environmentally sustainable* level

CONTENT

3. Statement of my problem (1/2)

- « Degrowth » often has a negative connotation in our social imaginary *(still…)*
- In current capitalist systems, economic growth is a *structural imperative*



Data from INSEE

3. Statement of my problem (2/2)

- **GDP degrowth is a plausible *consequence* of Degrowth**

⇒ Can it happen in a socially and environmentally *sustainable* way?

⇒ Under which conditions? (any institutional or structural obstacles?)

⇒ Which concrete proposals could enable a *sustainable* Degrowth?

⇒ Welfare state in a degrown economy?

-> What can applied modeling tell us?

CONTENT

4. Preliminary concerns (1/2)

- *How to implement « degrowth » in a modeling framework?*

-> Starting from *concrete* proposals emerging from the Degrowth movement:

Tax proposals:
- Taxes or caps on resources extraction or consumption, or on waste emission
- Progressive pricing for energy, water, …
- Bans, regulation or taxation of advertisement

Technology (reorientation /redefinition of technical progress)
- Selective moratoria on technologies and limits to new large-infrastructure projects
- Eco-design, repairing, reusing, recycling (durability of goods against obsolescence)
- Switching from industrial agriculture to agroecology and organic farming

Agent behaviors
- Development of not-for-profit organizations, cooperatives, social enterprises
- Consumption sobriety
- "Commoning"; house-, car-, bike-, equipment-,(…)- sharing

Institutions
- Reduced working time in the paid sector, work-sharing
- Basic Income (BI) or Unconditional Autonomy Allowance (UAA), and income ceiling
- Development of non-speculative local currencies
- 100% reserve banking and transformation of the credit-debt-based money creation system

Structure
- Economy (re-)localization
- (Etc.)

Cf. G.A.P.!!!

->Arising from **systemic** considerations

=> Modeling various **sets/combinations** of proposals (*≠nature and scale*)

- *Which criteria and indicators to assess « degrowth » scenarios ?*

- Choosing an “appropriate” set of indicators remains highly value-laden

=>accounting for value pluralism means including a broad range of indicators of ***different nature***

- Among indicators that can be “processed” in a quantitative model:

=>Special focus on:

-Macro socio-economic evolutions
(Employment, working hours, poverty, public debt,…)

-Environmental sustainability
(Energy consumption, GHG emissions, Waste Production)

CONTENT

5. Current tools for *economy-environment-energy* modelling

Most common quantitative modeling paradigms:

- Agent-Based Models (ABM)
- System Dynamics (SD)
- Bayesian (Beliefs) Networks (BBN)
- Macro-econometric models
- Computable General Equilibrium Models (CGEM)
- Partial equilibrium models
- Centralized optimization models (Ramsey-Cass-Koopmans optimal growth models (ex: DICE) or energy chain models such as MarkAl-TIMES)
- Extended input-output analysis

=> Which one(s) fit(s) our purpose?

-> There is no *obvious* « best tool » to cover *simultaneously* the wide range of indicators (social *and* biophysical) and the variety of degrowth proposals

5. Comments on Current tools

A few epistemological and methodological considerations:

-> Inappropriateness of extrapolative approach (paradigmatic change)

-> Inacurrateness and irrelevance of utilitarianist approaches

-> Interest of Dynamic features

-> Dealing with complexity:

« Ce qui est simple est faux, ce qui ne l'est pas est inutilisable » [Paul Valery]

-> Limited dual complexity & complicatedness of the model

-> Dealing with uncertainty with « what-if » Scenarios and Sensitivity Analyses

CONTENT

6. Our approach

-> Home-made Dynamic Simulation Model with STELLA ®
-> Based on *French* National Accounts
-> Focus on *Structural* (rather than conjonctural) issues (Long term concerns)

Survey results

Degrowth proposals

(e.g.: frugality, "commoning" and sharing (cars, equipment, etc.), repairing, reusing, recycling –durability of goods-, fiscal policy and redistribution, Working time policy, re-localization, small scale farming and agroecology, not-for-profit organizations, etc.)

Scenarios for Sectorial Demand

Input-Output Analysis

Sectorial Production targets, Added Value (GDP)

Output

Energy Consumption, GHG Emissions, Employment, Poverty, Government budget balance, public debt…

6. Our approach

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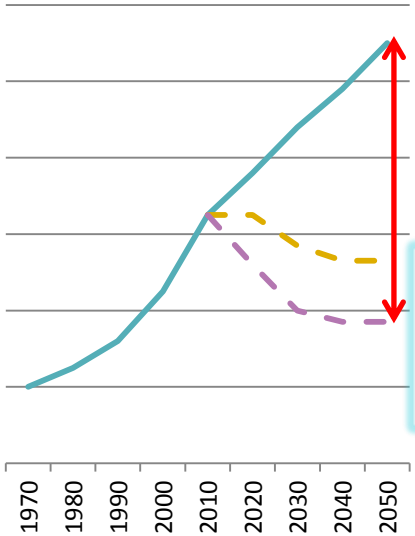
6. Our approach

Survey- Focus Groups

- **Purpose:** participative building of scenarios for the evolution of final demand in goods and services

- Using the classification in Products or functions of consumption (COICOP)

FON01	Produits alimentaires et boissons non alcoolisées
FON02	Boissons alcoolisées et Tabac
FON03	Articles d'habillement et chaussures
FON04	Logement, eau gaz, électricité et autres combustibles
FON05	Meubles, articles de ménage et entretien courant de l'habitation
FON051	Meubles, articles d'ameublement, tapis et autres revêtements de sol
FON052	Articles de ménage en textile
FON053	Appareils ménagers
FON054	Verrerie, vaisselle et ustensiles de ménage
FON055	Outillage et autre matériel pour la maison et le jardin
FON056	Biens et services liés à l'entretien courant de l'habitation
FON07	Transports
FON071	Achats de véhicules
Etc.	



« How much? »
&
« How ?»

- For each function:

  -> Discussing its possible, desirable/acceptable evolution *per person* or *per household* with respect to current level

  -> And possible ways to operate this evolution

  (e.g. gross reduction of service consumption, equipment sharing, repairing, extended lifetime, etc.)

6. Our approach

Survey results

Degrowth proposals

(e.g.: frugality, "commoning" and sharing (cars, equipment, etc.), repairing, reusing, recycling –durability of goods-, fiscal policy and redistribution, Working time policy, re-localization, small scale farming and agroecology, not-for-profit organizations, etc.)

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Energy Consumption, GHG Emissions, Employment, Poverty, Government budget balance, public debt…

The Model - Sectorial Macro Final Demand *(1/7)*

- **Total Final Demand in goods and services**

For each branch ***i*** of the economy:

Total Final Demand $_i$ =

Final Consumption $_i$ *(households)*

+

Investment in products $_i$

+

Export $_i$

–

Import $_i$

6. Our approach

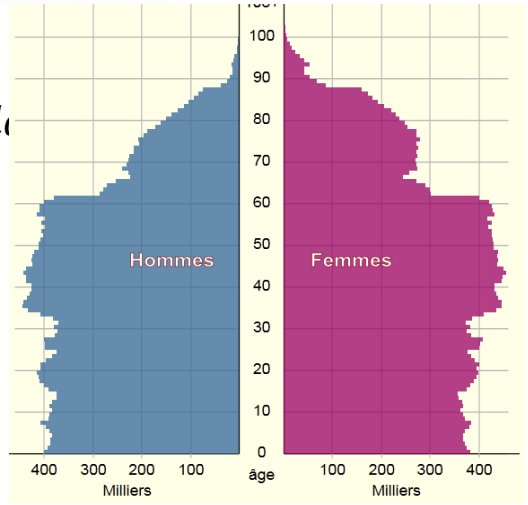
The Model - Sectorial Macro Final Demand *(2/7)*

$$Final\ consumption\ of\ household = Final\ consumption\ per\ person\ or\ household \times Population\ or\ households$$

- **Population**

- Cohorts Model

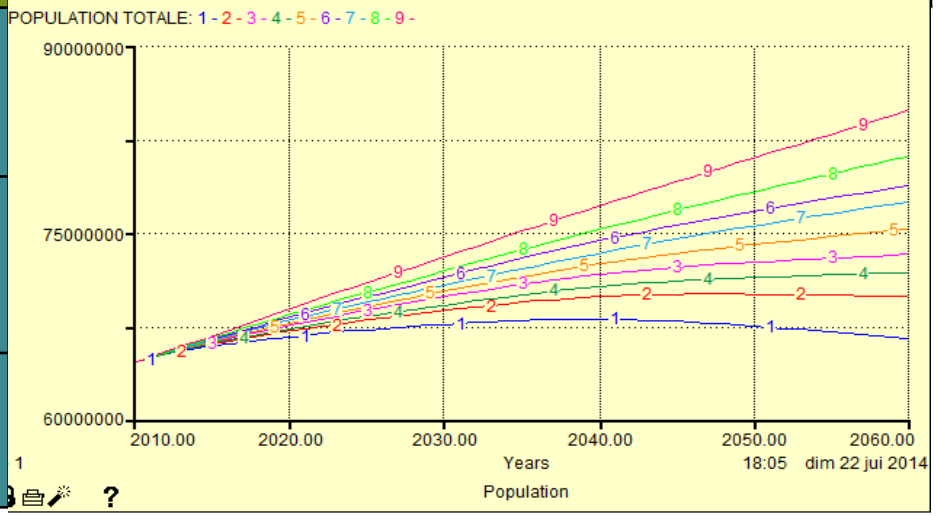
0-2	3-10	11-14	15-17	18-24	25-29	39-49	50-54	55-59	60-64	65-74	75-84	85 &+



Source: http://www.insee.fr/fr/ppp/bases-de-donnees/irweb/projpop0760/dd/pyramide/pyramide.htm

- 9 scenarios from INSEE up to 2060:

Demography \ Immigration	LOW	MEDIUM	HIGH
LOW			
MEDIUM			
HIGH			



The Model - Sectorial Macro Final Demand *(3/7)*

- **Total Final Demand in goods and services**

For each branch ***i*** of the economy:

Total Final Demand $_i$ =

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+

Investment in products $_i$

+

Export $_i$

–

Import $_i$

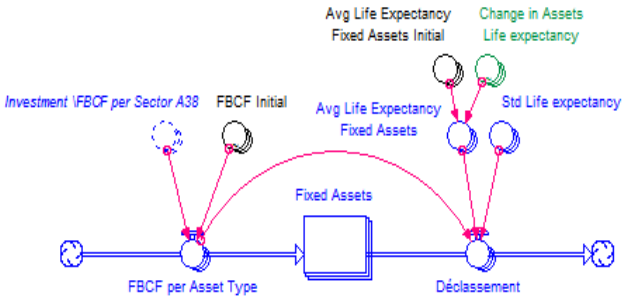
The Model - Sectorial Macro Final Demand *(4/7)*

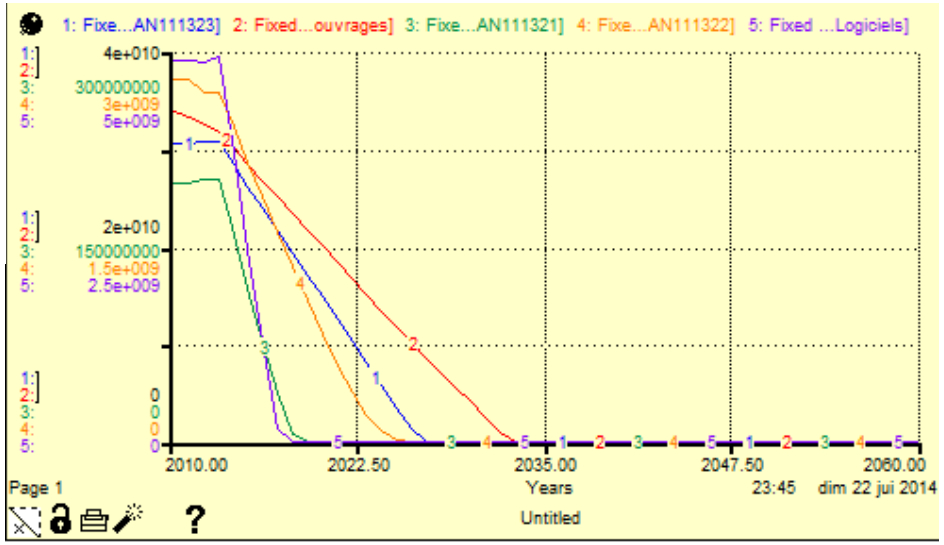
- **Capital Stocks and Investment (1/2)**

⇒ Survival laws: Asset Life expectancy following a normal distribution (avg lifetime;std) for each branch i and each asset type j

$$\sum_{t=-\infty}^{t=time} Investment_{i,j}(t) * \left(1 - S_{i,j}(time - t)\right)$$

with Sij the survival coefficient, and (1-Sij) following a cumulated normal distribution





Different asset types

Housings
Other buildings
Transport equipement
IT equipment
Cultivated assets
Softwares
Etc.

The Model - Sectorial Macro Final Demand *(5/7)*

- **Capital Stocks and Investment (2/2)**

$\Rightarrow$ Investment:

Matching a *capital stock target* corresponding to « forcasted » production level and capital productivity ($\frac{Production}{K}$) of branch i

$$Investment_{branch\ i,asset\ type\ j}(t) = \frac{Forcasted\ production_i(t+dt)}{Kproductivity_{i,j}(t)} - stock\ K_{i,j}(t)$$

The Model - Sectorial Macro Final Demand *(6/7)*

- **Total Final Demand in goods and services**

For each branch ***i*** of the economy:

Total Final Demand $_i$ =

Final Consumption $_i$ *(households)*

+

Investment in products $_i$

+

Export $_i$

–

Import $_i$

The Model - Sectorial Macro Final Demand *(7/7)*

- **Foreign Trade**

⇒ **Import**:

Using import coefficients for final consumption, investment and intermediate consumption

$$Total\ Import_i = \sum_i Final\ Goods\ \&\ Services_i * Import\ Share_i + \sum_i Intermediate\ Goods\ \&\ Services_i * Import\ Share_i + \sum_i Capital\ formation_i * Import\ Share_i$$

⇒ **Export**:

Proportional to import, or exogeneous

6. Our approach

The Model - Input Output Analysis

Survey results

Degrowth proposals

(e.g.: frugality, "commoning" and sharing (cars, equipment, etc.), repairing, reusing, recycling –durability of goods-, fiscal policy and redistribution, Working time policy, re-localization, small scale farming and agroecology, not-for-profit organizations, etc.)

Scenarios for Sectorial Demand

Input-Output Analysis

Sectorial Production targets, Added Value (GDP)

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Energy Consumption, GHG Emissions, Employment, Poverty, Government budget balance, public debt…

The Model - Input-Output Analysis

- **Input-Output Analysis - 38 Branches**

Hypothesis : Macro Supply = Macro Demand

$$Total\ Domestic\ Production = Intermediate\ Consumption + Final\ Consumption$$

$$x_1 = (a_{11}.x_1 + a_{12}.x_2 + \cdots + a_{1n}.x_n) + y_1$$
$$x_2 = (a_{21}.x_1 + a_{22}.x_2 + \cdots + a_{2n}.x_n) + y_2$$
$$x_{\dots} = (a_{\dots 1}.x_1 + a_{\dots 2}.x_2 + \cdots + a_{\dots n}.x_n) + y_{\dots}$$
$$x_n = (a_{n1}.x_1 + a_{n2}.x_2 + \cdots + a_{nn}.x_n) + y_n$$

with:

$\boldsymbol{x_i}$ = Total **output** of branch *i*

$\boldsymbol{y_i}$= Final **demand** for products *i* domestically produced

$\boldsymbol{a_{ij}}$= **Intermediate consumption** of domestic product *j* used to produce one unit in the branch *I*

$$=> [X] = [A]\ [X] + [Y]$$

Solving for [X], we have: $[X] = [I-A]^{-1} . [Y]$

where $[I-A]^{-1}$ is called the Leontief Inverse

6. Our approach

Survey results

Degrowth proposals

(e.g.: frugality, "commoning" and sharing (cars, equipment, etc.), repairing, reusing, recycling –durability of goods-, fiscal policy and redistribution, Working time policy, re-localization, small scale farming and agroecology, not-for-profit organizations, etc.)

Scenarios for Sectorial Demand

Input-Output Analysis

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The Model – Main Outputs *(1/3)*

- **Energy, GHG and Waste from production:**

⇒ Using « *Intensity coefficients* »
(estimated from Eurostat Data, INSEE, World Input-Output Database, Evolution rates to be fixed by the modeler)

$$Final\ \boldsymbol{Energy\ Consumption}\ from\ production(t) = \sum_{branche\ i} Production_i(t) \times EnergyIntensity_i\ (t)$$

$$\boldsymbol{GHG\ emissions}(t) = \sum_{branche\ i} Production_i(t) \times GHG\ Intensity_i\ (t)$$

NB: Output detailed for:
SOx, NOx, NH3, CO, NMVOC, CH4, N20, CO2, PM10, PM2.5, and CO2equivalences

$$\boldsymbol{Waste\ production}(t) = \sum_{branche\ i} Production_i(t) \times Waste\ Intensity_i\ (t)$$

NB: So far, output detailed for 14 types of waste
(Glass, wood, lether, metal, plastic, rubber, mineral, hazardous and non-hazardous waste, etc.)

The Model - Main Outputs *(2/3)*

- **Public Budget and Public Debt**

APU Revenue		APU Expenditure (by function: classification COFOG)
Fiscal Revenue	**Taxes on Products (D21)** V.A.T., Taxes on Imports, Other (TICPE, tabacco, beverages, etc.)	General Services APU (inc. Debt repayment…)
	Taxes on Production (D29) Tax on Wages and Labour, Other taxes on production	« Defense » (or « attack »)
	Impôts courants sur Revenu et Patrimoine (D5) IRPP, CSG, CRDS, Impôt sur les sociétés, taxe d'habitation, impôt foncier ménages, ISF, etc.	Public order and « safety »
		Economic Affairs
	Taxes in Capital (D91)	Environmental protection
Social Contributions (employeurs et ménages)		Housing and community amenities
Non-Fiscal Revenue	**Property Income** Investment Revenue (D41 & D42), Land and Deposits rents (D45)	Recreation, culture and religion
		Education
		Health
	Production Income	**Social Protection**

The Model - Main Outputs *(2/3)*

- **Public Budget and Public Debt**

special focus on:

- **Education (11% Public exp. in 2012)**

=>Cohort model:

$$Exp. = \sum_{age\ i;level\ j} (people_{age\ i} \times school\ enrolment_{age\ i,\ level j} \times cost\ per\ student_{level\ j})$$

- **Health (15% Public exp. in 2012)**

=>Cohort model (similar to [Geay and Lagasnerie, 2013]), accounting for age effect, end-of-life effect, health quality:

$$Exp. = \sum_{age\ i} \begin{array}{c} (people\ surviving\ non - ALD_{age\ i} \times cost\ survivor\ non - ALD_{age\ i} \\ +people\ surviving\ withALD_{age\ i} \times cost\ survivor\ with\ ALD_{age\ i} \\ +people\ not\ surviving\ non - ALD_{age\ i} \times cost\ non\ surviving\ non - ALD_{age\ i} \\ +people\ not\ surviving\ with\ ALD_{age\ i} \times cost\ non\ survivor\ with\ ALD_{age\ i}) \end{array}$$

- **Social Protection (43% Public exp. in 2012)**

=>High level of disagregation :
Retirement Pensions, Unemployment, Family and child, housing, Illness and disability, Social Exclusion (rsa…) , ***Basic Income***

6. Our approach

The Model - Main Outputs *(2/3)*

- **Public Budget and Public Debt**

APU Revenue		APU Expenditure (by function: classification COFOG)
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		Health
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Budget Balance = Public Deficit/Surplus

$$Public\ Debt = \sum_{t} Public\ Deficit$$

The Model - Main Outputs *(3/3)*

- **Employment & Unemployment**

⇒ Total amount of working hours required to match a given level of production using *Labour productivity* ($\frac{Production}{Hours\ worked}$)

$$Hours\ Worked_{branch\ i}(t) = \frac{production_i(t)}{Labour\ productivity_i(t)}$$

Nb: evolution of labour productivity can be extrapolated or chosen by the modeler with considerations on possible combinations of (K,L)

$$\Rightarrow Employed\ people_{branch\ i}(t) = \frac{Hours\ worked\ i(t)}{Average\ working\ time\ per\ person_i(t)}$$

NB: Additional informative output-> *composition of « active » population in* ***Socio-Professional categories*** using initial shares of each « CSP » in each branch.

⇒ *Unemployed people= Total Active population – ∑Employed people*

$$With\ Active\ population = \sum_{age} Population_{age} \times Activity\ rate_{age}$$

CONTENT

1. Context
2. What is Degrowth?
3. Statement of my problem
4. Preliminary concerns
5. Comments on existing modeling tools
6. Our approach
7. First Results
    1. Co-housing
    2. Re-localization
    3. One example of a “degrowth” scenario
8. Next steps

7. First Results

A) The example of Co-Housing *(1/2)*

- Discerning the components of final consumption which are (generally) put *in common* within a household

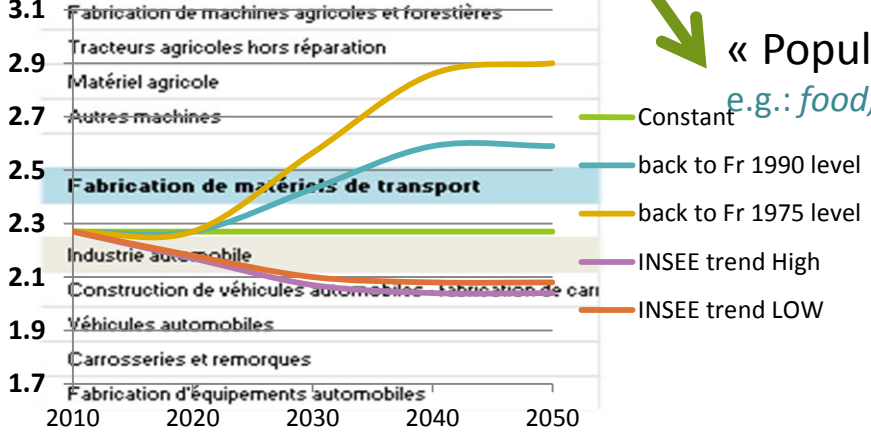
Detailed classification of G&S

Fabrication d'équipements électriques

Fabrication d'appareils ménagers
Réfrigérateurs et congélateurs domestiques
Lave-linge domestiques
Lave-vaisselle domestiques
Cuisinières électriques, appareils de chauffage et de nettoya
Appareils de toilette électriques
Autres petits appareils électroménagers
Appareils ménagers non électriques
Fabrication d'autres équipements électriques

Fabrication de machines et équipements nca
Fabrication de machines et d'équipements de bureau (hors
Fabrication d'outillage portatif à moteur incorporé
Fabrication de machines agricoles et forestières
Tracteurs agricoles hors réparation
Matériel agricole
Autres machines

Fabrication de matériels de transport
Industrie automobile
Construction de véhicules automobiles ; fabrication de carr
Véhicules automobiles
Carrosseries et remorques
Fabrication d'équipements automobiles



- Hypotheses on the change in average household size:

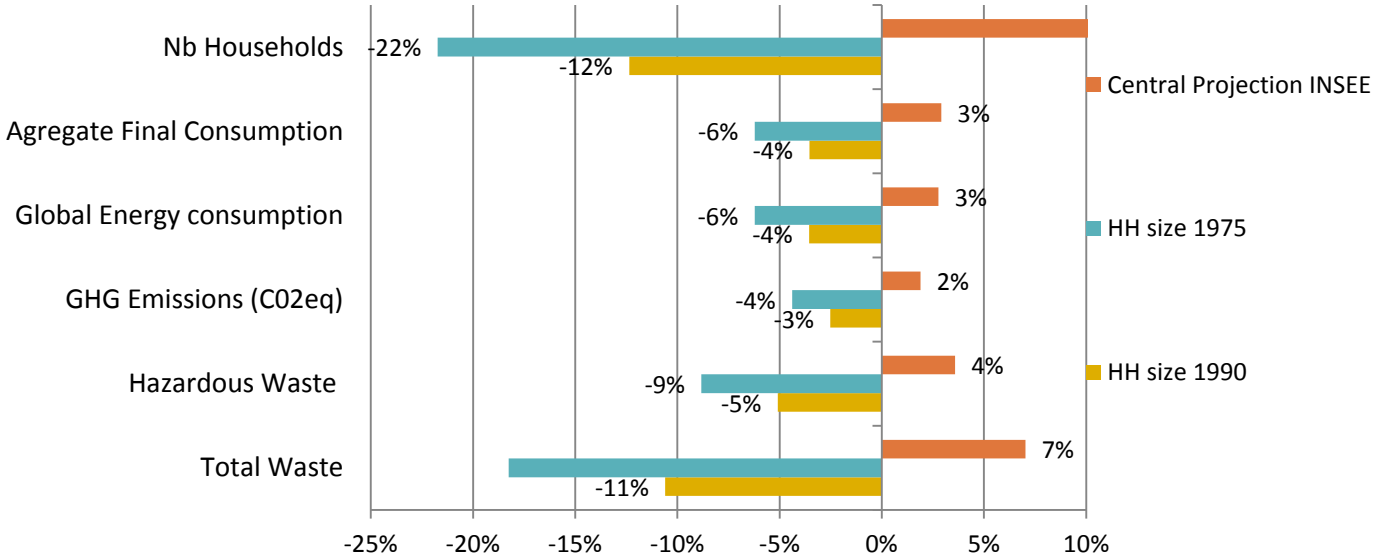
« Households-Proportional »
e.g.: *washing machine, cooking ustensils, etc.*

« Population-Proportional »
e.g.: *food, clothes, etc.*

A) The example of Co-Housing *(1/2)*

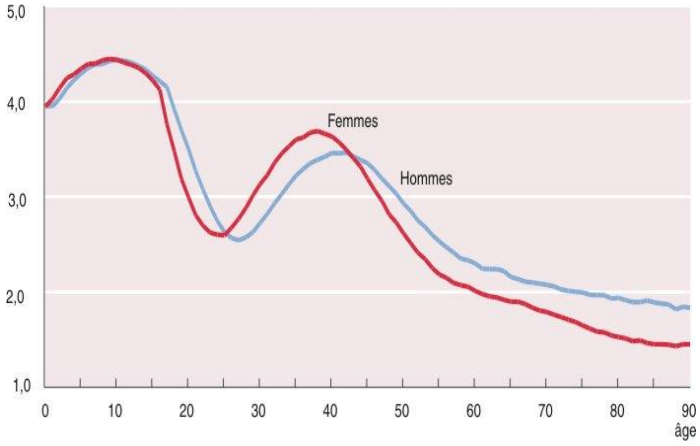
➢ **Results**:

Values in 2040 ***with respect to the constant household size hypothesis***



➢ ***Nota:***

Evolution of the age-structure of population may counter-balance co-housing behaviors!



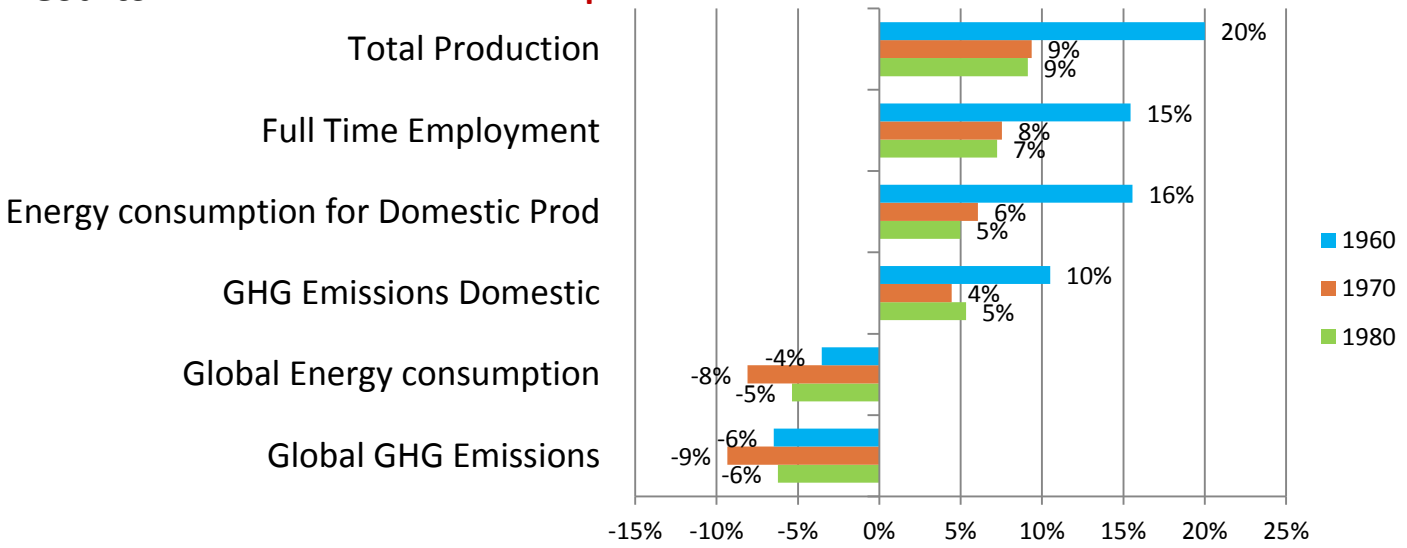
Source: INSEE, 2005

7. First Results

B) « Re-Localization »

- **Implementation in our model:**
  - Change in Technical coefficients /Intermediate consumptions of *Transport* in Input-Output Tables
  - Change in import Ratios: $\frac{Imported_i}{Domestically\ Produced_i + Imported_i}$
  - Exports in proportion of Imports
  - Simulations: back to the values of 1980 - 1970 - 1960

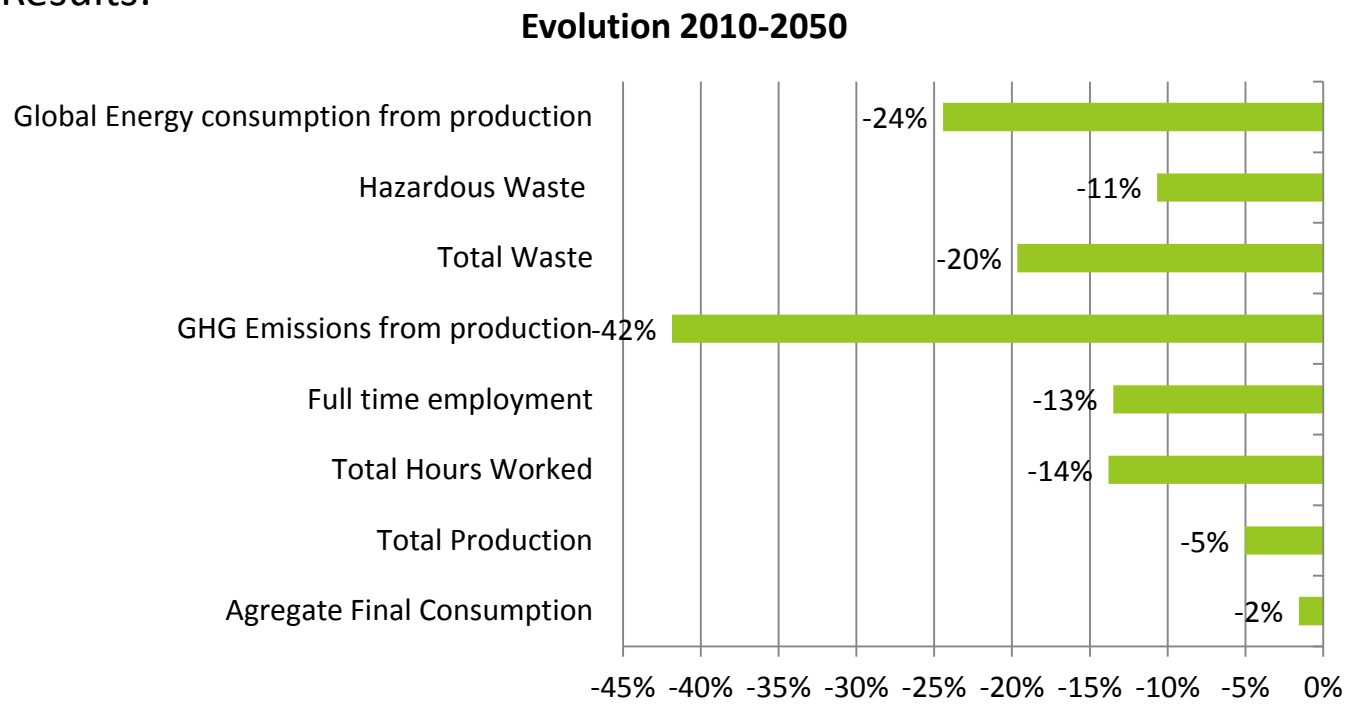
- **Results:** **Values in 2040 with respect to scenario with 2010 values**



C) One example of a « Degrowth » Scenario

- Hypotheses:
  - Constant household size (2010), central projection for population
  - Localization of the economy: values of 1960
  - Slowdown in labour productivity improvement rates
  - Slowdown in energy efficiency and CO2 intensity improvements
  - Decrease in final consumption of : clothes, electronic devices, cars, transport, furnitures, financial activities and insurances, medical drugs etc.

- Results:



7. First Results

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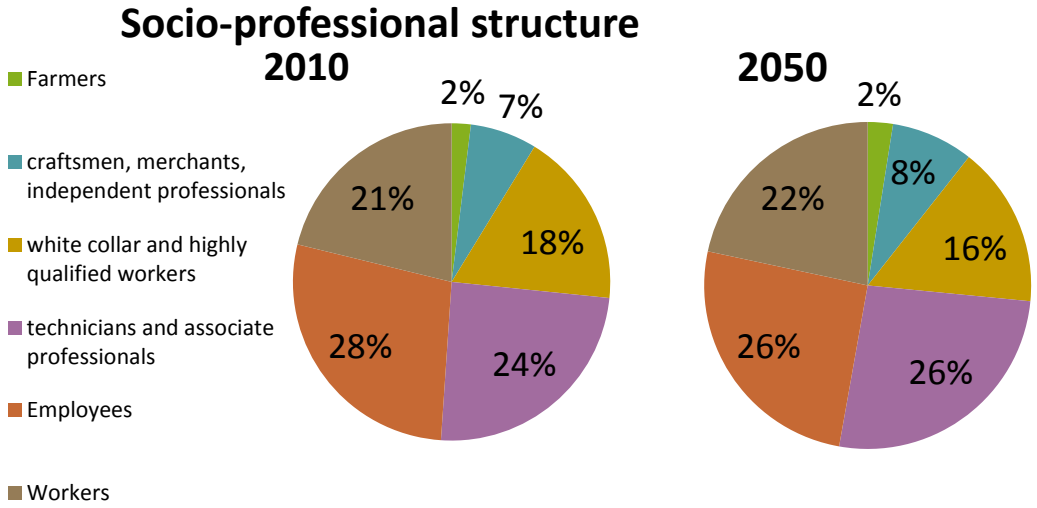
- Results:



7. First Results

C) One example of a « Degrowth » Scenario

- Hypotheses:
  - Constant household size (2010), central projection for population
  - Localization of the economy: values of 1960
  - Slowdown in labour productivity improvement rates
  - Slowdown in energy efficiency and CO2 intensity improvements
  - Decrease (different intensity) in final consumption for : clothes, electronic devices, cars, transport, furnitures, financial activities and insurances, medical drugs etc.

- Results:

  - If no working time reduction policy: High Unemployment

    (23% in 2050 = Global Working time Reduction needed)

  - With the current sheme of redistribution of wealth:

    Nb of people under poverty threshold X 2.4 between 2010 and 2050

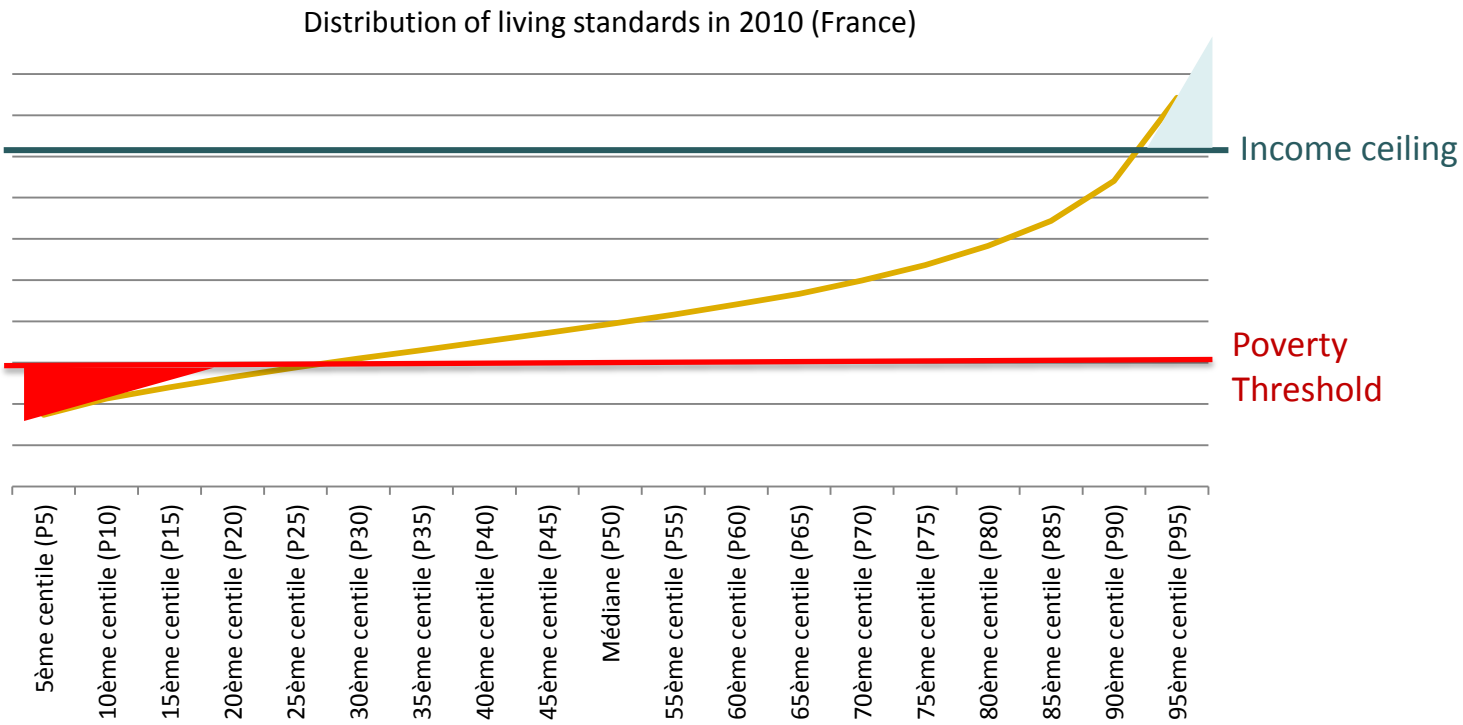
C) One example of a « Degrowth » Scenario

- Results:

With the current sheme of redistribution of wealth:

Nb of people under poverty threshold X 2.4 between 2010 and 2050

- « Rawlsian » redistribution with Income Ceiling ?



Income ceiling such that = -> 51000€$_{2010}$/ year

CONTENT

8. Conclusion (1/2)

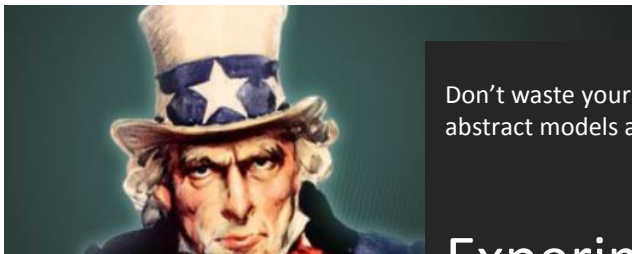
- About our model: a quite simple, accessible, but powerful tool for debate and « consensus » building

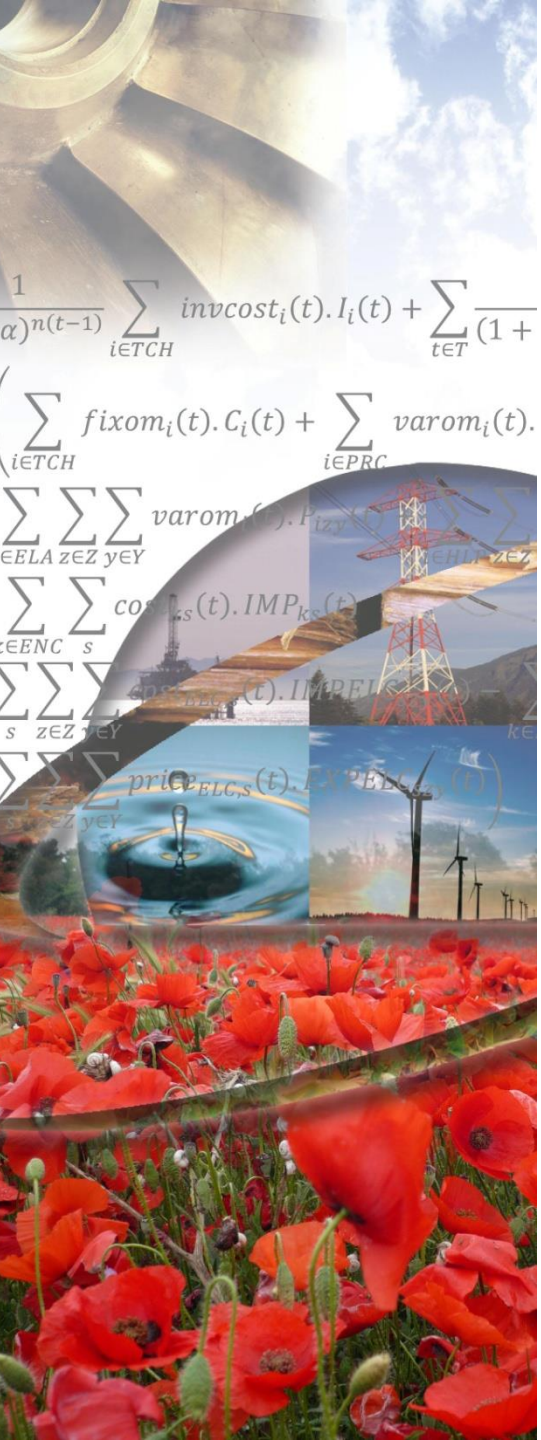
- About first results:
  - Significant impact of non-technical degrowth proposals
  - ~~**T.I.N.A.**~~ : so many (theoretical) degrees of freedom to change society
  - More than time for economists to focus (seriously) on redistribution

- Next steps:
  - Exploring other degrowth proposals (switch for small scale organic farming, etc)
  - **Focus Group Surveys !!**
  - Scenario Building, Modeling and Analysis

- A few comments:
  - Irrelevance of many mainstream macroeconomic concepts in a degrowth paradigm (e.g. « employment », « activity », etc.)
  - Difficulty to capture qualitative dimensions of Degrowth (but essential!)
  - What about « decommodification »?

So what now





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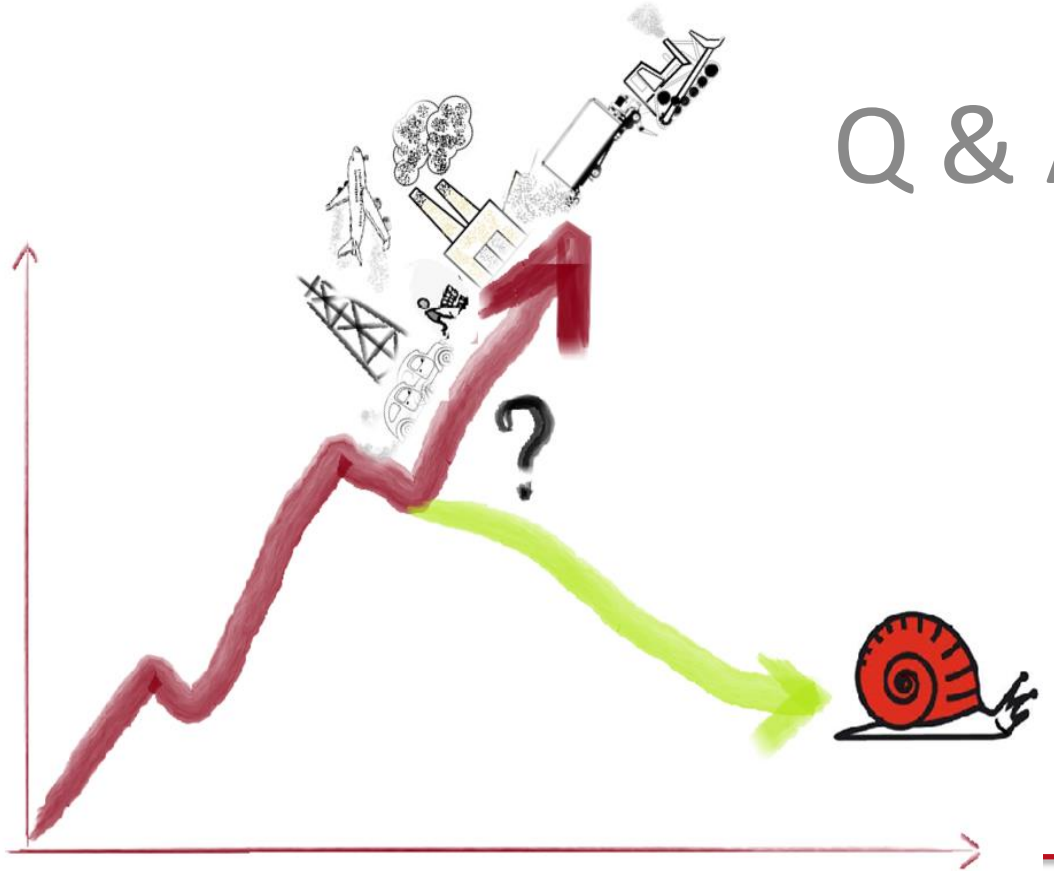
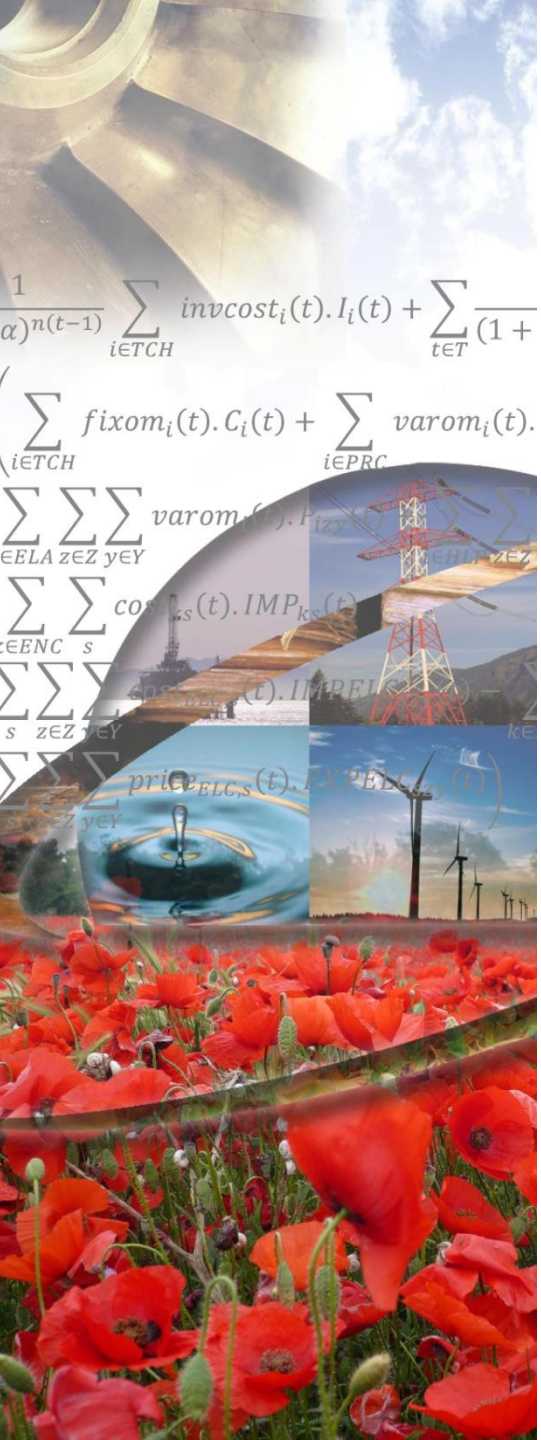
Thank you for your attention



Q & A?



Éléments de bibliographie

Assoumou, E. (2006). *Modélisation MARKAL pour la planification énergétique long terme dans le ccontext français*. PhD thesis, Ecole des Mines de Paris.

Crassous, R. (2008). *Modéliser le long terme dans un monde de 2nd rang: Application aux politiques climatiques*. PhD thesis, Institut des Sciences et Industries du Vivant et de l'Environnement (Agro ParisTech).

Duesenberry, J. S. (1949). *Income, Saving and the Theory of Consumer Behavior*. Cambrige (Mass.) Harvard University Press

Janssen, M. A. and Jager, W. (2001). Fashions, habits and changing preferences: Simulation of psychological factors affecting market dynamics. *Journal of Economic Psychology*, 22(6):745 – 772.

Latouche, S. (2009). *Farewell to growth*.

Robert E. Lucas, J. (1976). Econometric policy evaluation: A critique. *Carnegie-Rochester Conference Series on Public Policy*, 1(1):19–46.

O'Neill, D. W. (2012). Measuring progress in the degrowth transition to a steady state economy. *Ecological Economics*, 84(0):221 – 231.

Victor, P. and Rosenbluth, G. (2007). Managing without growth. *Ecological Economics*, 61(2-3):492–504.