Green Growth Knowledge Platform (GGKP)
Third Annual Conference
Fiscal Policies and the Green Economy Transition: Generating Knowledge – Creating Impact
29-30 January, 2015
Ca' Foscari University of Venice, Venice, Italy

Carbon Tax, Pensions and Deficits. The hidden cost of the compartmentalization of expertise

Emmanuel Combet (CIRED)
Jean Charles Hourcade (CIRED)

The GGKP's Third Annual Conference is hosted in partnership with the Ca' Foscari University of Venice, The Energy and Resources Institute (TERI) and the United Nations Environment Programme (UNEP).

GREEN GROWTH
Knowledge Platform

Carbon Tax, Pensions and Deficits
The hidden cost of the compartmentalization of expertise

Emmanuel Combet[*] and Jean Charles Hourcade[*], 2014

Abstract

This paper aims to draw attention to two intertwined issues. The first concerns the consequences of the prevailing intellectual compartmentalization of questions related to energy and climate, on the one hand, and to the viability of social security systems, on the other, for the choice of structural reforms in public finance. The second issue concerns the use of partial equilibrium analyses to frame the debates. Expertise on the pension systems typically ignores the general equilibrium effects of the funding options on competitiveness, employment, and wages.

We contribute to this discussion with a case study and a numerical experiment. We take the methodological venture of building a general equilibrium vision of France in 2020 that is consistent with one of the partial equilibrium scenarios of the *Conseil d'Orientation des Retraites* (the French pension advisory board). The partial forecasting scenario is introduced into a broader accounting system, which also includes a description of the future constraints on energy and demand.

This methodological innovation enables us to understand why the current compartmentalization of expertise is dangerous, both for funding social accounts and for removing the obstacles to an ambitious climate policy. On the one hand, we show the limitations of archetypical single-objective reforms which either *(i)* use one of the present instruments of the pension system (social security contributions on wage income, age of retirement), or *(ii)* absorb the deficits of the pension system by preempting revenues generated by the climate policy (a non-recycled carbon tax). On the other hand, we provide an example of a multi-objective policy package that enables the limitations to be removed. In so doing, we present a way of exploring potential synergies between long term development goals.

[*] CNRS, *Centre International de Recherche sur l'Environnement et le Développent* (CIRED). 45 bis, avenue de la Belle Gabrielle, 94736 Nogent-sur-Marne CEDEX, France.

1 Introduction

To avoid possible misunderstandings, we wish to point out from the start that the goal of this paper is not to identify *the* optimal scheme of reform for funding pensions and restructuring energy systems. Our aim is to draw attention to the risks of the prevailing intellectual compartmentalization of issues related to the 'energy transition' on the one hand, and the 'sustainability of social protection systems' on the other. These issues interact, especially in countries undergoing a demographic transition and increasing exposure to international competition. Beyond the specific case we consider here (France), the importance of linking such long term issues has been advocated in many international reports: the IPCC (IPCC, 1995 and 2001), the European Union (EC. 1994 and 2012), the United Nations (UNEP, 2011), the OECD (OCDE, 2011) and the World bank (WB, 2012). Finding synergies will help design sound public finance reforms and facilitate their implementation.

This intellectual compartmentalization is reinforced by some questionable analytical choices. Analysis of the pension systems is usually performed within a partial – rather than a general – equilibrium framework. Thus, while most stakeholders are wondering how to pay pension benefits without adversely affecting competitiveness, employment and wages, within the partial analytical frameworks of the pension systems, none of the funding schemes affect growth, employment, and the macroeconomic state of the economy (except, as we shall see, a rise in the age of retirement). Similarly, analyses of climate policies usually assume the respect of some kind of 'budget neutrality' and disregard ongoing demographic transitions. Both assumptions limit the relevance and the practical appeal of the analyses for real context-driven policy discussions.

In this paper, we take a methodological gamble. We include in a comprehensive general equilibrium picture of an open economy a partial scenario describing the future of the pension system together with a projection of energy flows and final demand. We illustrate this methodology with a projection of France at the 2020 horizon. First, we show how a comprehensive framework enables a better understanding of the deadlocks of a 'do-nothing' scenario (section 2). Second, we use the framework to simulate alternative policies. We describe the limitations of reforms that do not change the structure of the tax system (section 3), and show how a comprehensive tax reform could alleviate some of those difficulties, while removing the obstacles to an ambitious climate policy (section 4).

2 The future of pensions in a general equilibrium analysis

2.1 The issue of pensions from a partial equilibrium perspective

In France, the future of pensions is analysed by the *Conseil d'orientation des retraites*, the COR (the French Pension Advisory Board). The last COR assessment report was prepared for the reform by Fillon's government (COR, 2010). It provides different forecast scenarios of the financial needs of the pension system. Let us consider the most optimistic one (scenario A). The French economy rapidly catches up with production losses caused by the crisis, which have no long term effect on potential growth. On average, over the 2011-2020 period, labour productivity increases by 2.1% per year -

which is significantly higher than the assumed long-term productivity trend (1.8%) - but unemployment remains high, although it finally decreases at the end of the period (6.4% in 2020).

The resources of the pension system are simply deduced from a projection of the employed labour force and two simplifying assumptions: a constant value-added sharing between operating surpluses and the compensations of employees[1], and a constant rate of social security contributions on those compensations[2]. The forecasts of expenditures (the future pension benefits) are provided by the main pension schemes and extrapolated to the whole system by the DRESS[3]. The difference between resources and expenditures gives the deficit (or financial needs) of the system.

In this partial equilibrium framework, the issue of pensions is framed only in redistributive terms. A reform - or a business-as-usual scenario - has no effect on production costs, wages, demand, etc. In the end, these policy choices are almost neutral for growth and employment. This is particularly important since the public debate focuses exactly on those macroeconomic consequences. In addition, it should be noted that only a rise in the retirement age mechanically benefits growth by increasing the labour force. Production increases in proportion to this new supply of labour according to a simple calculation: the new number of hours worked is multiplied by a constant labour productivity parameter. In other words, wages remain unaffected and the entire additional labour supply matches a corresponding demand.

This typical pension system scenario helps assess one of the main macroeconomic constraints an ageing economy will be facing: the growing financial burden of pensions. However, this assessment is made independently of the climate policy constraint (for instance, the French "*Facteur 4*" target which requires dividing greenhouse gas emissions by four by 2050[4]), as well as two other important macroeconomic constraints that will appear within the same time horizon:

- An external constraint which combines the competitive pressure on goods and services made in France on the one hand, and the financial pressure on households and firms caused by higher prices of imported hydrocarbons, on the other.

- An internal constraint: a decreasing trend in savings available for investment due to a relative increase in the "dependent" population (the number of people aged over 75 and below 20). Savings and investments compatible with scenario A are not specified in the partial equilibrium setting.

Omitting the interactions between all the above mentioned constraints and growth is equivalent to assuming that the economy will continue to rely on external debt to finance its pensions and its energy imports (as we assume its dependence on fossil energy will remain high). Let us introduce this proposition, independently of any modelling, using a simple accounting reasoning.

[1] Total gross labour costs, including social contributions of employers and employees.

[2] In scenario A, employees' compensations amount to 57.6% of the GDP; the rate of social security contributions is 22.0%; the employed labour force is obtained by applying an unemployment rate of 6.4% to the active population in 2020; the number of retired people and the levels of retirement benefits are assessed under the hypothesis of constant returns in the main French pensions schemes.

[3] Assessment board of the Ministry of Social Affairs and Health.

[4] Enshrined in the French legislation since 2005.

Consider an open economy with balanced external trade (X). Domestic consumption (C) and investment (I) are funded by the gross domestic income (GDP).

$$GDP - C - I = X = 0$$

For the sake of simplicity, we also assume that all final energy consumptions are imported (no refining or production of electricity). This imported energy (Xe) is consumed by households (Ce) and industries (Ci). The previous accounting identity can thus be detailed, with (Cq) standing for non-energy consumptions and (Xq) non-energy exports:

$$GDP - Cq - Ce - I = Xq - Xe$$

Because we assume balanced trade, exports of goods and services (Xq) must equal imports of energy (Xe). In addition, demand for domestic products and services (Cq + I + Xq) must exceed disposable revenue (GDP) in order to finance industries' energy bills (Ci):

$$Cq + I + Xq = GDP + Ci$$

Now, considering an increase in energy prices and assuming that the "fundamentals of the economy" are the same (volumes of energy consumption, non-energy consumption, investment and exports), there are two implied consequences. On the one hand, national disposable income decreases ($\Delta GDP = -\Delta Ci$): the higher energy costs of industries must be financed with the same production. On the other hand, the heavier energy bill reduces available savings ($\Delta [GDP - C - Ce] = -\Delta Xe$) and the deterioration of the current account balance leads to higher external deficit and debt.

Of course, this simple reasoning says nothing about the mechanisms by which the two constraints of energy dependence and social protection funding interact. But it reveals the importance of deepening the analysis of these macroeconomic interactions.

2.2 Towards a comprehensive macroeconomic analysis

Let us first build a comprehensive macroeconomic picture of France in 2020 that is compatible with the previous assumptions of scenario A. Starting from a consistent dataset for a given base year (here, 2004), it is possible to build a projection if a given amount of information is available to describe all the accounting identities of a general equilibrium. The COR scenario provides the future levels of gross domestic product, wages, social security contributions, and retirement benefits. However, the picture needs to be completed with the calculation of some coherent levels of external trade, final demand, capital flows, and energy consumption by households and firms. This is done by (1) importing data from other studies and (2) computing the calculation with a version of the IMACLIM model, which was specially designed to evaluate a carbon tax reform in France[5] (Combet, 2013).

[5] Details on the data, the IMACLIM model, the projection method, and the results of the simulations are available online at: http://www.imaclim.centre-cired.fr/spip.php?article316.

The imported data and their sources are summarized in table Table 1. In what follows, we disregard uncertainties about the future, but other plausible quantitative visions of the future could also be defended. The discussion of uncertainties is very important. However, with respect to our heuristic aim, what matters here is (1) to obtain a coherent picture from explicit assumptions, and (2) to shed light on the interactions between demand, energy, and demographic constraints.

Demographic transition and financial tensions	2004-2020
Old-age dependency ratio[a] (COR, 2012)	+29 %
Retirement benefits (COR, 2012)	+215 %
Household saving rate[b]	-37 %
Energy resources and tensions on international markets	
Price of imported oil	+95%[c]
'Price competitiveness' of domestic productions	-0.5%[d]
Limited energy saving opportunities and possibilities for technical change[e]	

[a] Ratio of the number of retirees to the number of active people.

[b] From Aglietta and Borgy (2008), business-as-usual scenario without pension reform.

[c] Equivalent to an oil import price of €60 per barrel (scenario from Bibas et al., 2012).

[d] Ratio of the French production price to the mean world production price; simulation from the *Energy Modeling Forum* (IMACLIM-R World model).

[e] Scenario from the IMACLIM-R-France model, which represents explicitly technical inertia. This scenario gives the energy consumption and the CO_2 emission coefficients for households and firms in 2020. No ambitious climate policy is assumed at the global scale, and no major national infrastructure policy (no building renovation, collective transport, or rail and river freight).

Table 1 Key assumptions about the future (2020 France)

Three parameters influence the calculation of the trade balance and capital flows: a 37% decrease in the household saving rate with the ageing of the population, a 95% increase in the price of imported oil and gas due to faster growth of international demand than of supply, and a 0.5% increase in the mean French production price relative to the mean production price abroad. The latter assumption is consistent with the hypothesis that the higher burden of dependent populations in France will lead to faster progression of labour costs here than in the rest of the world.

Under these assumptions, the incomes and expenditures of the national agents are almost settled. An additional hypothesis about the level of investment is made to complete the picture. We assume that this level will rise along with the capital intensity and the level of production (we assume the 1.5 proportional coefficient, which was that observed in 2004). The calculation of the trade balance for non-energy production is determined by the levels of domestic demand and supply. Given the level of domestic savings, foreign capital flows balance the financial needs for investment. Lastly, the financial positions of agents display the net accounting counterpart of their loans/borrowings assuming that all assets/liabilities accrue linearly over the 2004-2020 period.

The resulting 2020 system of national accounts is given in table Table 2.

Billions of euros	Private agents	Administrations	Rest of the world
Trade balance			
Energy	-	-	78
Other goods and services	-	-	227
Gross operating surpluses	632	62	-
Compensations of employees	1 100	-	-
Taxes minus subventions on production and indirect taxation[a]	-	364	-
Social contributions	-	311	-
Primary incomes[b]	1 732	737	305
Property incomes[c]	57	-336	279
Social transfers [d]			
Unemployment	36	-36	-
Retirement	352	-352	-
Other	174	-174	-
Other transfers	6	-22	16
Direct taxation[a]	-292	292	-
Gross disposable income	2 064	110	600
Consumption	1 646	620	-
Gross fixed capital formation	431	77	-
Expenditures on final use	*2 077*	*696*	
Self-financing capacity	*-13*	*-587*	*600*
Net financial position[e] (Net excess of claims over liabilities)	1 166	-6 251	5 085

[a] Without reform, the mean tax rates remain at their 2004 levels.

[b] The gross domestic product is equal to the sum of the primary incomes of private agents and administrations.

[c] The property income transfers reflect the trends in agents' net financial position. For public administrations, this encompasses payment of debt service.

[d] Social transfers evolve proportionally to the number of unemployed, retired, and the total population (according to the COR's assumptions). The mean level of retirement benefits is available in the COR data. The other levels of social benefits follow the progression of wages.

[e] Linear accumulation of self-financing needs/capacities over the period (2004-2020).

Table 2 Comprehensive macroeconomic accounts (2020 France)

2.3 A long-term trend towards higher debt: the role of energy and savings

The projected macroeconomic accounts resulting from this exercise point to deeper public deficits and higher social transfers (respectively 24% and 23% of the GDP). Despite the optimistic assumptions of scenario A, the rise in retirement benefits is sharp (from 12% to 14% of GDP). This increase more than offsets the decrease in unemployment benefits (from 1.9% to 1.5% of GDP).

The key element in this scenario is the significant increase in the national debt (which reaches twice the level of GDP)[6]. The significant inflow of foreign capital results from two contextual

[6] We need to underline that we are talking about an extreme (and unrealistic) case in which no reform is implemented. We also assume that the debt of private and public institutions does not alter their behaviours at the time horizon considered. In other words, we assume that the players are short sighted: the levels of their debts have no impact on either household saving rates or the firms' investment decisions. These two variables (savings and investments) only depend on growth and demographic assumptions.

elements. First, export surpluses of non-energy goods and services are not sufficient to finance the higher energy bill (3.2% of the GDP). Second, available domestic savings are not sufficient to finance productive investments. However, this high level of debt does not constrain the economy to growth at a slower pace than the one assumed in scenario A. In this calculation, the country can further rely on debt to pay its debt (creditors do not impose an absolute limit on the level of national debt).

This assumption is obviously unrealistic[7], but it is a convenient one, since we want to identify an order of magnitude for the imbalances that could result from a 'do-nothing' scenario.

Now, compared to this do-nothing scenario, each of the simulated reform schemes will trigger three mechanisms according to equations which describe the behaviours of the productive systems, the domestic agents, the labour market, and the globalised product and financial markets (Figure 1).

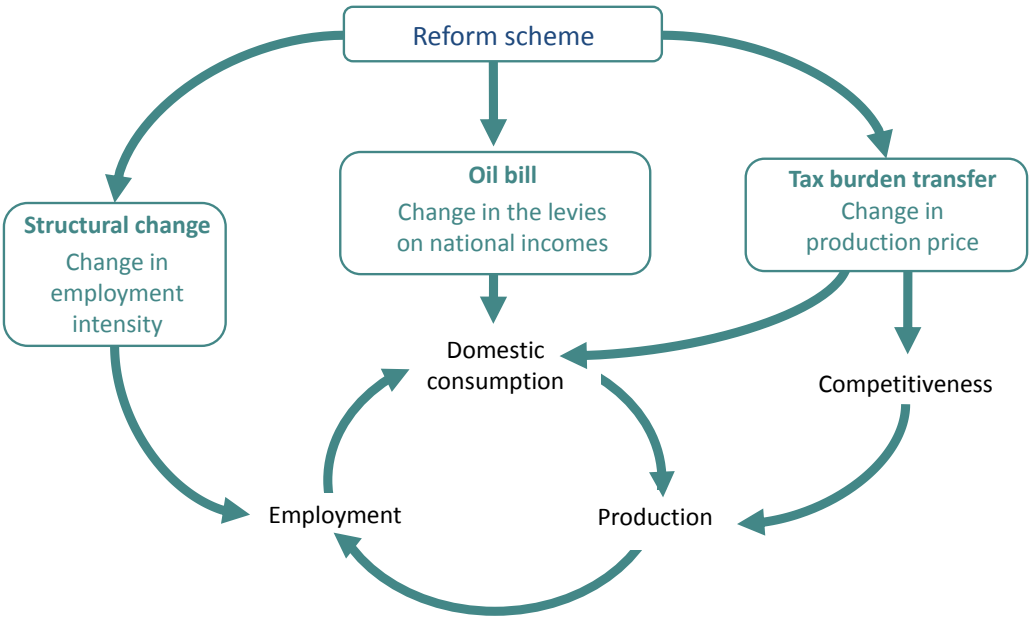


Figure 1 Interaction between three main mechanisms

1. *Impacts on wages and production costs* will affect external trade and domestic demand[8]. The domestic production price will be affected by any change in the share of taxation bearing on production costs, but also by any policies that affect the level of investment (assumption of 'induced technical change'), the level of production ('static decreasing returns'), and the level of employment (sensitivity of wages to the unemployment rate).

2. *Impacts on fossil energy consumption and the oil bill* will affect the purchasing power of households and the capacity of the country to control its trade balance and debt. The energy-

[7] Typically, econometric studies show that economic growth is significantly reduced when the ratio of public debt to the GDP exceeds 90% (Reinhart and Rogoff, 2010).

[8] The link between labour costs and 'competitiveness' is sometimes challenged. It is argued that there are many other important determinants of competiveness: product quality, organization of production and supply chains, workers' training, etc. This is an argument against the idea that any improvement in competitiveness requires wage moderation, while such moderation has a recessionary impact on final demand. This argument is valid. Nevertheless, it remains true that competiveness will be affected by higher labour costs under any set of assumptions about these determinants of productivity.

carbon taxation will encourage energy efficiency and penetration by renewable energies. The estimation of the possibility of technical change is taken from Bibas et al. (2012) and the IMACLIM-R model, which explicitly represents energy production techniques and equipment. By 2020, the price-elasticities of household consumption of fuel and housing energy are estimated at -0.57 and -1.03; the corresponding income-elasticities at +0.29 and +0.52. However, these elasticities decrease with an increase in energy consumption towards zero for some minimum levels of 'basic energy needs'.

3. *A structural change* will modify the labour and energy content of production if the reform modifies the relative costs of inputs. Here we are talking about *structural change* because, at this level of aggregation, substitution between labour and energy encompass both technical change within industries and changes in the relative weights of industries within the whole production structure. We use an aggregated elasticity of substitution to input prices (+1.2). Again, technical inertia is assumed, and the existence of constant minimum levels of input consumption (not at all responsive to relative prices or other economic signals).

3 Funding plans without tax reform: some hopes partially disappointed

Two solutions are put forward to avoid both deadlock of a do-nothing scenario and the difficulties of a process of tax reform: an increase in the retirement age (IRA)[9] and a decrease in public spending (DPS). The former was favoured in previous French reforms[10], while the latter is being increasingly advocated to reduce deficits, and to offset the increase in other public expenditures (including retirement benefits).

3.1 Increase in the retirement age

The COR estimates that "a 3-year increase in the average retirement age (compared to 2008)" would be needed to balance the budget of the pension system (COR, 2010). This would be the equivalent of increasing the demographic ratio (labour force / retirees) by 13%[11]. Although a rise in the age of retirement needs to be considered, here we wish to point out certain limitations which have previously received little attention. The previous result relies on the assumption that a larger active population (here, 4.8% larger) will mechanically boost economic growth: under a constant unemployment rate and productivity, an additional labour supply increases production. However, social partners doubt that domestic demand, exports, and hence labour demand, will increase similarly (Chérèque et al., 2010).

To analyse the risk that it is neither certain nor mechanical that the economic system would be able to absorb this - far from marginal - excess supply of labour, we consider that the reform will affect the level of real wages, and hence aggregate demand. We test a response of the labour market using a specification which formalises a limited sensitivity of net nominal wages to any change in the

[9] Here we disregard any impacts on the activity behaviours or on the dates on which workers retire. Therefore, any increase in the retirement age will trigger a corresponding decrease in the proportion of retired people.

[10] 1993 (Balladur's reform specified an increase in the period of the contribution from 150 to 160 quarters), 2003 (Fillon's reform, specified a discount rate for missing years of contribution and premium rate for additional years).

[11] This equivalence is given by the accounting identity which describes the financing of the pension system.

unemployment rate, and we assume a small negative sensitivity (the elasticity of this 'wage curve' is -10%). This is a convenient way of modelling a 'wage moderation' in a context of crisis, high energy prices, and increasing exposure to industrial competitors. In the literature, the value of the elasticity and the indexation of wage are discussed at length, especially for the long term (Blanchard and Katz, 1997). Notwithstanding these uncertainties, our assumptions on the response of the labour market are sufficient to grasp the potential differences between the COR's strong hypothesis of a constant sharing of value added.

Compared to our do-nothing scenario (with unlimited debt), the increase in the retirement age allows better control of deficits and debts (Table Table 3, '3-year IRA'). The current account deficit decreases by 9.8%, public deficits by 10.0%, and the national and public debts to GDP ratios by 6.7% and 4.9%, respectively. However, this better result has a cost: the GDP is 1.4% lower and the unemployment rate 1.4 point higher. The reform triggers the following depressive mechanism:

- The additional supply of labour pushes wages down (-3.3%).
- This erodes the purchasing power of households, but benefits price competitiveness
- The increase in exports (+0.9%) and the lower share of imported goods in consumption (-1.5%) are however not sufficient to offset reduced household consumption (-2.4%).
- This depressive impact is not compensated for by a structural change towards a higher employment rate because the relative prices of labour, capital and energy do not vary much.

Therefore, the additional labour supply is only partially absorbed. The potential increase in domestic production is not released and only 79% of the social debt is funded. The increase in the retirement age needs be higher to reach 100% (table Table 3, 'IRA > 3 years'). In this case, we see an improvement in the trade deficit (-7.2%) and debt repayments (-18.3%). But the previous depressive mechanism is also stronger. It leads to higher contraction of wages (-4.2%) and household consumption (-3.2%). As a consequence, the GDP is 1.9% lower and unemployment 1.8 point higher compared to the do-nothing scenario.

Reform scheme	3 years IRA	IRA > 3 years
Funding of pension deficits in the period 2011-2020	79%	100%
Demographic ratio	+13%	+17%
CO_2 emissions	-1.5%	-1.9%
Real gross domestic product	-1.4%*	-1.9%
Unemployment rate (% points)	+1.4**	+1.8
Labour intensity of composite production	+0.0%	+0.0%
Oil bill to GDP ratio	+1.9%	+2.4%
Non-energy household consumption	-2.4%	-3.2%
Non-energy production price	-1.7%	-2.1%
Exported volumes of non-energy productions	+0.9%	+1.2%
Imported proportion of non-energy productions	-1.5%	-1.9%
Trade balance deficit	-5.6%	-7.2%
Net nominal wages	-3.3%***	-4.2%
Public debt to GDP ratio	-4.9%	-6.2%
National debt to GDP ratio	-6.7%	-8.5%
National debt repayments	-14.6%	-18.3%

Note: results are expressed relative to the situation in 2020 resulting from the do-nothing scenario.

* A 1.4% decrease in GDP in 2020 compared to the do-nothing situation is equivalent to a 0.12 variation point in annual growth over the 2004-2020 period, which corresponds to slightly more than a five month delay in growth.

** A 1.4 point higher unemployment rate is equivalent to a 1.8 point reduction in employment since 2004 (from 9.6% to 7.8%), or to a mean job creation of about 22 000 jobs per year.

*** A 3.3% decrease in the purchasing power of employees is equivalent to a 0.29 point variation in the annual growth rate over the period 2004-2020, which corresponds to about a nine month delay in wage development.

Table 3 Macroeconomic impacts of an increase in the retirement age (IRA) compared to the do-nothing scenario (no reform)

This pessimistic conclusion can be questioned by arguing that an effective extension of the working period will produce some significant gains in productivity (higher qualifications, improved organisation in production, and improved accumulation of work experience). It should nonetheless be noted that some additional conditions are necessary to actually foster employment and resolve the issue of pensions through an increase in the retirement age.

3.2 Decrease in public spending

The choice of decreasing public spending has something to do with the right 'weight of the state' and the relative efficiency of public and private expenditures with respect to social welfare. Here we do not discuss the 'cost of public funds'[12]. A complete cost-benefit analysis would have to balance the expected entrepreneurial gains arising from a reduction in the whole tax burden, against the productivity losses due to fewer public resources devoted to R&D, development of new sectors,

[12] The ambiguity of this concept was discussed by Guesnerie (2007).

education, health, and public infrastructures (Glomm et Ravikumar, 1992). We simply assume that all these long term impacts on productivity offset each other.

Under these hypotheses, the volume of public expenditures[13] must be reduced by 6.1% to fund pensions over the period concerned (Table 4). The impacts on activity and employment are very similar to those triggered by an increase in the retirement age. Compared to the COR's scenario A, GDP and unemployment are slightly less affected (-1.7% versus -1.9%, and +1.7 versus +1.8 point).

Budgetary objective	Funding the pensions over the period 2011-2020	
Reform scheme	IRA > 3 years	DPS
Demographic ratio	+17%	id.
Volume of public expenditures	id.	-6.1%
CO_2 emissions	-1.9%	-1.5%
Real gross domestic product	-1.9%	-1.7%
Unemployment rate (% points)	+1.8	+1.7
Labour intensity of composite production	+0.0%	+0.0%
Oil bill to GDP ratio	+2.4%	+1.9%
Non-energy household consumption	-3.2%	-1.4%
Non-energy production price	-2.1%	-2.0%
Exported volumes of non-energy productions	+1.2%	+1.1%
Imported proportion of non-energy productions	-1.9%	-1.8%
Trade balance deficit	-7.2%	-6.8%
Net nominal wages	-4.2%	-4.0%
Public debt to GDP ratio	-6.2%	-6.2%
National debt to GDP ratio	-8.5%	-8.5%
National debt repayments	-18.3%	-18.3%

Note: results are expressed relative to the 2020 situation resulting from the do-nothing scenario.

Table 4 Macroeconomic impacts of a decrease in public spending (DPS) compared to the do-nothing scenario (no reform)

A sustained reduction in public expenditure has a depressive impact on effective demand. However, this contraction affects employment less than the increase in the retirement age. A higher proportion of the population leaves the labour market and the downward pressure on wages is lower. Consequently, the purchasing power of households and private consumption are less affected. Nevertheless, higher wages mean higher production costs, and lower trade performance.

Hence, the decrease in public spending performs slightly better than the increase in the retirement age, although there is no strong qualitative difference. Nevertheless, it should be kept in mind that this comparison implicitly assumes the development of private structures able to deliver

[13] With a constant proportion between current consumption and investment in the public budget.

equivalent collective services at a comparable quality/cost ratio. This is of course required to maintain global productivity and ensure social cohesion.

4 The leverage offered by a comprehensive carbon tax reform

The true limits appear when we try to fund pensions without reforming the tax system. However, we are also aware of the serious difficulties encountered along this path: higher social contributions could favour undeclared work, higher VAT rates could have strong distributional impacts, higher income taxation could increase tax evasion. These arguments are familiar and there is thus no need here to emphasize them. But surely the fact that deliberations on tax reform are locked in public debate represents a major problem for collective action. We aim to show that carbon taxation could help crack this deadlock by providing new room for manoeuver.

4.1 A potential for economic synergy

To reach this conclusion, let us compare four different options to bridge the financial gap of pensions evaluated in the COR's scenario A:

1. An increase in the retirement age (the previous "IRA > 3 years" scheme);
2. A 7-point increase in employers' and employees' social security contributions on wage incomes (SSC), which is, after all, the natural solution within the current system;
3. A €709/tCO_2 non-recycled carbon tax (all revenues used to finance pensions);
4. A comprehensive carbon tax reform: a carbon tax that gradually increases to reach €200/tCO_2 in 2020 and whose revenue is used to reduce the labour tax by 7 points (SSC). The remaining deficit of the pension system is filled by a 2-point increase in income tax (IT)[14].

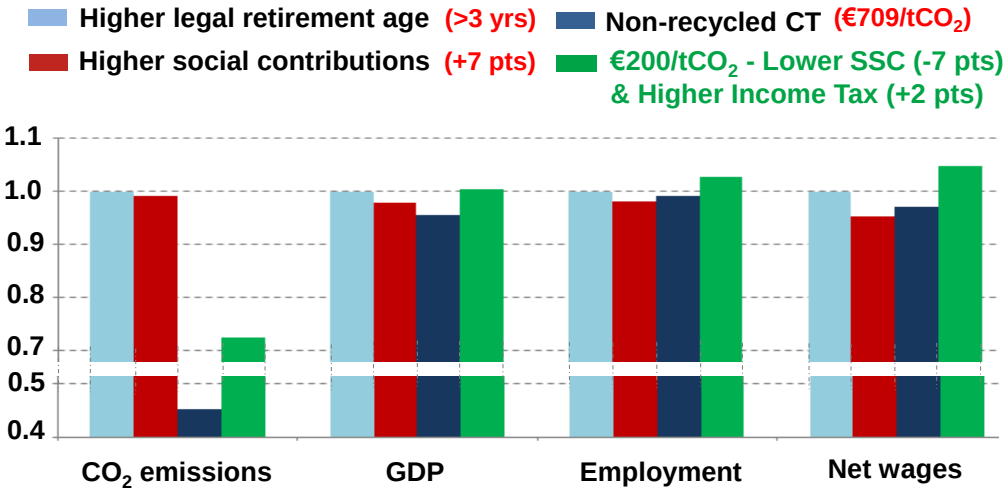
In the environmental economics literature, the best way to reduce CO_2 emissions at low cost is to implement a carbon tax and to use its revenue to reduce some existing distortive tax - in the European context, taxes on labour[15]. Here we do not discuss theoretical questions about the possibility of obtaining a 'strong double dividend': a *net economic gain* for production and employment, as it would be necessary to discuss the reasons why a reallocation of the tax burden away from labour has not been implemented before, independently of a climate policy, without resorting to energy tax[16] (Bovenberg, 1999). Notwithstanding this theoretical debate, important questions remain: do we want to reduce our energy dependence and CO_2 emissions? If the answer is yes, how should we introduce a carbon tax component? In which general tax and benefit system?

[14] SSC rates decrease from 22.7% to 15.7% and IT rates from 10.7% to 12.7%. In our model, the aggregate impacts of higher VAT are very similar to the impacts of higher IT. To analyse the specificities of higher VAT, it would be necessary to design a model with a larger number of productions.

[15] For theoretical analyses, see Goulder (1995) and Bovenberg (1999), for empirical analyses, see IPCC (1995, 2001).

[16] The best option would be to substitute income tax for labour tax. Given the same reduction in labour tax (-7.0%), there would be a slightly higher level of consumption (+0.5%) and a lower employment rate (-0.2 percentage point). Yet this good result comes at the cost of a higher trade deficit (+4.0%), and a much higher oil bill (+20.1%). In addition, the mean increase in IT must reach +3 points (1 point more than with a carbon tax component). The increase would have to be even higher for high income levels, if lower and middle classes are to be spared.

Figure 2 gives an overview of the results. Two typical reforms of the pension system, the non-compensated carbon tax, and the comprehensive tax reform are compared. Not surprisingly, the increase in social security contributions is the most costly measure for activity, wages, and employment. More surprisingly, the comprehensive carbon tax reform performs better, not only with regards to the environmental indicator, but also with regards to the three economic indicators.



Note: The three reforms fund the pension system deficit over the period 2004-2020. Results are expressed relative to the 2020 situation in the higher retirement age scenario ('IRA > 3 years').

Figure 2 Comprehensive carbon tax reform: potential room for synergies

Below we detail the mechanisms involved. But first, we need to introduce our main conclusion. The results depicted in figure 2 clearly show that analysing a climate policy on the one hand, and a pension reform on the other, can prevent us from identifying potential synergies or antinomies. This is true not only from the perspective of funding social security systems, but also with regard to the objective of mitigating CO_2 emissions and climate change.

Obviously, only the schemes that include a carbon tax will allow the French economy to follow a path compatible with the French "*Facteur 4*" target, which implies CO_2 emissions must be below 317 $MtCO_2$ in 2050 (a 19% decrease compared to 2008). Both 'IRA > 3 years' and 'SSC' scenarios lead to a level of emissions 68% higher than the target (the reduction in CO_2 emissions falls short by respectively 215 and 219 $MtCO_2$). However, an ambitious climate policy will not be implemented if it jeopardizes the attainment of other socio-economic objectives. This is the case of a non-compensated carbon tax that would have too negative impacts on households and businesses (non-recycled TC). Its rate would have to be pushed too high to fund pensions alone (€709/tCO_2). Implementing a carbon tax in this way would be equivalent to achieving a CO_2 reduction target at a too high economic cost[17]. In our opinion, this risk is the main obstacle to the necessary increase in carbon price signals.

[17] In our model, the same emission reduction target can also be reached with a non-recycled €200/tCO_2 carbon tax in 2020. But in this case, the resulting GDP is 1.0% lower, unemployment 1.3 point higher, net wages and household consumption 3.2% and 0.2% lower, and the public and national debts to GDP ratios 2.4% and 4.2% higher.

4.2 Understanding the mechanism of synergy

As will become clear, the different components of the comprehensive carbon tax reform help reinforce the three positive mechanisms which determine the levels of activity and employment. They tend to (1) increase wages while controlling production costs, (2) decrease imports of fossil fuels, and (3) increase the labour intensity of domestic production.

To understand this mechanism of synergy, it is useful to consider the impacts of each tax component separately. To this end, we compare the results with the higher retirement age scenario (Table 5). In each case, the same targets with respect to the funding of pensions and the national debt are achieved. We use the household saving rate as a variable to meet the required national debt to GDP ratio.

The results for higher social contributions (SSC) are hardly surprising: the rate of increase would have to rise by 7.2 points to fund pensions and this would increase the cost of production by 2.3%. A higher domestic price leads to (1) a reduction in net exports (-1.2%), (2) a rise in the proportion of imported products consumed domestically (-2.0%)[18], and (3) a reduction in the purchasing power of households. Under the assumption of increasing exposure to international competition, the resulting contraction in demand is reinforced by a downward pressure on net wages (-4.7%). This significantly affects the purchasing power of households and their consumption (even though the latter is only reduced by 1.7%). Consumption is indeed sustained both by social transfers indexed on prices, and non-wage incomes, which are less affected. As a result, activity and especially employment deteriorates more rapidly than in the retirement age scenario (-2.1% of GDP and +2.2 points of unemployment).

[18] The reader may be surprised by the moderate deterioration of the trade balance depicted in table 5. The explanation is that the country also exports non-energy production at higher prices than in the retirement age scenario.

Budgetary objective	Funding pensions over the period (2011-2020)			
Reform scheme	SSC	CT	IT	CT/SSC & IT
Rates adjustments	+7.2 pts	709 €/tCO_2	+1.4 pts	200 €/tCO_2 -7.0 pts (SSC) +2.0 pts (IT)
Household saving rate	-0.0 pts	+0.3 pts	+0.0 pts	0.2 pts
CO_2 emissions	-0.8%	-54.7%	+0.1%	-27.7%
Real gross domestic product	-2.1%	-4.4%*	+0.1%	+0.4%
Unemployment rate (% points)	+2.2 pts	+1.3 pts	-0.1 pts	-1.9 pts
Labour intensity of composite production	-0.3%	+1.2%	-0.0%	+0.9%
Oil bill to GDP ratio	-1.1%	-28.9%	-0.0%	-17.2%
Non-energy household consumption	-1.7%	-2.5%	+0.1%	+1.3%
Non-energy production price	+2.3%	+3.7%	+0.1%	+0.1%
Exported volumes of non-energy productions	-1.2%	-1.9%	-0.0%	-0.1%
Imported proportion of non-energy productions	+2.0%	+3.3%	+0.1%	+0.1%
Trade balance deficit	-1.0%	-9.0%	0.2%	-2.6%
Net nominal wages	-4.7%	-2.8%	+0.1%	+4.8%
Public debt to GDP ratio	id.	id.	id.	id.
National debt to GDP ratio	id.	id.	id.	id.

CT: introduction of a carbon tax; SSC: increase in social security contributions; IT: increase in income tax.
Note: results are expressed relative to the 2020 situation in the retirement age scenario ('IRA > 3 years').

Table 5 Macroeconomic impacts of different tax reform schemes compared to the retirement age scenario (IRA > 3 years)

A non-compensated carbon tax (CT scheme) has even more impact on economic activity (-4.4% of GDP). This highly negative impact results from a major increase in production costs (+3.7%), primarily due to the high rate of carbon tax that is required to fund pension benefits (€709/tCO_2). The resulting depressive consequences on demand and production are not offset by either the significant reduction in the oil bill (-28.9%) or by the slight increase in labour intensity (+1.2%).

Nevertheless, in comparison with the SSC scheme, the constancy of social security contributions enable better control of labour costs (they increase, but less than capital and energy costs). As a result, the CT scheme benefits more labour-intensive sectors[19] and employment (+1.3 point of unemployment, versus +2.2 with the SSC scheme). The constancy of social contributions also enables a smaller contraction of net wages (-2.4% versus -4.7%). But these two positive effects do not offset the negative impacts of higher fuel and other energy prices (187% and 108%):

- The purchasing power of households decreases. The share of their budget devoted to energy is would be multiplied by 1.5 and their savings rate increases by 0.3 point to achieve the same national debt to GDP ratio as in the retirement age scenario.

[19] The profitability of high labour intensive sectors increases in comparison to the profitability of high energy intensive sectors.

- The trade balance of non-energy production deteriorates. The share of energy in production costs doubles, exports decrease by 1.9%, and the share of imports increases by 3.3%.

The high carbon tax rate exacerbates these negative impacts (€709/tCO_2). This rate is required to bridge the financial gap in the pension system using only revenues from the carbon tax. At such a high rate, the economy enters an area where its 'decarbonisation potentials' are saturated[20] (Figure 3). No further substitutions are possible and the negative impacts of higher prices are magnified.

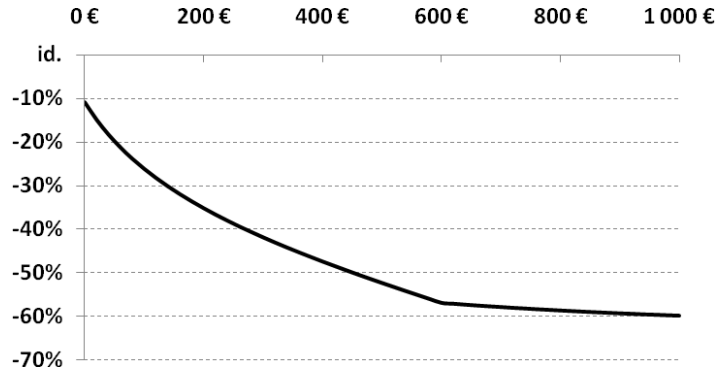


Figure 3 **Reduction in the CO_2 content of growth, compared to 2004, as a function of the level of non-recycled carbon tax reached in 2020 (€0-1000 /tCO_2)**

Compared to the two previous options, the performance of an increase in income tax (IT) is greater. These impacts are rather similar to those resulting from the 'IRA > 3 years' scheme (+0.1% of GDP, -0.1 point of unemployment)[21]. However, in this case, there is less variation in the composite price (+0.1%), as the tax burden on production costs is alleviated. Therefore, exports and imports are almost the same as in the 'IRA > 3 years' scheme (the demand for domestic products is only slightly higher). This result can be explained by the fact that the negative impact of higher IT on disposable incomes and household consumption is more than offset by the positive consequence of higher net wages (+0.1%). The number of job seekers is lower than in the retirement age scenario ('IRA > 3 years'), and therefore the balance of power in wage bargaining benefits workers more. Finally, both household consumption and GDP are higher (+0.1%).

The better performance of the comprehensive carbon tax reform ('CT/SSC & IT') is due to the combination of the three positive mechanisms we saw above:

[20] The possibility of describing the levels of saturation is the main feature of 'hybrid' models (Ghersi and Hourcade, 2006).

[21] As noted above, very similar results can be obtained with an increase in VAT. Higher VAT gives a slightly better result because it benefits household consumption more (+0.4% versus +0.1%), and this favorable effect is not outweighed by lower trade performances (+1.0% against +0.6%). However, the impacts of IT on labour supply are not modelled here, neither are the impacts of VAT on the relative competitiveness of sectors.

1. The recycling of the carbon tax revenue allows a 7-point reduction in the rate of social security contributions. Part of the tax is ultimately paid by non-wage incomes[22], and, as a whole, the tax burden on production costs is alleviated. Thus, the cost of non-energy productions is hardly higher than in the retirement age scenario (+0.1% more), and the increase is in fact due to faster wage progression (+4.8%)[23].

2. The control of production costs and the progression of wages benefit demand for domestic production. The trade balance of non-energy products is hardly impacted, while the purchasing power and consumption of households are higher. The positive consequences of job creation and wage progression therefore exceed the negative consequences of higher energy bills and higher IT.

3. The lower relative price of labour compared to the price of energy is a stronger incentive for a structural change towards a higher employment path. The labour intensity of the domestic production increases (+0.9%) and the overall burden of the oil bill is alleviated (-17.2%).

From this combination of mechanisms, a virtuous cycle is established. Compared to the 'IRA > 3 year' scheme, this comprehensive carbon tax reform makes it possible to reconcile a reduction in CO_2 emissions (-27.7%) with lower unemployment (-1.9 point), and higher GDP and consumption (+0.4% and +1.3%). The key point here is that decarbonisation potentials are not saturated and higher energy prices are compensated. The benefits of lighter tax burden thus outweigh the costs of heavier energy bills.

5 Conclusion

Our primary aim in this paper was to draw attention to the prevailing intellectual compartmentalization of analyses of the 'funding of pensions' on the one hand, and the 'energy transition' on the other. With a model which links the two issues, we have tried to highlight some of the shortcomings arising from separate analyses, and we have shown the feasibility and usefulness of joint analyses. Three key lessons can be learned from this exercise.

i) In today's economies, interactions between energy, trade and demographic constraints explain why conducting different policies related to energy transition, industrial policy, pension reform and fiscal consolidation separately is likely to lead to unexpected interactions and to create potential efficiencies. Partial equilibrium analyses are needed to examine the specifics of each objective and policy, but such analyses ignore possible interactions. In this paper, we have emphasized the potential and the feasibility of developing some complementary general equilibrium analyses to provide meaningful insights into overall policy interactions.

[22] Part of the carbon tax falls on transfers, property and financial incomes. Some specific sectors, like energy-intensive industries, may bear heavier burdens. Nevertheless, the majority of sectors will gain and the administration may compensate the vulnerable ones without jeopardizing the whole performance of the reform (Bovenberg et al., 2008).

[23] This faster wage progression makes the higher income taxation more acceptable (+2.0 points versus +1.4 in the case of the increase in IT scheme). Overall, the purchasing power and the consumption of households are higher (+1.3% versus +0.1%).

ii) The risk of underestimating the limitations of single-objective policies in partial equilibrium frameworks are illustrated by evaluating two typical pension reform schemes (higher social security contributions and an increase in retirement age) and one climate policy (non-recycled carbon tax). Their simulation within our general equilibrium framework revealed potential negative impacts on production costs, the purchasing power of wages, domestic demand or international trade. Acknowledging those mechanisms somewhat undermines the expected benefits of such policies.

iii) An approach to identify a desirable multi-objective policy is illustrated by simulating a comprehensive tax reform which includes a carbon tax component. The focus is on the search for a synergy mechanism at the macroeconomic level. However, as our goal is essentially heuristic, we ignored uncertainties related to the functioning of the economy, as well as future constraints and opportunities. The relevance of this kind of scrutiny also lies in the difficulties involved in overcoming the 'acceptability' problems encountered with single-objective policies. It reveals a possible path to follow to help reach a broad consensus on 21st century tax reforms.

Going further in that direction would benefit most from adding discussions on (1) distribution and justice, (2) the strength and weakness of other available policy instruments, (3) the sensitivity of the best policy choice to the conflicting beliefs held by stakeholders about crucial uncertainties.

References

Aglietta, M., Borgy, V., 2008. Demographic Uncertainty in Europe Implications on Macro Economic Trends and Pension Reforms. An Investigation with the INGENUE2 Model. CEPII working paper.

Bibas, R., Mathy, S., Fink, M., 2012. An "acceptable" low carbon scenario for France. CIRED & RAC-F, 48 p.

Blanchard, O., Katz, L.F., 1997. What We Know and Do Not Know about the Natural Rate of Unemployment. *Journal of Economic Perspectives*, 11, 51–72.

Bovenberg, A.L., 1999. Green Tax Reforms and the Double Dividend: an Updated Reader's Guide. *International Tax and Public Finance*, 6, 421–443.

Bovenberg, A.L., Goulder, L.H., Jacobsen, M.R., 2008. Costs of alternative environmental policy instruments in the presence of industry compensation requirements. *Journal of Public Economics*, 92, 1236–1253.

Chérèque, F., cosignataires, 2010. Une autre réforme des retraites est possible ! Le Monde.

Combet, E., 2013. Carbon Taxation and Social Progress. The case of France, 404 p.

COR, 2010. Retraites : perspectives actualisées à moyen et long terme en vue du rendez-vous de 2010 - Huitième rapport du Conseil d'orientation des retraites, La documentation française.

E. C., 1994. Taxation, Employment and Environment : A Fiscal Reform for Reducing Unemployment, in study n°3 in Annual Economic Report for 1994 (56), *European Economy*. European Commission.

E. C., 2012. Towards a job-rich recovery. European Commission.

Ghersi, F., Hourcade, J.-C., 2006. Macroeconomic Consistency issues in E3 Modeling: The Continued Fable of the Elephant and the Rabbit. *The Energy Journal*, SI2006.

Glomm, G., Ravikumar, B., 1992. Public versus Private Investment in Human Capital: Endogenous Growth and Income Inequality. *Journal of Political Economy*, 100, 818–834.

Goulder, L.H., 1995. Environmental taxation and the double dividend: a reader's guide. *International Tax and Public Finance*, 2, 157–183.

Guesnerie, R., 2007. De l'utilité du calcul économique public. *Economie & prévision*, 175-176, 1–14.

IPCC, 1995. Climate Change 1995: Economic and Social Dimensions of Climate Change, in: Bruce, J.P., Lee, H., Haites, E.F., Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, p. 448.

IPCC, 2001. Climate Change 2001: Mitigation, in: Metz, B., Davidson, O.R., Swart, R., Pan, J., Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, p. 700.

OECD, 2011. Towards Green Growth.

UNEP, 2011. Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication.

Reinhart, C.M., Rogoff, K.S., 2010. Growth in a Time of Debt. *American Economic Review*, 100, 573–78.

WB, 2012. Inclusive Green Growth: The Pathway to Sustainable Development. World Bank.