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Master Analyse et Politiques Économiques

**Financing Welfare Expenditure in France:  
the Incidence of Different Reform  
Scenarios**

**TVA Sociale ou Contribution Patronale  
Généralisée? L'incidence de différents  
scénarios de réforme du financement de la  
Sécurité Sociale en France**

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## Abstract

This paper considers the incidence of a change in the tax instruments used to finance social security expenses in France. We look at a decrease in payroll taxes equivalent to 4.3% of private sector value added (55 million euros) financed by either an increase in the VAT or the creation of a new tax on net value added (the CPG). Our first result concerns the incidence of VAT on transfer incomes : reforms such as the one we are studying are usually calibrated to keep the nominal level of transfers constant, but because the VAT increases the after tax price real transfer incomes falls by 3.45%. Unless this side-effect is taken into account in the calibration the increase in labor income due to the fall in the cost of labor induced by the reform will be financed by those living off transfer income even more than by capital incomes. The comparison of the VAT and CPG reforms (holding real transfers constant) reveals that their effects on economic activity are very similar : output increases by 0.6-0.75%, and between 150,000 and 200,000 jobs are created. The differences between both reform options lie in the size of the tax base and the extent to which the tax weighs on the cost of labor - whether the tax weighs on the gross or net wage. The differences are larger when it comes to the redistributive effects of the reforms : workers always gain, and capital owners always loose, but the increase in labor income relative to capital income are larger for the VAT option (7.1%) than for the CPG option (5.3% or 4% depending on the form of the CPG). We explain that this is due to the double taxation of capital nature of VAT in France today - persistent VAT-, and the automatic protection of returns to labor from inflation embedded in the model. In the last part of the paper we model the impact of the reform in a dynamic infinitely lived agent model, in which unsurprisingly all the reforms are recessive, but the ranking of the different options is preserved : the VAT reform always has a more positive (less negative) impact on the economy, and it brings about more redistribution between capital and labor.

## Résumé long en français

Ce mémoire s'intéresse à différents scénarios de réforme du financement de la sécurité sociale en France. On fait l'hypothèse que les pouvoirs publics veulent réduire les cotisations sociales de 10.2 points, ce qui correspond aux cotisations sociales qui aujourd'hui financent les dépenses des branches famille et santé, et on envisage différentes manières de financer cette baisse par un impôt (ou une cotisation) pesant sur une assiette plus large que les seuls revenus du travail en taxant une partie des revenus du capital. La première option envisagée (la "réforme TVA") est une augmentation de la TVA correspondant à une hausse du taux normal de 5.7 points. Cette hausse peserait sur les prix à la consommation mais également sur les prix des biens d'investissement, par le biais des rémanences de TVA (on trouve que 22% des dépenses d'investissement des entreprises sont soumises à la TVA). La deuxième option envisagée (la "réforme CPG") est la création d'une 'Contribution Patronale Généralisée' (CPG), qui taxerait à la fois les revenus du travail et le résultat courant avant impôt des entreprises, qui constitue aujourd'hui l'assiette fiscale de l'impôt sur les sociétés. On considère deux variantes de cette CPG, l'une taxant les revenus super-bruts du travail (salaires nets et cotisations sociales), l'autre taxant seulement les salaires nets. La première version nécessiterait la création d'une taxe de 5.1%, la deuxième une taxe de 6.56%<sup>1</sup>

Le principal modèle qu'on utilise est un modèle d'équilibre général statique avec un agent représentatif qui offre du travail et du capital, une entreprise et un Etat qui collecte des impôts et les redistribue sous forme de transferts sociaux à l'agent représentatif. Dans ce type de modèle le mécanisme principal par lequel les réformes ont un impact sur l'économie est le marché du travail, dans la mesure où elles modifient le coût du travail. Ce modèle nous permet de tirer trois grandes conclusions concernant les différentes réformes envisagées.

### L'incidence d'une réforme de type TVA sociale sur les détenteurs de revenus sociaux

La réforme TVA est généralement calibrée de manière à ce qu'elle permette de maintenir le niveau de transferts sociaux nominaux financés par l'Etat fixe, ce qui conduit implicitement à faire peser l'incidence de la réforme sur une catégorie sociale qu'on aurait pu penser a priori non concernée par la

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<sup>1</sup>Ce mémoire envisage aussi la création d'une 'Contribution sur la Valeur Ajoutée', soit une taxe sur toute la valeur ajoutée des entreprises. Si cette option comporte un intérêt théorique, dans la mesure où elle pousse à l'extrême l'idée d'utiliser une assiette fiscale beaucoup plus large pour financer la sécurité sociale, elle est relativement impraticable car il n'existe pas aujourd'hui de définition fiscale de l'assiette valeur ajoutée, et il serait probablement assez difficile d'en définir une.

réforme. On montre en effet que la hausse de la TVA augmente le prix toutes taxes comprises, ce qui donne lieu à une baisse du revenu réel des détenteurs de revenus sociaux de 2.76%. Ainsi l'augmentation des revenus du travail (+5.4%) est elle financée plus par une taxation implicite plus importante des retraités par exemple que par une ponction sur les détenteurs de capitaux, dont les revenus chutent de 1.6%. On s'intéresse à ce que donnerait une réforme TVA qui éviterait de pénaliser les détenteurs de revenus sociaux, en les compensant pour l'augmentation de la TVA qu'ils auront à payer : le taux normal de TVA devrait alors augmenter de 8.3 points. Cette hausse serait financée par les revenus du travail et du capital qui bénéficieraient d'un impact positif sur la croissance de la production et de l'emploi inférieur de 30% à ce qu'on trouvait pour la première version de la réforme. On identifie ainsi un arbitrage important dans la mise en oeuvre de cette réforme : soit la hausse de la TVA est calibrée de telle sorte que les détenteurs de revenu sociaux soient les grands perdants de la réforme, soit on preserve leur niveau de vie et le gain en terme d'emplois et de points de croissance est bien moindre.

### **Des effets positifs sur la croissance et l'emploi**

Les différentes réformes envisagées ont des effets assez similaires sur l'économie, sauf la version de la réforme TVA qui pénalise les transferts sociaux qui aurait un effet nettement plus positif. Toutes font baisser le coût du travail en remplaçant une partie des cotisations sociales par un autre impôt dont l'assiette fiscale est plus large et qui pèse moins sur le travail. Cette baisse du coût du travail mène à une hausse de l'emploi donc de la production et du salaire réel des travailleurs. Le rendement de l'épargne est lui négativement affecté par toutes les réformes car toutes taxent d'une manière ou d'une autre les revenus du capital. Pour les réformes CPG et la réforme TVA pour laquelle les transferts réels sont fixes, le PIB croît entre 0.6% et 0.75%, les créations d'emploi sont comprises entre 150 et 200 milles emplois; la réforme TVA qui pénalise les transferts sociaux créerait plus de 300 milles emplois, avec une hausse du PIB de 1.02%.

La réforme TVA pénalisant les revenus de transfert mise à part, deux éléments déterminent l'ampleur de cet impact positif sur l'activité économique: la taille de la nouvelle assiette fiscale (plus elle est large, plus le coût du travail va baisser), à quel point le nouvel impôt (ou l'augmentation de la TVA) pèse sur le coût du travail, et le traitement des revenus de transfert (seule la réforme TVA peut potentiellement les pénaliser). Le premier élément avantage clairement la TVA, dont l'assiette fiscale (1000 milliards d'euros) est plus large que celle de la CPG taxant les salaires super-bruts (950 milliards d'euros), ou la CPG taxant les salaires nets (700 milliards d'euros). Le deuxième élément avantage la deuxième version de la CPG, qui en ne

Table 1: La distribution du revenu total selon le type de revenus et le type de réforme, en milliards d'euros 2007 (*en % par rapport à avant la réforme*)

Type de revenu	Avant la réforme	TVA <sup>1</sup>	TVA <sup>2</sup>	CPG1*	CPG2**
Travail	541.7	571.2 (5.4%)	562.6 (3.9%)	555.4 (2.3%)	559.1 (3.2%)
Capital	390.1	383.8 (-1.6%)	377.7 (-3.2%)	383.3 (-1.7%)	382 (-2.1%)
Transferts	358.8	348.8 (-2.8%)	358.8	358.8	358.8
Total	1290.6	1303.8 (1%)	1299.1 (0.8%)	1298 (0.6%)	1299.9 (0.7%)

<sup>1</sup> Réforme TVA, transferts nominaux fixes

<sup>2</sup> Réforme TVA, transferts réels fixes

\* Réforme CPG pour laquelle la CPG pèse sur les revenus super-bruts du travail.

\*\* Réforme CPG pour laquelle la CPG pèse sur les revenus super-bruts du travail.

taxant pas 'deux fois' le travail (en taxant les salaires nets et pas les cotisations sociales) se révèle être plus favorable à une baisse du coût du travail. Au final la réforme TVA a l'impact le plus positif sur l'économie, et la CPG pesant sur les salaires super-bruts l'impact le moins positif.

### Une redistribution favorable aux revenus du travail

Dans tous les cas les revenus du travail augmentent grâce aux réformes, car l'emploi et le salaire net augmentent, alors que les revenus du capital souffrent de la création ou l'augmentation d'une taxe qui les inclut de facto dans l'assiette du financement de la sécurité sociale : la CPG en les taxant directement, la TVA par le biais des rémanences qui pèsent sur les dépenses d'investissement et de la hausse des prix à la consommation qui affecte tous les revenus (voir tableau 1). La hausse relative des revenus du travail par rapport aux revenus du capital est plus importante pour la réforme TVA (7%) que pour les réformes CPG (4% et 5.3%), ce qui peut sembler suprenant. On explique (section 4.5.2) en quoi ce résultat dépend partiellement de nos hypothèses, en particulier celle concernant le taux d'épargne des différents types de revenus, et on présente une intuition de la manière dont ces résultats changeraient sous différentes hypothèses.

Une dernière partie du mémoire s'intéresse à l'impact des réformes dans un autre type de modèle, dynamique, et dans lequel on inclut des fondements micro-économiques au comportement d'épargne. Dans ces modèles la taxation du capital est à bannir, car elle a un coût très important en terme d'efficacité, on trouve donc sans surprise que toutes les réformes ont un effet recessif sur l'économie. On ne suggère pas qu'il faille se baser sur ce modèle - qui préconise de commencer par abolir toute taxation du capital

- pour éclairer le choix politique. Il est par contre intéressant de constater que la hiérarchie entre les différentes réformes est la même lorsqu'on utilise ce type de modèle : la réforme TVA est à la fois celle qui a l'effet le moins récessif sur l'économie, et qui redistribue le plus entre revenus du travail et du capital.

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## 1 Introduction

In spring 2007 the newly elected French president Nicolas Sarkozy evoked the idea of reforming the finances of the social welfare system in France by decreasing social contributions levied on labor income and replacing the lost revenue by an increase in the Value Added Tax. This suggestion was met by immediate opposition from trade unions, consumer associations and opposition political parties, and the report (Besson (2007)) which was written on the topic was quickly put at the end of the queue of reforms planned by the government. It seems the idea has today been abandoned, but the recent history of debates on French fiscal policy suggests it is likely to re-appear in the near future. Mr Sarkozy's idea was indeed far from new: the idea that the burden of financing social security expenses should be shifted from their traditional tax base - contributions paid on wages which are equivalent to a payroll tax<sup>2</sup> - to a new larger one such as value added dates back to at least the early 1970's. The justifications for such a shift have long been part of the French political debate, and even seem to be agreed upon amongst economists : there is no reason to make labor income pay for social expenses which benefit the whole of the population and not just workers, especially in times of high unemployment possibly caused by the tax wedge between the cost and the returns to labor. Disagreements appear when the question of how best to finance a decrease in the payroll tax is put on the table. Mr Sarkozy's favored option, the VAT, was unpopular because the VAT is seen as a tax which, because it excludes investment from its tax base, does not weigh on capital income - so that *in fine* it would be similar to the payroll tax. Another option was put forward by the previous French president, Mr Chirac, in 2006 : tax the whole of value added through a new tax called 'Value Added Contribution' (VAC), which would mean both capital and labor income bear the burden of the tax, or alternatively include in the tax base the net profits made by firms, already subject to the corporate income tax (this option is called 'Contribution Patronale Generalisee', or CPG). The reports written on the subject were also put at the bottom of the pile, in part because of the opinion expressed by various economists (Blanchard (2006), Aghion and Cohen (2006)) that such a tax would result in taxation of savings and hence have a negative impact on capital accumulation and growth.

The discrepancy between the number of administrative reports written on the question of a shift to a tax on value added and the lack of political resolution to actually reform the system (at least since the creation of the Contribution Sociale Generalisee in 1991) is probably due to the fact that

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<sup>2</sup>We use the terms social contributions and payroll taxes interchangeably in what follows.

such a reform is generally expected to have an important impact on all sectors of the economy, so that political and economic point of views can differ greatly depending on what they choose to focus on. The impact on unemployment is probably that which has been the most discussed and analyzed in the literature, with the possible increase in competitiveness of French products coming second (see Gauthier (2008), Coupet and Renne (2007) amongst others). This paper concentrates on two aspects of the reform consisting in decreasing the payroll tax and either creating a VAC, a CPG, or increasing the VAT (which we call the VAC reform, the CPG reform and the VAT reform for short, and we focus on the last two because they can be more easily implemented) which have been less studied in the literature. One is the incidence of the reform on the substitution between capital and labor. The other is the redistributive impact of the reform : we are interested in what happens to the relative incomes of those providing capital and labor, but also that of those individuals unlikely to be affected by the hoped for substitution between labor and capital in production - those whose main source of income comes from social transfers financed by the social security system, generally considered fixed in nominal terms at least in the short run. We will show that the VAT reform in particular can be modeled as increasing the after tax price, thus shifting some of the tax burden towards those whose nominal incomes are fixed.

This paper is organized as follows. Section Two presents the debate on the financing of the social security system in France in more details and gives a first intuition concerning the difference between the options considered. Section Three outlines the reforms and describes what part of the French economy is likely to be affected, justifying a restriction of the scope of our analysis to a well defined 'private sector'. Section Four presents a simple static general equilibrium model of the reforms which abstracts from consideration of labor market imperfections but provides results concerning the incidence of both reforms. The shortcoming of this framework is that it cannot model the reason why it is argued that the VAC or the CPG are likely to have a worse impact on capital accumulation than the VAT. This leads us to constructing a dynamic model of the economy in section Five which explains this argument - the predictions of such a model concerning the efficiency of different tax instruments are well know, and we discuss the pertinence of its use for fiscal policy predictions. Section Six concludes.

## 2 The Debate on Social Security Finance in France

### 2.1 The social security system in France : 60 years of existence, 60 years of debate on taxes and contributions

The origins of the present day French system of social security can be found in the social insurance mechanisms organized by workers and employers during the 19th century. In exchange of contributions on their wages workers had a right to subsistence income when confronted with a life accident which prevented them from working. When the modern system was created after the second world war trade unions and the political elites of the time chose to remain in the continuity of such a system, rather than centralize funding and organization of the *protection sociale*<sup>3</sup> at the state level as was decided at the same moment in the United Kingdom. One advantage put forward at the time was the isolation of social insurance expenditure from the government budget constraint, which was thought to guarantee a certain level of social expenses. By choosing to make workers pay for their own social insurance through contributions levied on their wages, the French social security system has a distinctive Bismarckian edge; however a contradiction was introduced at its very creation, when the founders of the system adopted - in theory if not completely in practice - the Beveridgian principle of universality, according to which all citizens should be covered (Palier (2007)). This tendency towards universal provision of social security - universal provision being traditionally seen as a function of the state - explains why the conviction that the system's finances should be organized and collected by the state was found amongst some political elites as early as the 1950's<sup>4</sup>. How best to finance the social security system has been an open question since its creation .

We have to wait until the 1970's for the debate regarding the pertinence of using labor income as the sole source of finance for the social security system to gain real political salience. It arose out of three preoccupations which all remain part of the public debate today. The most stringent one at the time was the rise in unemployment and an increasing concern with a possibly excessive cost of labor. This went hand in hand with the belief that the surge of social contributions in the after-war period had accelerated the substitution between capital and labor (Carre, Dubois, Malinvaud, (1972)), and that such a substitution was no longer a good thing for the French economy. A second concern was the slower growth of labor income, especially problematic in comparison with the steady increase in social security

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<sup>3</sup>As we shall see this term, loosely translated into 'social security system', or welfare system, refers both to social insurance and some social assistance.

<sup>4</sup>In 1952 the then head of the government, Antoine Pinay, tries to make the collection of social contributions a prerogative of the state. He is stopped by an intensive lobbying by trade unions and employers organizations.

Table 2: Average yearly growth of social security expenses, GDP and labor income, 1970-1996, in %

	1970-1973	1973-1983	1983-1991	1991-1996
Social security expenses	6.5	5.7	2.9	2.5
GDP <sup>1</sup>	5.6	1.95	2.75	1
Total Labor Income <sup>2</sup>	6.2	3.15	1.75	0.9

1.GDP deflated by the consumer price index

2.labor income gross of all social contributions

*Source:* Sterdyniak and Villa (1998)

expenses : since 1960 social security expenditure have been multiplied by 7 whilst labor income only increased by a factor of 3.5 (table 2.1). Finding a larger tax base for social contributions was seen as a way to cope with these diverging dynamics, and the progressive removal of the ceilings to social contributions was decided as a result. This turned out to be insufficient, and the contribution rates themselves were progressively increased during the 1970-80's : the employer contribution rate increased from 32% to 38% from 1973 to 1983, and the employee rate from 7% to 12%.

Finally the increasing universal provision<sup>5</sup> of the expenses financed by the social security system introduced a social justice element to the debate : why should expenses which benefit everyone be financed solely by labor income? It is customary to distinguish between social security expenses on risks associated with employment (pensions, unemployment, accidents at work), and those which benefit all citizens (health and family expenses) whether or not they are employed. There is a growing consensus amongst politicians and economists alike that social justice entails that the former should remain paid by social contributions on labor whilst the later should be financed by all citizens (Sterdyniak (2002))<sup>6</sup>.

During the 1980's the conclusion reached by political elites was that the burden of paying for social security expenses should be shifted away from

<sup>5</sup>The introduction of universal health coverage, decided in 1999, was one of the major steps in the trend towards universal provision of the services offered by the social security system

<sup>6</sup>Our paper relies on this idea as well - it is at the basis of the different reform scenarios we will consider. However it is important to note that this typology of social security expenses is not as clear cut as it seems : health is one of the qualities of human capital which is affected by work, and as such health risk can be seen as a consequence of work. Similarly, natality facilitating expenses can be seen as linked to the need for labor to reproduce itself, as has been argued by classical authors from Ricardo to Marx. What differentiates family and health expenses is thus not particularly the nature of the risk they cover, but the scope of the population which is entitled to them.

firms towards households in times of economic stagnation and increasing international competition. The idea that was finally implemented is that of a new tax on all types of income, the Contribution Sociale Generalisee (CSG), born in 1991. One of the aim of the tax was to clearly establish what part of social expenses served a purpose of universal social assistance and, as such, should be financed by the state : progressively the CSG was increased to replace all employee payroll taxes which were affected to health expenses. The introduction of the CSG was very far from closing the debate, though the question of the tax base lost importance relative to concerns regarding unemployment during the 1990's. The focus of those wishing to optimize the structure of the French fiscal system during that period was the decrease of the fiscal wedge between the costs and the returns to labor seen as necessary for the least qualified who were subject to high unemployment. Employer contributions on low wages were progressively decreased from 1993 onwards, and they have now reached a level of 2.1%<sup>7</sup>. This has had some positive result on unemployment (see below), but because these decreases were generally not financed by an increase of some other tax they also exacerbated the problem as to how to extract sufficient revenue to finance social expenses. Aware of the problem nearly each successive government asked for a report on the subject since the mid 1990s (Chadelat (1997), Malinvaud (1998), Foucault (1994), Besson (2007), Conseil d'Orientation pour l'Emploi (2006) to cite just a few), whose conclusions tended to be cautious and divergent. The rise in the share of public taxes in the finances of the social security system which started in the early 1980's went on, with governments allocating revenue from their budget to finance the expenditure but never finding a secure source of revenue allocated to the social security system.

Today social security expenses<sup>8</sup> represent 22% of the French GDP. 60% of the resources of the social security system come from social contributions, 20% from the CSG, with the remaining being paid by the state to the institutions in charge of social security. Reforming the system once again was a question at the heart of the last French presidential elections, with both leading parties favoring one version of a tax on value added to finance a decrease in social contributions. The VAC was suggested by the socialists, whilst one of the first steps taken by the new conservative government after its election was to ask for an administrative report on the potentialities of a 'social VAT'. This option of decreasing social contributions on labor whilst financing the measure by an increase in VAT has been nicknamed in numerous ways since : social or anti-social VAT, anti-delocalization VAT, pro-employment VAT, pro-competivity VAT, pro or anti purchasing power

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<sup>7</sup>This excludes contributions paid for work accidents, the rates of which vary according to the type of firm

<sup>8</sup>These include health, family and unemployment expenses, as well as public pensions

VAT.. All these reflects the political opinions of the name-givers at least as much as the desired or feared impacts of the reforms, so the remainder of this section looks at what the economics of tax incidence can teach us concerning these potential impacts.

## 2.2 The economics behind the politics

### 2.2.1 Reasons for decreasing taxes on labor

This section discusses the economic rationale for the reforms we are going to consider and their potential impact.

Social contributions represent today 43.9% of the gross cost of labor for an employee paid the minimum wage, 51% for one paid the average wage, and 64% for the highest wages. This makes France one of the first countries at which a recommendation made by the OECD recently is aimed : "Reduce non-wage labor costs, especially in Europe, by reducing taxes on labor" (OECD Jobs Study 1994 p.46). The implicit idea behind this recommendation is that the cost of labor in Europe (and thus in France) is too high, and that this explains persistent high unemployment. Reducing payroll taxes should reduce this cost, hence making firms more willing to hire new workers

In the long run the OECD idea appears incomplete, if not flawed : it is generally agreed that though changes in the payroll tax may have short run impacts on the cost of labor, they are ultimately shifted on to the net wages received by employees. The cost of labor to the firm should thus not decrease in the long run so that no favorable long term effect on employment should be expected from this channel, but the increase in returns to work may well lead to an increase in employment if one of the reasons for unemployment is that some individuals choose not to work because the wage which is offered to them is too low. Though explaining the bulk of French unemployment by this factor would be clearly going one step too far, the shift in recent years towards policies aiming at 'making work pay' in Europe, including in France, and the proliferation in the economic literature of estimates of the impact on employment of such policies, suggests this channel is one neither economists nor politicians think should be neglected. Indeed the rare estimates which are available on the elasticity of participation to returns to work for France show that it can be significant (Piketty (1998)), as we will show later.

Two arguments in favor of the OECD theory have been often put forward however. The first one points out that whilst in the long run it is accepted that the share of capital and labor remuneration in value added is fixed, the share of labor has been declining since the 1980's in France, and is currently at an all time low(table 3). Decreasing payroll taxes may help it get back

Table 3: Share of labor income<sup>1</sup> in value added, 1960-2007, in %

1960-65	1966-70	1971-75	1976-80	
54.4	55.5	57.3	61.9	
1981-85	1986-90	1991-95	1995-2000	2001-07
62.3	58	58	58.2	58

1. Including social contributions, but excluding mixed revenue

*Source:* National Accounts

to its standard medium run level faster (through both an increase in wages and an increase in employment) than waiting for one of the iron laws of economics to establish itself in some far away long run.

The second one is more institutional : in France today low wages are typically fixed by law around the minimum wage level (SMIC), so that a decrease in the payroll tax for those wages may lead not to an increase in the wage but to a decrease in the cost of labor. If unemployment is the result of the nominal rigidity introduced by the minimum wage, it should decrease. The 'employment efficiency' of decreasing payroll taxes on low wages is reinforced by another observation concerning the nature of the labor which is remunerated at such levels. It is generally thought that little qualified labor is by nature more substitutable with capital than qualified labor, and hence that its demand is more responsive to its cost (see De Vreyer (2002) for a review). This is the argument put forward by Salanie (2000) and Gauthier (2008) amongst others, and generally used to justify the decrease of employer contributions on low wages. Between 1993 and 2003 employer social contributions at the level of the minimum wage were reduced from over 40% of the gross wage to less than 15% today<sup>9</sup>. Several ex post estimations of this policy have been made, and suggest some positive results. Gafsi, L'Horty and Mihoubi (2004 and 2005) in the most comprehensive ex post estimation done to this day estimate that the number of jobs created or saved was under 150,000 between 1994 and 1997<sup>10</sup>. They point out one large uncertainty in all the estimates which can be found in the literature which is of particular interest to us : no estimation has been able to take into account how the necessary financing of this decrease in the payroll tax has affected employment. This is due to the fact that there was no explicit

<sup>9</sup>These number include as employer social contributions the contributions affected to the finance of health, family, public pensions, work accidents and unemployment expenditure. We exclude from this number and in all that follows 'other' types of contributions such as the training tax or the transport tax which are also a % of the gross wage. Altogether these 'other' contributions represent 4% of the gross wage

<sup>10</sup>Theirs is the most recent and argued estimate, it is also one of the lowest, as some authors report up to 400,000 jobs created.

means of finance<sup>11</sup>, and that the missing payroll taxes (1% of GDP in 2003) most probably affected the level of employment in the economy, in a way that cannot be taken into account by ex post estimates. This points out the necessity of making explicit ex ante how a possible decrease in the payroll tax will be financed. The good news is that, contrary to what happened for the targeted decrease in payroll taxes during the 1990's, the current debate on whether to decrease payroll taxes further always includes the question of how the reform would be financed.

### **Should the decrease be targeted to low wages only?**

This is the argument put forward by Bell and Nickel (1996) amongst others, and the above discussion, as well as the persistently higher level of unemployment for the least qualified, suggests it has some merit. The current level of employer contributions<sup>12</sup> on low wages however leaves very little room for manoeuvre : there remain only 2.1 points of contributions that could be lowered (Conseil d'Orientation pour l'Emploi (2006)). Moreover a targeted reform does not coincide well with the aim of social justice mentioned above - as it shifts the burden of financing the system on a smaller portion of workers - and may reenforce existing negative side-effects of having progressive social contributions. The progressive nature of social contributions has created a discontinuity between the cost to the firm of increasing wages and the increase of the returns to labor which the employee will get from it : today a 10% increase in the wage of someone paid at the minimum wage level provides an extra 29 euros to the employee, and costs 202 euros to the firm (Sterdyniak (2004)). There is a fear that pushing these types of policies any further could create even more of a low wage trap as a side effect of fighting against the unemployment trap. The difficulty of accessing better paid jobs could also provide strong disincentives for human capital accumulation. Finally, though low employment of the least qualified is undoubtedly a problem in France today, one may ask if it is more of a problem than general unemployment, which affects in priority the old and young. Table 4 shows that the repartition of unemployment levels by qualifications in France is indeed skewed to the left, but not more so than in countries like the UK and the US, where unemployment is much lower.

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<sup>11</sup>Part of the already existing taxes on alcohol and tobacco were affected to the financing of the missing resources for social security expenses, but these existed before the reform so that their affectation represented a drop in resources for the state

<sup>12</sup>The above argument is generally seen as applying only to a decrease in employer contributions, because in the short run a decrease in employee contribution will simply lead to an increase in the net minimum wage level

Table 4: Unemployment rate by education level in 2002, in%

	No high school diploma	High school diploma	Higher Education	All
United States	10.2	5.7	3.0	5.8
Germany	15.3	9.0	4.5	8.6
France	11.8	6.8	5.2	8.8
United Kingdom	8.5	4.1	2.4	5.1

Source: OECD (2004), Perspectives de l'Emploi

### 2.2.2 Why shift to a tax on value added?

The idea behind the shift of social security finance from labor to another tax base is to make the burden of the tax weigh more evenly on all types of income. The value added is a good candidate for such a shift, as by definition value added is equal to the sum of revenues distributed to households. This better repartition of the tax burden has an important corollary : value added is a much larger tax base than labor income, so that the tax needed to finance a decrease in social contributions of 1% is around 0.46% of value added, if the whole of value added is taxed. A tax on value added should also lead firms to choosing to substitute labor to capital, if it replaces a decrease in the payroll tax : the extra tax paid by the firm on one more unit of value added produced will be the same if this unit is produced using capital or labor, whereas payroll taxes will be paid only in the first case.

#### The 'Value Added Tax'

The Value Added Tax has a deceptive name : it does not tax the whole of value added (in theory at least expenditure on investment made by firms are exempt from value added) and therefore does not have all of the desirable properties of a tax on value added described above. In particular the amount of tax paid by the firm will not be the same if an extra unit of value added is obtained from using more labor or more capital - all expenditures on acquiring new capital will be exempt from VAT<sup>13</sup>, whilst expenditure on hiring new labor will not. This does not turn the VAT in a tax which is equivalent to the payroll tax however: the advantage of VAT is that it is levied on consumption, a tax base which is larger than labor income. To see this write the equality between aggregate production and aggregate demand in a closed economy

$$pY + VAT = Cp(1 + t_v) + pI$$

<sup>13</sup>In practice the VAT in France does tax some investment expenditure, see below

Where  $Y$  is the value added,  $VAT$  the tax receipts from VAT,  $C$  aggregate consumption,  $I$  investment made by firms, and  $p$  the before tax price. The equality between aggregate production and aggregate income is

$$pY + VAT = wL(1 + t_l) + rK + VAT$$

Where  $t_l$  is the average payroll tax rate,  $K$  and  $L$  are the production factors,  $r$  and  $w$  factor remuneration net of all taxes, and we have used the fact that when the production function exhibits constant returns to scale value added is equal to the sum of factor remunerations. We can thus write that the tax base for the VAT, consumption, is equal to factor remuneration minus investment:

$$pC = (1 + t_l)wL + rK - pI \quad (1)$$

The payroll tax and the VAT are therefore only equivalent if  $t_l = 0$  and  $rK = I$ . The first condition does not hold by definition in the economy we are considering (but already suggests the size of the VAT base will be affected by the reform even if none of the agents adapt their behavior, because  $t_l$  will decrease), and it is a stylized fact generally agreed upon that investment is lower than capital remuneration (Carre, Carton and Gauthier (2008)). The tax base for the VAT is therefore necessarily larger than that for the payroll tax, so that any decrease in the payroll tax will be compensated by a smaller increase in the VAT. Because both of these tax weigh on the cost of labor (see equation (1)), we already have an intuition as to why we can assume the reform to have a positive impact on labor demand despite the fact that investment expenditure are exempt from VAT.

### The Value Added Contribution

The VAT does not have all the apparently positive characteristics for employment which a tax on the whole value added would have, so the creation of a tax on the whole of value added - 'Cotisation sur la Valeur Ajoutée', which we simply translate as Value Added Contribution (VAC)- has been proposed. This tax does not as yet exist, so its precise definition is left to the imagination of the researcher (Blot et al (2007)). It is neutral with respect to the production choices of firms between using labor and using capital so we can expect it to have a much more favorable impact on the substitution between capital and labor than the VAT. However most economists who have expressed a point of view on the VAC tend to disfavor it (Blanchard (2006), Aghion and Cohen (2006)), on the ground that because it fails to exclude investment expenditure from the tax it taxes savings, and hence creates a large disincentive to capital accumulation. Malinvaud (1998) also objects to the VAC, on the ground that it would tax the gross value added, including that part of value added which will have to be spent on replacing capital which has depreciated. Finally it can be argued that considering the

VAC option may have theoretical interest but does not provide a practical answer to the question we are considering : there is no fiscal definition of 'value added' and it may well be very difficult to define one, so that the creation of the VAC may be a complicated affair, and one not favored by policy makers when existing tax bases could be used to tax a larger share of the value added : the suggested idea is to include 'net profits', fiscally defined as the tax base for the corporate income tax, in the tax base for social contributions- what we have called in our introduction the CPG reform. This is equivalent to the creation of a tax which would weigh on the whole of value added bar expenditures on capital depreciation , and thus answers Malinvaud's criticism of the VAC.

### 2.3 The ground covered by the existing literature

In recent years several articles in the economic literature have analyzed the impact of either a VAT or a VAC reform (the CPG has not been studied outside of government or administrative reports). The focus is generally on the impact of the reforms on unemployment. Gauthier (2008) and Beauvallet and Restout (2007) for example include three factors of production and rigidities on the market for unskilled labor, thus obtaining estimates which take into account the different labor market conditions for the skilled and unskilled. Gauthier (2008) finds that a shift in the tax bases of around 1% of GDP would lead to an extra 50,000 new jobs should the decrease in payroll taxes be uniform, and five times as much were it targeted to low wages. He briefly considers the VAC option and finds effects which are very similar to that of the VAT. Beauvallet and Restout (2007) find that a shift of one point of payroll tax on the VAT would have a mild expansionist effect, but hardly any positive impact on unemployment. Both these papers model the reform in an open economy framework which allows them to look into the 'hidden devaluation' impact of the VAT, much discussed politically<sup>14</sup>. They, like and Coupet and Renne (2007) find a small positive impact on GDP of the decrease in the price of domestic goods with respect to imported goods due to the reform.

Coupet and Renne (2007) and Laffargue (2000) use numerical simulations to estimate the impact of the reforms in dynamic models. Coupet and Renne (2007) find a positive short term impact on employment (an extra 80,000 jobs created after a year) and on GDP a of a shift in tax bases equal to 1% of GDP, but in the long term these positive effects are counteracted by a nega-

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<sup>14</sup>The idea is that whilst the increase in VAT would bear on all goods consumed in the economy, including imports, the decrease in payroll taxes would only benefit domestic firms. The price of domestic goods with respect to imports, and exports with respect to foreign goods, should decrease, thus providing domestic goods with a competitive advantage in a globalized economy

tive impact on investment. They only consider the VAT. Finally, Timbeau, Blot, Heyet et Plane (2007) use a macro-econometric model to estimate the impact of the creation of a VAC to substitute for 10 points of payroll taxes. Theirs is the sole paper devoted to the VAC and it relies on the estimation of reduced form equations for factor demands, the coefficients of which are then used to estimate the impact of a VAC. They find that such a VAC would create 130,000 jobs over four years, but a 10% decrease in investment. Whilst these models cover the impact of the reform on job creation at length, most do not introduce a micro-founded modelization of saving behavior, none compare the VAT and the VAC options comprehensively, and none look at the CPG option. Coupet and Renne (2007) do introduce intertemporal substitution of consumption but the lack of analytical solutions for the impact of the reform in their paper makes the role of different economic behavior and of specific assumptions regarding parameters difficultly tractable.

Our paper contributes to the existing literature by constructing two models - one static, one dynamic - which are much simpler than most of those quoted above but which try to take into account precisely what we think is lacking, or has not been analyzed enough in the literature : we look at how different models with different assumptions can take into account the impact of the reforms on capital accumulation<sup>15</sup>, and the incidence on those whose major source of income is social transfers. In order to concentrate on these two questions we abstract from considering labor market imperfections and the impact of the reforms in an open economy which have been exhaustively covered in the literature. This enables us to keep the structure of the models simple and the impact of the reforms analytically tractable.

In our first model, similar to a simplified version of the one constructed by Gauthier (2008) we analyze in a static framework what impact the reforms would have on labor, capital income, labor income, and social transfers income. Because this model is static, we have to assume suppliers of capital do not react to a change in the returns to savings, which necessarily limits the pertinence of our analysis. We therefore construct a second model based on what is possibly the opposite assumption : supply of capital is infinitely elastic, in the long run, to the relative prices of consumption today and in the future. We discuss the long run impact of the reform in a dynastic dynamic general equilibrium framework in which we can include a micro-founded behavior of capital accumulation, and derive analytical solutions for the short run impact following a method pioneered by Judd (1985). We discuss the shortcomings of such a model in terms of its assumptions and well known predictions concerning optimal tax policy, and suggest it is not more appropriate for informing economic policy decisions than the static

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<sup>15</sup>Coupet and Renne (2007) is the only article in which there is an explicit trade-off between consumption today and in the future

model. Our models systematically compare all the reform options, showing in which cases and under which assumptions their effects on the economy will be significantly different.

## 3 The Reforms Considered

### 3.1 Which reforms?

We believe that most of the progressivity that can be introduced in the social contribution system has already been introduced, so that going any further would have little impact on unemployment, whilst re-enforcing existing disadvantages explained above. As a consequence we will only consider a uniform decrease in social security contributions. We do not differentiate between employer and employee contributions, as in the medium-long run these are equivalent. The amount of the decrease turns out to be of little relevance, as the results obtained below are all proportional to the amount of the tax burden shifted (results not shown). We consider a 10.2 point decrease in the payroll tax, but all our results can be generalized to a point decrease in the tax by dividing them by 10.2. We obtain this number of 10.2 points by assuming that the whole of social contributions used to finance family and health expenditure are shifted - they represent around 55.2 billion euros in 2007, which corresponds to a 10.19 decrease in the payroll tax. The size of the increase of the VAT or the new VAC or CPG required to finance this decrease will depend on both the size of the tax bases of the fiscal instruments, which is what we turn to in the next paragraphs, and the reaction of those bases to the reforms, which we take into account in our models.

### 3.2 The scope of the French economy concerned by the reform

The VAT and the payroll tax are not levied on all types of production equally and neither would the VAC or CPG, for reasons explained below. In order to concentrate on the impact the reforms would have on the substitution between capital and labor in production sectors for which factor and output prices are directly affected by the reform we restrict our analysis to these sectors, which we group under the name 'private sector'<sup>16</sup>. Such a restriction - similar to those which can be found in the existing literature, see for example Gauthier (2008)- makes our analysis less general, in the sense that some general equilibrium effects are not taken into account: we are implicitly assuming that the reforms will have no effects on the sectors of the economy we are disregarding and that these will have no feedback

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<sup>16</sup>This name is slightly misleading as publicly owned firms which sell goods on the market at a competitive price are included in our analysis. It merely suggests that we are concentrating on the decision of firms as producers and households as buyers as they are the ones directly concerned by the reform, ignoring public production and consumption, and domestic production.

effects on the private sector we are studying. This assumption is of course too strong, one can think for example that an increase in VAT on the price of houses will lead to some households choosing to rent instead of investing into their own lodgings, and yet we exclude rents from our analysis. Such cross price effects however are unlikely to be large enough to affect our results, and restricting the analysis in such a way allows for models which remain relatively simple and general equilibrium effects which are tractable.

The largest sector excluded from the models is public production ( with a value added of 295.7 billion euros in 2007), understood as the production of goods and (mostly) services by public administrations which are not sold at their market price (*Administered services* in the French National Accounts). Public production - mostly health, education, and public administration services- is generally available for free or taxed at a very reduced rate; this means that the assumption that no VAT is levied on this production is reasonably accurate. On the other hand public administrations buy goods at their after tax price, so that they pay VAT not only on their final consumption, like consumers, but also on the goods they buy for production - their intermediate consumption and investment. This VAT paid by public administration however cannot be assimilated to a fiscal receipt as it also represents an expenditure by the state, and it will be neutralized in what follows. Similarly estimating the value added produced by sectors which do not sell goods at the market price (public administrations) is difficult, and these sectors do not pay corporate income tax; for these reason it is unlikely that these will ever be subject to the VAC or the CPG.

This restriction of the scope of our analysis is less justifiable when it comes to payroll taxes, as public administrations also pay payroll taxes<sup>17</sup>, but they typically do not pay as much payroll taxes as private firms, with the state compensating for the missing amounts by transfers from its budget to social security administrations. The decrease in employer payroll taxes on low wages which has occurred since the 1990's was restricted to the private sector, so it is possible to think that any decrease in employer contributions will not affect the public sector. On the other hand it is difficult to see how a decrease in employee contributions could not affect public sectors employees as well as private sector ones, though the level of their contributions today differs slightly. The questions of which type of contributions to decrease, as well as what equivalent in the public sector a decrease in payroll taxes in the private sector should have, are political ones, left out of our analysis. In what follows payroll taxes paid by employers and employees in the public

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<sup>17</sup>They paid 43 billion employer payroll taxes in 2007, out of a gross remuneration of their labor force of 210 billion. Employees of the public sector paid an estimated 17.8 billion employee contributions.

sector are excluded from aggregate taxes<sup>18</sup>.

Also excluded from the private sector is the production of goods and services by households (221.1 billion euros value added in 2007) - the production by households when these are declared as unincorporated firms is however considered as part of the private sector. Household production net of unincorporated firms production as recorded in national accounts consist in mostly two kind of services : domestic services (housekeeping, baby-sitting...), for which they employ labor, and housing services as soon as they are owners of real estate and someone occupies their housing. Domestic services are directly consumed by the households themselves so by definition they are not subject to VAT, and neither are rents paid to real estate owners. Households pay employer contributions for the labor they hire to produce domestic services, but these contributions are much lower than those paid by firms, and as such are unlikely to be concerned by a fall in the payroll tax. Similarly estimating the value added produced by each household in domestic services would be subject to enormous technical difficulties, so it is unlikely that it would be subject to the VAC or the CPG. Rents received by households could in theory be easily subjected to both these taxes, but this would create a disincentive to let for real estate owners, which already explains why rents are not subject to the VAT. Domestic production therefore won't be directly affected by the reform, as long as we maintain the hypothesis that there are no cross price effects between the private sector thus defined, and public and domestic production.

Finally we are considering a closed model of the French economy : they is no trade, import and exports levels are fixed at 0. All the numbers given below refer to the private sector of the French economy thus defined, unless otherwise specified. Appendix A describes how we compute aggregate values for the private sector from the national accounts for the whole French economy in 2007.

### 3.3 The payroll tax

The payroll tax is levied on the remuneration of the labor force. It is divided between three types of taxes (or contributions in the French typology of fiscal tools): employer contributions (161.9 billion euros in 2007), employee contributions (58.5 billion) and contributions made by non em-

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<sup>18</sup>A simple calculation suggests that including the public sector in the analysis would increase the yield of a point of payroll tax by 1.5 billion. If we take the yield of the VAT point to be 10.2 billion, this means a one point increase in VAT only allows for an ex ante 1.4 point decrease in the payroll tax.

ployees who own unincorporated firms (22.6 billion). For our purpose and in medium and long run equilibrium of the economy all these taxes are equivalent in so far as they drive a wedge between the cost of labor to the firm and the net wage received by the household. Gross remuneration of the labor force was 690.2 billion in 2007<sup>19</sup>, and total payroll taxes receipts were 243 billion, which gives an average payroll tax of 44.8%, and a fiscal yield of 5.65 billion euros per point of payroll tax. Unlike for the case of the VAT (see below), this average tax rate hides important disparities, as employer contributions on low wages have been greatly reduced since the early 1990's so that the payroll tax schedule is today clearly progressive. In what follows however we shall assume there is only one payroll tax rate.

### 3.4 The VAT

#### VAT in theory

Aggregate household consumption in the private sector was 1079.6 billion euros in 2007 after tax prices, whilst VAT receipts were 135.7 billion. These VAT receipts however include VAT expenses by public administration, which, as explained above, must be taken out as they do not represent a source of revenue for the state. According to a report by the Conseil des Impôts (2001), VAT paid by public administration represents 14.7% of the total, so that from now on we consider VAT receipts as 115.75 billion euros. The theoretical average VAT rate in the economy is thus 12%. Though there are three types of VAT rates in France (19.6% for most goods, 5.5% for food and most health products, and 2.1% for a very limited number of goods, mostly newspapers and medication which are reimbursed by the social security system), 90% of tax receipts come from goods taxed at the highest rate, so using the average tax rate as the sole VAT rate is not a bad approximation of reality, from the point of view of fiscal receipts<sup>20</sup>. A point of VAT yields in theory 9.64 billion euros, so that keeping fiscal receipts constant and assuming the shift between tax bases does not affect the bases themselves (as we will say below, keeping the government budget balanced *ex ante*) a one point increase in VAT allows for a 1.7 points decrease in the payroll tax.

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<sup>19</sup>See Appendix A for the repartition of value added between labor and capital remuneration

<sup>20</sup>However this variety of tax rates does lead to a differentiation of the share of consumption expenditure spend on VAT according to some household characteristics, especially age (Courtioux 2007)

### VAT in practice

In practice the VAT does not completely exempt firm's investment expenditures, and some of the firm's intermediate consumption used in production are not deductible from VAT. Part of the 115.75 billion euros collected as VAT receipts therefore weigh on the costs of production by firms, and these specific fiscal revenues are called persistent VAT. Based on estimations by the French public administration<sup>21</sup> and our own calculations we find that 22% of investment expenditures are subject to the VAT. These may seem large, and indeed taking into account that more than 20% of investment expenditures are subject to the VAT mitigates the idea according to which the VAT distorts firms' technological decisions towards increasing capital relatively to labor, but average implicit VAT rates paid by firms are low : 2.2% on investment expenditures, and less than 0.3% on intermediate consumption. Taking into account persistent VAT widens the tax base, which is now of 1000 billion euros, and gives a lower average tax rate of 11.55%. This larger tax base has a positive impact on the fiscal accounting of the reforms we are considering, as a one point increase in VAT, under the same assumptions as above, now allows for a nearly 2 points (1.81) decrease in the payroll tax. Finally, though we are considering an increase in an theoretical average tax base, it is possible to compute what increases in the different existing tax rates would correspond to this increase. We know, for example, that a point increase in the highest rate yields 5.9 billion euros (Besson (2007)), so that a one point increase in the average rate (which yields 10 billion euros) corresponds to a 1.69 point increase in the highest rate.

### 3.5 The Contribution on Value Added

The idea behind the creation of a new tax on value added is to widen the tax base used to finance welfare expenditure : instead of taxing solely that part of value added which goes towards remuneration of labor income, tax both parts of value added, including the part which goes towards remuneration of capital income.

#### The Contribution on Value Added in theory : the VAC

One suggested form of such a tax on the whole of value added (see Blot et al 2007) is simply to tax the whole of value added, ie the whole of the wealth created by firms during production. We follow the existing literature by calling this tax a Value Added Contribution (VAC). The tax base of the tax would then be simply 1174.7 billion euros, the sum of value added

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<sup>21</sup>These estimates are taken from a report by the *Conseil des Impôts* on VAT published in 2001. See Appendix B for detailed explanations of how we go from these estimates to the shares of investment and intermediate consumption subject to persistent VAT.

produced by the private sector, and the creation of a 1% VAC levied on the whole of value added would allow for a nearly 2.2 points decrease in the payroll tax (2.17).

### **The Contribution on Value Added in practice : the CPG**

In practice however the creation of a VAC as described above is unlikely, or would be fairly complicated administratively : the fiscal definition of a firm's value added is subject to some controversy and would have to be defined, as value added is not the tax base of any existing fiscal instrument. A more practical alternative to the VAC has been proposed however, which is based on existing fiscal practices in France : the suggestion is to create a tax which would weigh on both labor income distributed by the firm and that part of capital income (or profits) which is already taxed by the corporate income tax (*impôt sur les sociétés*), the CPG. The tax base for the corporate tax is grossly speaking capital income minus all the expenditure needed to finance capital depreciation<sup>22</sup> which in France in 2007 is estimated to be 165.3 billion euros. The corporate tax rate is 33.3%, and the amount collected by the tax is around 50 billion euros : 33.3% of 165.3 billion euros is 55 billion, so that our estimate of the corporate tax base is consistent with the amounts collected.

Exactly what part of labor income the CPG would tax is open to question. We look at two alternatives : one in which super gross labor income is taxed (the sum of net labor income and the payroll tax) which would give a tax base of 950 billion euros - and a 1% CPG would finance a 1.75 decrease in the payroll tax - and one in which only net labor income is taxed which would give a tax base of 707 euros, and a 1% CPG would finance a 1.3 decrease in the payroll tax. We call these two CPG options respectively the CPG1 reform and the CPG2 reform in what follows.

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<sup>22</sup>The tax base of the corporate income tax is indeed a little bit more complicated : it is equal to 'profit'- or capital income - minus an allowance for capital depreciation, plus the 'financial result' of the firm which takes into account its level of debt, plus its 'extraordinary result' which is the balance of any gains and losses above those which can be normally expected by the firm. As we show however simplifying the tax base as we do is consistent with the amount collected by the corporate income tax.

## 4 The Static Model

The aim of this section is to provide an insight as to what the incidence of the reforms would be using a simple static general equilibrium model. We are considering an economy with three agents : the State, one representative firm and one representative household. The household owns all factors of production, capital  $K$  and labor  $L$ , and rents them out to the firm at prices  $w$  and  $r$ .

### 4.1 The VAT reform

#### 4.1.1 The state

The state extracts its revenue from the economy using two types of tax : a payroll tax  $t_l$  and the VAT  $t_v$ . Tax receipts are redistributed to the household in the form of transfers,  $T$ . The states' tax receipts are :

$$T = t_l wL + t_v(pC + p_i pI), \quad (2)$$

Where  $C$  stands for consumption,  $I$  for investment,  $p$  for the before VAT price, and  $p_i$  is the share of investment subject to persistent VAT (see Appendix B). For a given tax policy ( $T$  and  $t_l$  are given), (2) gives  $t_v$ . If the tax bases of the fiscal instruments are not affected and the government's aim is to decrease the payroll tax by 10.2 points whilst keeping  $T$  fixed<sup>23</sup>, a 5.5 point increase in the tax on value added is required. However, as we show below the reform has a positive impact on output and unemployment so that the tax bases increase : what we are interested in is the increase in VAT needed to satisfy the government budget constraint ex post, so that we discuss results for values of  $t_v$  for which the ex post budget constraint is satisfied.

#### 4.1.2 The household

The household receives labor and capital income from the firm as well as transfers from the state,  $T$ . There are no labor market imperfections, so she chooses how much labor to supply given the real returns to labor,  $w/p(1 + t_v)$ . We assume she desires savings, and she uses these savings to buy investment goods, which increase the stock of capital available to the firm. Following Gauthier (2008) we write that the shares of consumption and investment expenditure in real household income ( $Y$ , which is equal to the whole of value added produced in the economy) are fixed :

$$C = (1 - s)Y \quad (3)$$

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<sup>23</sup>This may not be the appropriate way to think of the government budget constraint as 'keeping transfers fixed', as we discuss below.

and

$$I = sY \quad (4)$$

Note that this assumption implies that an equal proportion ( $s$ ) is saved out of all types of income : workers, capitalists and pensioners all have the same behavior with respect to saving and consumption. The household then maximizes:

$$u(C, L) = C - L^\alpha \quad (5)$$

subject to

$$(1 + t_v)pC + S = wL + rK + T, \quad (6)$$

Where  $S$ , savings is such that

$$S = (1 + p_it_v)pI \quad (7)$$

The household's first order condition for maximization gives the equation for labor supply:

$$L^s = \left( \frac{w}{\alpha p(1 + t_v)} \right)^{\frac{1}{\alpha-1}} \quad (8)$$

The amount of capital supplied by the household is given by:

$$K^s = K_0(1 - \delta) + I \quad (9)$$

Where  $K_0$  is the capital stock before the reform,  $\delta$  is the depreciation rate, and we choose  $\delta = I_0/K_0$  so that if investment after the reform is still equal to its pre-reform level  $I_0$  the capital stock is unchanged. Demand for the final good is given by (6).

The assumption of one representative agent is common in static general equilibrium models. Taken seriously it implies that we abstract from all redistributive considerations, but because the household receives three types of income and is supposed to represent the entire economy this simple framework enables us to see how the reforms will affect the repartition of aggregate income amongst three types of income, those from labor, capital, and government transfers. A theoretical stretch then allows us to show how much 'capitalists' (those who earn capital income) 'workers' (those who earn labor income) and 'pensioners' (those who earn transfer income<sup>24</sup>) gain or loose from the reform.

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<sup>24</sup>Pensioners are of course not the only ones who receive transfer income from the state, so this term must not be taken literally.

### 4.1.3 The firm

The production function has constant returns to scale, and is of the Cobb Douglas type :

$$Y = K^\beta L^{1-\beta} \quad (10)$$

Where  $\beta$  is the share of capital income in value added.

The use of a Cobb Douglas function implies a unitary elasticity of substitution between capital and labor in production. This is larger than that which is usually estimated empirically using a CES production function, where the elasticity is found to be closer to 0.5 than 1 (see for example Blot et al(2007)). However these estimates capture the short run effect of an change in the relative costs of factors of production on the firm's production decision. In a general equilibrium framework we expect such a change in the relative price of factors to have two effects leading to substitution in production. One is at the firm level, and is the one estimated at around 0.5-0.7. The other one is a volume effect, and goes through the relative prices of consumption goods : firms which are relatively more intensive in labor will be faced with lower production costs thanks to the reform, hence will be able to lower their price. This will lead to a shift in demand towards labor intensive goods, and away from capital intensive goods. Because we assume there is only one good produced in the economy we cannot capture such relative price effects, but the use of a production function with an elasticity of substitution higher than that which simply reflects substitution at the firm level enables us to include both substitution and volume effects, as was argued by Malinvaud (1998). The empirical validity of the properties of the Cobb Douglas production function regarding the stability of the shares of labor income and capital income in value added re-enforces this idea.

The firms maximizes its profit :

$pY - w(1 + t_l)L - rK$  where  $p$  is the before tax price, and  $t_l$  is the rate of payroll tax fixed by the state.

The firm's first order conditions for maximization, which give us demand for capital and labor, are:

$$L^d = \frac{p}{w(1 + t_l)}(1 - \beta)Y \quad (11)$$

$$K^d = \frac{p}{r}\beta Y \quad (12)$$

Such factor demand functions imply that the firm is acting competitively by taking the before tax price as given. This is a standard assumption in the literature on this type of models (see for example Gauthier (2008) or Salanie (2000) ) and greatly simplifies our analysis. It implies that an increase in the tax levied on the producer's price will be fully shifted onto the consumer's price (if demand is held constant) because there are no profits, or markups on the price, which the firm could dip into to prevent full tax

shifting. Carbonnier (2005) shows that this assumption is unrealistic, and that the extent of tax shifting depends on the level of competition in the sector. This suggests the relative price of goods will be affected by factors other than the relative labor intensity of the production technology, but our model ignores such considerations. The no profit assumption also assumes that all value added is directly redistributed to the household, so that all the incidence of the reforms can be seen by looking at the evolution of the different types of income the household receives. Considerations often found in popular debates about the reform such as the ones suggesting the tax burden 'is shifted from the firm to households' are of no relevance in this model<sup>25</sup> : the firm is a production 'black box' and does not itself earn income or invest.

Equation (2) determines  $t_v$  for given levels of  $T$  and  $t_l$ . We therefore have ten unknown variables ( $Y, K, L, C, S, I, p, w, r, t_v$ ), and equilibrium in the economy is given by equations (2)-(4), (7)-(12). Taking the final good as the numeraire, and normalizing its before tax price  $p$  to 1 we have nine unknown variables for nine equations, which determine the equilibrium. All variables are therefore considered as fixed with respect to the before tax price, including transfers  $T$ <sup>26</sup>.

#### 4.1.4 The impact of the reform on the equilibrium

We are interested in the reaction of the economy to a change in  $t_v$  and  $t_l$ . We write  $\hat{x} = dx/x_0$  where  $x_0$  is the pre-reform value of  $x$ , apart for taxes for which  $\hat{t} = dt/(1+t)$  where  $dt = t$  when a tax is created. The impact of the reform is described by the following equations:

Supply of the final good

$$\hat{Y} = \beta \hat{K} + (1 - \beta) \hat{L} \quad (13)$$

Demand of the final good is :

$$\frac{C_0(1+t_{v0})}{R_0}(\hat{C} + \hat{t}_v) + \frac{S_0}{R_0}\hat{S} = \frac{w_0L_0}{R_0}(\hat{w} + \hat{L}) + \frac{r_0K_0}{R_0}(\hat{r} + \hat{K}) + \frac{T_0}{R_0}\hat{T} \quad (14)$$

Where  $R_0$  is equal to output estimated at the after tax price, or total income in the economy  $R_0 = w_0L_0 + r_0K_0 + T_0$ .

<sup>25</sup>Unless what they really mean is that the tax burden is shifted from those who earn capital income to those who earn labor income, which is precisely what our model is interested in.

<sup>26</sup>Note that because the fiscal receipts used to finance  $T$  are either indexed on the before price tax itself (for the VAT) or the wage indexed on the price (for payroll taxes), it is realistic to assume that if the producer price falls transfers will also fall.

Supply of labor

$$\hat{L} = \sigma_l(\hat{w} - \hat{t}_v) \quad (15)$$

Where  $\sigma_l = \frac{1}{\alpha - 1}$  is the elasticity of labor supply with respect to the real wage,  $w/(1+t)$ , and  $\hat{t}_v$  corresponds to the increase in the after tax price.

Demand of labor

$$\hat{L} = \hat{Y} - \hat{w} - \hat{t}_l \quad (16)$$

Supply of capital

$$\hat{K} = \frac{I_0}{K_0}(1 + \hat{I},) - \delta \quad (17)$$

where:

$$\hat{I} = \hat{S} - \hat{t}_v \frac{p_i(1+t_v)}{1+p_it_v} \quad (18)$$

Demand of capital

$$\hat{K} = \hat{Y} - \hat{r} \quad (19)$$

Consumption is a fixed share of output

$$\hat{C} = \hat{Y} \quad (20)$$

And the government budget constraint is given by :

$$\hat{T} = dt_v \frac{C + p_i I}{T} + \frac{t_v}{T} (\hat{C}C + p_i \hat{I}I) + \frac{t_l w L}{T} \left( \frac{dt_l}{tl} + \hat{w} + \hat{L} \right) \quad (21)$$

This gives us a system of 9 linear equations, which can be solved if we specify a value for  $dt_l$  and  $\hat{T}$ .  $dt_l$  we have chosen to be 0.102, and a natural candidate for  $\hat{T}$  would simply be zero, implying that the level of transfers redistributed by the state is held constant. We consider results for such a budget constraint which is generally that (implicitly) assumed in administrative reports. However  $T$  is normalized at the before tax price, and the reform will increase the after tax price, so that holding  $T$  constant leads to a loss in the purchasing power of pensioners as they now have more VAT to pay : our assumption regarding consumption and saving implies that pensioners will pay 27.8% of the increase in VAT, as transfers they receive represent 27.8% of total income. We will therefore also consider one version of the government budget constraint for which  $\hat{T} = 0.278\Delta VAT$ , where  $\Delta VAT$  is the increase in VAT due to the reform.

### 4.1.5 Analytical Solutions

Solving the system gives the following solution for the change in value added, or total real income, due to the VAT reform:

$$\hat{Y} = -\frac{\sigma_l(1-\beta)}{1+\beta\sigma_l-\beta\delta(1+\sigma_l)}(\hat{t}_l + \hat{t}_v) \quad (22)$$

Because  $\hat{t}_l$  is negative and larger in absolute value than  $\hat{t}_v$  the impact of the reform on output is unambiguously positive. This positive impact goes through the labor market : as the payroll tax decreases the demand for labor increases, and the firm is willing to pay a larger net wage to the household, which in turn increases its labor supply. Note that the larger  $\sigma_l$ , the larger the output response, because the decrease in the cost of labor leads to a higher increase in labor supply. To see the distributional impact of the reform we decomposed the increase in the real returns to labor into the increase in the wage minus the increase in the after tax price<sup>27</sup>:

$$\hat{w} - \hat{t}_v = \frac{\hat{Y} - \hat{t}_l - \hat{t}_v}{1 + \sigma_l} \quad (23)$$

Plugging in the expression for  $Y$  shows that the impact of the reform on the real returns to labor is unambiguously positive, again because of the relative sizes of the tax bases considered.

The change in the real returns to savings can be decomposed into three parts: the change in the remuneration of capital  $r$ , equal to  $\hat{Y}(1-\delta)$ , the increase in the price of the investment good (so that one euro of savings leads to less than one euro of investment in capital, once persistent VAT has been paid for), equal to  $-p_i dt_v / (1 + p_i t_v)$ , and the increase in the price of consumption capitalists will have to pay once they decide to consume their returns to savings :

$$\text{returnstosavings} = \hat{Y}(1-\delta) - \hat{t}_v \left(1 + \frac{p_i(1+t_v)}{1+p_i t_v}\right) \quad (24)$$

## 4.2 The CPG reforms

### 4.2.1 The state

The CPG taxes roughly 42% of capital income, and either all of labor income including payroll taxes, or just labor income net of taxes. In the first

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<sup>27</sup>The analytical solutions given here consider the impact of the reform on real incomes by assuming all of these real incomes are consumed, so that we must subtract the increase in the after tax price of consumption. This is done in our order to keep the solutions simple, but in our discussion of the results we are more rigorous in the sense that we assume all types of individuals save a positive and equal share of their income.

case - the CPG1 - reform the government budget constraint is (as before the before tax price is set equal to 1):

$$T = t_l wL + t_v(C + p_i I) + t_{c1}(wL(1 + t_l) + \lambda rK), \quad (25)$$

where  $t_{c1}$  is the new CPG tax, and  $\lambda = 0.42379$  is the share of capital income included in the tax base.

In the second case (the CPG2 reform) the government budget constraint is :

$$T = t_l wL + t_v(C + p_i I) + t_{c2}(wL + \lambda rK), \quad (26)$$

#### 4.2.2 The household

The equations depicting household behavior are the same as for the VAT reform

#### 4.3 The firm

The firm now maximizes

$$Y - wL(1 + t_l)(1 + t_{c1}) + rK(1 + \lambda t_{c1}), \quad (27)$$

for the CPG1 reform, and for the CPG2 case

$$Y - wL(1 + t_l + t_{c2}) + rK(1 + \lambda t_{c2}), \quad (28)$$

where the production function is the same as before. Note that in the CPG2 case the reform is equivalent to a decrease in the payroll tax financed by an increase in the corporate income tax.

##### 4.3.1 Equations of change for the CPG reforms

Labor supply, capital supply, the relationship between saving and investment and the demand and supply for the final good are all given by the same equations as for the VAT reform, setting  $\hat{t}_v = 0$ . Labor demand is now given by:

$$\hat{L} = \hat{Y} - \hat{w} - \hat{t}_l - t_{c1}, \quad (29)$$

for the CPG1 reform and

$$\hat{L} = \hat{Y} - \hat{w} - \frac{dt_l + t_{c2}}{1 + t_{l0}}, \quad (30)$$

for the CPG2 reform. The demand for capital is the same for both reforms:

$$\hat{K} = \hat{Y} - \hat{r} - \lambda t_c \quad (31)$$

And the government budget constraint is such that  $T$  remains constant (the after tax price is not affected by the CPG reforms).

### 4.3.2 Analytical solutions

The change in output due to the CPG1 reform can be written as:

$$\hat{Y} = -\frac{\sigma_l(1-\beta)}{1+\beta\sigma_l-\beta\delta(1+\sigma_l)}(\hat{t}_l + t_{c1}) \quad (32)$$

And that due to the CPG2 reform is

$$\hat{Y} = -\frac{\sigma_l(1-\beta)}{1+\beta\sigma_l-\beta\delta(1+\sigma_l)}\left(\hat{t}_l + \frac{t_{c2}}{(1+t_l)}\right) \quad (33)$$

These equations make the similarities between the impact of the VAT and both CPG reforms on output very clear : the only differences between those impact will be due to the size of the increase in the cost of labor due to the creation of a CPG or the increase in the VAT ( Note that in the VAT case  $\hat{t}_l + \hat{t}_v$  can be considered as the 'cost of labor' because the household will only increase her labor supply if  $\hat{w} - \hat{t}_v$  increases, so that to actually increase its labor by one unit the firm will have to pay a cost of  $\hat{w} + \hat{t}_l + \hat{t}_v$ , compensating the household for the increase in the after tax price of consumption). This is simply because we have assumed that the increase in capital will always be a fixed share of the increase in output, regardless of the type of taxes levied in the economy, so that all the impact of the reforms will go through the labor market, and the changes in the cost of labor they induce.

The change in the real returns to labor thanks to the CPG1 reform is :

$$\hat{w} = \frac{\hat{Y} - \hat{t}_l - t_{c1}}{1 + \sigma_l}, \quad (34)$$

And that for the CPG2 reform is:

$$\hat{w} = \frac{\hat{Y} - \hat{t}_l - t_{c2}/(1+t_l)}{1 + \sigma_l}, \quad (35)$$

The change in the real returns to savings for both types of reforms is given by:

$$returnstosaving = \hat{r} = \hat{Y}(1-\delta) - \lambda t_c \quad (36)$$

The implications of the reforms on the real wage level are similar to that of the VAT reform, with the differences depending on the relative size of  $t_{c1}$ ,  $t_v/1+t_v$  and  $t_{c2}/(1+t_l)$ , as for the impact on output. The comparison of the expressions for the returns to savings for the VAT and the CPG reforms suggests the former will have a more negative impact on savings. This may seem surprising, as the CPG is in theory aiming at taxing capital income directly, whilst the VAT affects all incomes equally. However the CPG only taxes returns to savings once, before they are distributed by the firm to the household, whilst the VAT taxes them twice : first when the savings are invested, through persistent VAT, and secondly when the returns to savings are consumed, through VAT on consumption<sup>28</sup>.

<sup>28</sup>It is precisely to avoid such a double taxation of savings that the VAT in theory does not tax investment expenditure.

#### 4.4 Calibration of the models

Most of the parameters of this model are easily obtained from the national accounts, and their computation is detailed in Appendix A. We find that  $\beta$  is equal to 0.332,  $wL/Y$  is 0.4197,  $rK/Y$  is 0.3022 and  $T/Y$  is 0.2781 (see Appendix A). We discuss our choice of value for the elasticity of labor supply with respect to the real net wage in this section.

In a recent review of the existing empirical literature on the elasticity of labor supply, Meghir and Phillips (2008) conclude that at the intensive margin it is close to 0.3 for females, and probably null for men. This is consistent with the available empirical estimates for France : Bourguignon and Magnac (1990) find intensive elasticities of 0.39 for women and -0.02 for men, and Bargain and Orsini (2004) report intensive elasticities in the range of 0.3-0.6 for married women. There is less consensus on the elasticity at the extensive margin, or participation elasticities : the estimates for women are numerous, and tend to all be close to 1, but those for men are scarce, with some studies suggesting it is close to 0. This is precisely what Piketty (1999) finds for France. Meghir and Phillips (2008) however estimate participation elasticities for men using UK data and a rich source of variation (the numerous reforms from 1980 to 2000 in the UK) and find that allowing for heterogeneity suggests they may be much higher for some men with low levels of education, 0.27 for singles and 0.53 for couples.

To decide which value applies to our representative agents two remarks must be made. Firstly, though the use of one representative agent suggests  $\sigma_l$  refers to elasticity at the intensive margin, what we are interested in is the impact of the reform on the whole French labor force. We must therefore take into account the fact that a change in the net wage will probably affect some individuals' decisions concerning whether or not to get a job, so that participation elasticities are also relevant for the calibration. Secondly most of the estimates of intensive elasticities given above refer to individual elasticities in the number of hours worked in a week or a month. At the aggregate level, and looking further than the immediate short run impact, the aggregate number of hours worked per year will be more flexible than individual number of hours per week, so that aggregate elasticities are probably larger than short run ones. We look at the sensitivity of our results to the value taken by  $\sigma_l$  by estimating the impact of the reforms for three different values: 0.2, an estimate which would imply that we are only looking at changes at the intensive margin, 0.5 one which would be the result of our assuming that half of the potential labor force is male and half female, and taking the weighted average of their participation elasticities, and 0.8, which implies that we believe that Costas and Meghir (2008)'s results concerning less qualified males also applies to France.

Table 5: Impact of the VAT reform for the two types of government budget constraint (in % change)

	Nominal transfers are kept constant			Real transfers are kept constant		
	$\sigma_l = 0.2$	$\sigma_l = 0.5$	$\sigma_l = 0.8$	$\sigma_l = 0.2$	$\sigma_l = 0.5$	$\sigma_l = 0.8$
Output	0.48	1.17	1.82	0.31	0.76	1.13
Labor	0.71	1.72	2.68	0.46	1.12	1.67
Cost of capital	0.46	1.11	1.73	0.29	0.77	1.07
Cost of labor	-0.23	-0.55	-0.86	-0.14	-0.36	-0.53
Net real wage*	3.56	3.45	3.35	2.29	2.25	2.08
Return to savings*	-3.50	-2.65	-1.72	-5.41	-4.77	-4.41
After tax price	3.25	3.33	2.82	4.60	4.43	4.12
Increase in VAT(points)	3.62	3.38	3.15	5.13	4.93	4.60

\* These changes in real factor returns correspond to the ones obtained in the section 'analytical solutions'.

## 4.5 Results

### 4.5.1 The VAT reform

Results for a 10.2 decrease in the payroll tax and a 3.1 to 5.1 points increase in the VAT are given in table 5. The first three columns show results when the government ex post budget constraint keeps the nominal level of transfers  $T$  constant. This is generally how the VAT reform is understood in the public debate, as the option of increasing government transfers simultaneous to the reform is rarely considered. As explained above however such a conception of the government budget constraint has an important side effect : as the after tax price increases keeping nominal transfers constant implies that the real income of pensioners is decreasing. If we think pensioners consume all their income, this decrease is equal to the increase in the after tax price, around 3.4%. The 3.3-3.6% increase in the real net wage as a consequence of the reform is paid for - as can be expected by a reform shifting a tax away from labor towards capital - by capitalists, who loose 1.7-3.5% of their returns to savings, but also by pensioners, who are more negatively affected than capitalists. This result is specific to the VAT reform, as (by assumption) the CPG reforms do not affect the after tax price, and points out to an important shortcoming of the VAT reform as it is generally discussed : more than half of the negative incidence of the reform will bear on precisely those individuals whose income the government has decided to support through transfers.

This side-effect can be considered as unintentional, if we assume this was not the government's aim : it therefore makes sense to look at the reform when the government budget constraint aims at keeping the real income of

pensioners constant. To remain consistent with our assumptions regarding consumption and savings, we model this new budget constraint as implying that the new level of transfers, minus 28% of the increase in VAT which is paid by pensioners, must be equal to the pre-reform level of transfers. The last three columns show results for this type of budget constraint : the necessary increase in the VAT is now 1.5 points larger, so that the positive impact of the reform is smaller, by around a third for the median value of the elasticity of labor supply. The comparison of both versions of the reform clearly identifies a trade-off : keeping the welfare of pensioners constant comes at the price of a less positive impact of the reform on employment. For the median value of the elasticity, the difference in the number of jobs created is around 100 thousands.

The direct impact of the change in fiscal policy can be seen on the cost of labor, which falls by nearly 0.36% for the intermediate value of  $\sigma_l$ , and the fall in the returns to savings as a consequence of both the increase in persistent VAT and the increase in the after tax price of consumption (the cost of capital is not directly affected by the VAT reform : both demand of capital and gross supply of capital increase one for one with output, but because the capital stock depreciates demand of capital is higher than supply, so that the interest rate will increase with output). This fall in the returns to savings is substantial - between 4.4 and 5.4% of the returns are lost due to the reform, but because the household will not react to this fall in the returns to savings, the capital stock simply increases as a proportion of output, which leads to very small increases - virtually zero, and not reported here<sup>29</sup>. The fall in the cost of labor leads, as expected, to an increase in the demand of labor and in the net real wage, which lead to an increase in the labor used in production. This is the channel which has a positive impact on the economy. Note that the impacts on labor and output are not negligible : the reform would lead to a three quarters point increase in output and more than 200 thousands jobs created (for the median value of  $\sigma_l$ ), more than the 150 thousands which Gafsy L'Horty and Mihoubi (2004) estimate have been created by the exoneration of low wages from most employer contributions.

Because the channel through which most of the impact of the reform is felt is the labor market the results are very sensitive to the value taken by the elasticity of labor supply. The impact on output for example nearly quadruples when the elasticity quadruples from 0.2 to 0.8. It is possible to get a rough idea of which value of the elasticity takes our model closer to the real situation of the French economy in 2008 by comparing our results with those obtained by different models whose assumptions are often less restrictive than ours (see table 6)but who look into reforms very similar to

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<sup>29</sup>This is the case for all the reforms we consider in this section.

Table 6: Impact on unemployment of a uniform decrease in the payroll tax financed by an increase in the VAT obtained by various models

Author	Size of reform	Jobs created	Timing of the impact	Comparison***
Gauthier (2008)*	13 billion euros	100,000	10 years	425,000
Gauthier (2008)**	13 billion euros	50,000	10 years	212,000
Minefi (2007)	9 billion euros	30,000	'medium run'	127,000
Coupet and Renne(2008)	$dt_l = -0.02$	22,000-47,000	1-2 years	110,000-235,000
OFCE (2007)	$dt_l = -0.02$	35,000	5 years	175,000
Blot et al (2007)	$dt_l = 10$	130,000	4 years	132,600

\* Using a Cobb Douglas production function

\* \* Using a CES production function

\*\*\* Number of jobs created for a 10.2 decrease in the payroll tax

the VAT reform we are studying. It is particularly interesting to note that though we have made the simplifying assumption of equilibrium on the labor market - hence no involuntary unemployment- our results are fairly similar to those obtained by models which do take into account rigidities in the labor market leading to unemployment. Most models suggest the reform we consider would lead to a creation of 130 to 230 thousand jobs, with Gauthier (2008) finding a much larger impact when he uses a Cobb Douglas function which he thinks is less appropriate than the CES. The number of individuals working in the private sector in 2007 was 18500 thousands, so that from table 5 we find that an elasticity of 0.2 leads to 85.3 thousand jobs created, an elasticity of 0.5 to 207.5 thousand jobs created and an elasticity of 0.8 309.5 thousands jobs created. Thus our median choice for the elasticity of labor supply<sup>30</sup> gives us results regarding job creation which are very close to those found in the literature for similar reforms, despite our assumption of a large (unitary) elasticity of substitution between capital and labor and no involuntary unemployment. We will concentrate on analyzing results for this value of the elasticity below.

#### 4.5.2 Results for the CPG reforms

Table 8 shows results for both versions of the CPG reforms and of the VAT reforms for the median value of the elasticity of labor supply. We have shown above that the relative impacts of each reform on economic activity and the wage level will only depend on the relative size of  $dt_v/(1+t_v)$ ,  $dt_{c1}$

<sup>30</sup>A value of 0.5 for the wage elasticity of labor supply is fairly high -see discussion above. What our comparison shows is that by taking such a fairly large value we are capturing part of the effect of a decrease in the cost of labor on employment which is due in the real world to involuntary unemployment, despite having assumed away such a phenomenon.

and  $dt_{c2}/(1+t_l)$ , these parameters showing how the increase in the tax used to compensate for the decrease in the payroll tax affect the 'gross cost of labor' understood as the cost the firm will have to pay to hire one more worker<sup>31</sup>. It is therefore enough to look at table 7 to rank the reforms in terms of their impact on output growth. The most striking element is how much the VAT reform calibrated to keep nominal transfer incomes constant stands apart from the other reforms : the trade-off identified before between the welfare of pensioners and a larger positive effect is therefore not only valid for the comparison between the VAT reforms, but also between this reform and the CPG reforms. Table 8 shows how these differences between the increase in the cost of labor translate into different impacts.

What both these tables also show is that the second version of the VAT reform and both CPG reforms will have fairly similar impacts on economic activity. Output, in particular, reacts very similarly to all reforms, by increasing by 0.57-0.76 points. The VAT reform creates 50 thousands more jobs than the CPG1 reform (which creates 153.8 thousand jobs) but only 10 thousands more jobs than the CPG2 reform (198.3 thousands jobs created). These three reforms are calibrated using the same government objective, so that the remaining difference between them can be explained by two factors. On one hand the larger the new tax base for social security contributions, the larger the positive impact on the economy, which gives a clear advantage to the VAT reform. On the other hand the less the tax used to replace payroll taxes weighs on the cost of labor, the more the reform has a positive impact on employment and hence on output, which gives an advantage to the CPG2 reform. The CPG1 reform is thus clearly the one with the least positive features, whilst the tax base effect dominates the cost of labor effect, making the VAT reform more efficient than the CPG2 reform.

Table 12 sums up the distributive impact of the reform on the three different types of income. These are calculated for the VAT reform using the assumption made in the model that all types of individuals have the same savings behavior so that VAT is paid by the three types of income in proportion to their share in total income<sup>32</sup>. This table shows that the differences between reforms in the distribution of total income amongst different sources are more substantial, as workers gain (and capitalists loose ) around 1.5 percentage points more of their income in the VAT reform than in the CPG1 reform. But the ranking of the three reforms in term of redistribu-

<sup>31</sup>Strictly speaking the cost of labor in the VAT reform only increases by  $\hat{w} + \hat{t}_l$ , which is the change in the gross wage due to the reform. However taking labor supply into account we find that to hire one more worker the firm will have to increase the wage by more than the increase in the after tax price, so that the 'gross cost of labor' becomes  $\hat{w} + \hat{t}_l + \hat{t}_v$ .

<sup>32</sup>We use both variations in prices ( $w,r$ ) and quantities ( $K,L$ ) to compute these incomes.

Table 7: The increase in the 'gross cost of labor' due to the increase in the tax

	VAT reform*	VAT reform**	CPG1 reform	CPG2 reform
	3.4	4.42	5.1	4.54

Table 8: Impact of the VAT and CPG reforms for  $\sigma_l = 0.5$  (in % change)

	VAT reform*	VAT reform**	CPG1 reform	CPG2 reform
Output	1.17	0.76	0.57	0.73
Labor	1.72	1.12	.83	1.07
Cost of capital	1.11	0.70	0.54	0.69
Cost of labor	-0.55	-0.36	-0.27	-0.35
Net real wage	3.45	2.25	1.66	2.14
Return to savings	-2.65	-4.77	-1.62	-2.1
After tax price	3.25	4.43	0	0
Increase in the tax(points)	3.63	4.93	5.103	6.58

\*With nominal transfers kept constant

\*\*With real transfers kept constant

tive impact may depend heavily on our assumption regarding how much of each type of income is consumed, and how much is spend. We may think that capitalists consume less of their income than workers, for example - something which cannot be captured by our model as it stands. We can get a flavor of the sensitivity of the results to this assumption by calculating incomes assuming capitalists save all of their income and thus pay no VAT (disregarding persistent VAT), and that workers and pensioners pay all of the VAT in proportion to their shares in total income (workers pay 60% of total VAT). The results are shown in the last column of table 10, 'VAT reform(2)'<sup>33</sup>. We see that the distributive impact of the VAT is now turned upside down : workers still gain, but by less than in the CPG reforms, and capitalists now gain from the VAT reform<sup>34</sup>, whilst the real losers (again) are pensioners.

<sup>33</sup>These results must not be taken too seriously however. To fully see the implications of the change in assumption we would have to change our model.

<sup>34</sup>Our new assumption implies that the impact of the reform on capitalists goes only through the change in the nominal interest rate, which increases.

Table 9: Impact of the reform on incomes of workers, capitalists and pensioners, in billion euros (*% change*)

	Before the Reform	VAT reform*	VAT reform**	CPG1 reform	CPG2 reform
Labor income	541.7	571.2(5.44)	562.6 (3.9)	555.4 (2.3)	559.1(3.2)
Capital income	390.1	383.8(-1.6)	377.7(-3.2)	383.3(-1.7)	382(-2.1)
Transfer income	358.8	348.8(-2.76)	358.8	358.8	358.8

\*With nominal transfers kept constant

\*\*With real transfers kept constant

Table 10: Impact of the reform on incomes of workers, capitalists and pensioners, in billion euros, with different assumptions about savings behavior (*% change*)

	Before the Reform	VAT reform*	CPG1 reform	CPG2 reform	VAT reform(2)
Labor income	541.7	562.6 (3.9)	555.4 (2.3)	559.1(3.2)	553.5(2.1)
Capital income	390.1	377.7(-3.2)	383.3(-1.7)	382(-2.1)	393(0.8)
Transfer income	358.8	358.8	358.8	358.8	338.45 (-5.7)

\*With real transfers kept constant

(2)With real transfers kept constant, but new assumptions about saving behavior.

## 4.6 The VAC

We now briefly consider the last of the reform alternatives : the creation of a value added contribution, a tax on the whole of value added. Though less realistic than the VAT and CPG reforms - because it would be difficult to implement them in France today - it can be seen in theory as the most accomplished version of a reform enlarging the tax base of welfare expenditure to the whole of the wealth created in the economy. It is therefore interesting to see how it differs from the other two reforms. One way to think of the VAC reform is simply as the creation of a new form of VAT for which the share of investment expenditure subject to the tax is 100%, setting  $p_i = 1$ . The VAC then taxes the whole of consumption and investment in the private sector which by definition is equal to value added.

The analytical solution for the impact of the reform on output is :

$$\hat{Y} = -\frac{\sigma_l(1-\beta)}{1+\beta\sigma_l-\beta\delta(1+\sigma_l)}(\hat{t}_l + dt_c/(1+t_v)), \quad (37)$$

Where  $t_c$  is the new VAC. Again, the difference between the VAC reform and the other types of reform will come from the relative size of the tax bases. As the VAC taxes the whole of value added it has a larger tax base than the VAT so we can expect  $dt_c < dt_v$  : the VAC will be the reform with the largest impact on the economy. The impact of the VAC reform on the net real wage is similar to the VAT reform in the sense that the fall in the cost of labor will lead to an increase in the nominal wage, but the after tax price will increase due to the tax, by  $dt_c/(1+t_v)$ . We can write:

$$\hat{w} - \frac{dt_c}{1+t_v} = \frac{\hat{Y} - \hat{t}_l - dt_c/(1+t_v)}{1+\sigma_l} \quad (38)$$

The returns to savings are taxed twice : once when savings are spend to buy investment goods, and once when the returns to savings are used for consumption, so that the real returns to savings are:

$$\hat{r} - dt_c - dt_c/(1+t_v) = \hat{Y}(1-\delta) - dt_c(2+t_v)/(1+t_v) \quad (39)$$

Table 11 and table 12 present results for the VAC reform in the first column. The budget constraint is assumed to hold real transfers constant, to ensure comparability between the reforms. We find that the VAC is more favorable to the economic activity than any other reforms, and also more 'redistributive'.

In this section we have used a model that enables us to study the impact of the different types of reform on the economy and their redistributive incidence, and we have come up with one interesting result : all reforms have

Table 11: Impact of the VAC, VAT and CPG reforms for  $\sigma_l = 0.5$  (in % change)

	VAC reform	VAT reform	CPG1 reform	CPG2 reform
output	1.13	0.76	0.57	0.73
labor	1.66	1.12	.83	1.07
cost of capital	1.07	0.70	0.54	0.69
cost of labor	-0.53	-0.36	-0.27	-0.35
net real wage	3.32	2.25	1.66	2.14
return to savings	-5.65	-4.77	-1.62	-2.1
after tax price	3.18	4.43	0	0
increase in the tax(points)	3.54	4.93	5.103	6.58

Table 12: Impact of the reform on incomes of workers, capitalists and pensioners, in billion euros (% change)

	Before the Reform	VAC reform	VAT reform	CPG1 reform	CPG2 reform
Labor income	541.7	568.23 (4.9)	562.6 (3.9)	555.4 (2.3)	559.1(3.2)
Capital income	390.1	381.7(-2.1)	377.7(-3.2)	383.3(-1.7)	382(-2.1)
Transfer income	358.8	358.8	358.8	358.8	358.8

a positive impact on the economy and favor workers rather than capitalists, and the VAT reform is not necessarily less efficient in redistributing from capital to labor than the CPG reforms. We have also shown that the redistributive impact of the VAT reform will differ greatly depending on whether we calibrate it by keeping real or nominal transfers constant - in the latter case pensioners will suffer more from the reform than capitalists. We have however been unable to capture the idea behind the often heard criticisms of the VAC options (see for example Blanchard (2006)), that which states that a tax on the whole of value added like the VAC or to a lesser extent the CPG will have a negative impact on growth because it taxes capital. This type of argument suggests that there is something terribly wrong about taxing capital, worse than taxing labor (after all the alternative - not changing anything - amounts to taxing labor rather than capital). To take into account the efficiency cost of taxing capital we must introduce a micro-founded savings behavior (so far our desire for saving came from an ad hoc consumption function), in which the returns to savings will affect household incentives. We now turn to modeling the impact of the reforms in the type of framework in which indeed taxing capital is always a bad idea - the infinitely lived agent model - to look at how our four alternatives compare under very different assumptions. We then briefly comment on the pertinence of using such a model for policy predictions.

## 5 The Dynamic Model

### 5.1 Presentation of the model

In order to model supply of capital in a framework founded in standard microeconomic principles we need to introduce time in the model, and move away from the purely static framework used so far. We use a simple version of a perfect foresight model infinite horizon model - the Ramsey Cass Koopmans model -, to look at the long run impact of the reforms by comparing pre and post reform steady states. We then develop a quantitative short run analysis of the impact of the fiscal reforms considered, following a method pioneered by Judd(1985) and generalized by Xioyong and Gong (2006).

The model relies on a series of restrictive but standard assumptions : perfect competition on the goods market, perfect capital markets, and an infinitely, perfectly far-sighted agent. It has however one major advantage with respect to its closest alternative (in terms of simplicity of use), the overlapping generations model : it does not restrict capital accumulation to be uniquely motivated by life-cycle saving for retirement. In other words, its dynastic nature allows for bequests, which are an important part of wealth, especially for the rich (Kotlikoff and Summers(1981)). Moreover its simplicity enables us to provide analytical solutions for the short run impact of fiscal policy which may differ in a quantitatively significant fashion from long run impacts - this is typically something which cannot be done by more complex general equilibrium models (see Coupet and Renne 2007 for example) which have to be solved numerically. Ours provides us with equations for the reaction of aggregate economic variables of interest which are fairly simple and in which the coefficients are derived from basic parameters of taste and technology, allowing for the examination of the sensitivity of policy shocks to these parameters.

The aim of this section is to provide an understanding of the impact of the reforms on capital accumulation. As we have argued before the impact on labor supply has been dealt with appropriately in the literature with static models which include involuntary unemployment. Including labor supply in the dynamic framework developed below introduces technical complications which are beyond the scope of this paper, so we follow Judd (1985) and Xioyong and Gong (2007) in assuming labor is supplied inelastically at all times.

## 5.2 The model with the VAT and the VAC

### 5.2.1 The household

As in the previous section we will model the VAC as a tax weighing on all consumption and investment expenditure.

Assume that we have one infinitely lived representative household<sup>35</sup>. The utility function is assumed to be additively separable in time, with a constant pure rate of time preference,  $\theta$ . The representative agent chooses her consumption path,  $C(t)$  and her capital accumulation  $\dot{K}$  subject to the instantaneous budget constraint, taking the (net) wage rate, rental rate of capital and tax rates as given (time arguments are suppressed when no ambiguity results):

$$\max \int_0^{\infty} e^{-\theta t} u[C(t)] dt \quad (40)$$

s.t.

$$(1 + t_v)(1 + t_c)C + (\dot{K} + \delta K)(1 + p_i t_v)(1 + t_c) = wL + rK + T, \quad (41)$$

where  $t_c$  is the VAC rate.

$$C(t) \geq 0 \forall t,$$

$$K(0) = K_0,$$

and the no Ponzi game condition :

$$\lim_{t \rightarrow \infty} K(t) e^{-\int_0^t r_s ds} \geq 0$$

Where utility is of the CRRA type :  $u(C) = \frac{C(1 - \gamma)}{1 - \gamma}$  if  $\gamma \neq 1$ ,  $u(c) = \ln(C)$  otherwise, and  $\gamma > 0$ .

Note that the instantaneous budget constraint considers as savings both investment per say ( $\dot{K}$ ) and savings which goes towards replacing capital which has depreciated ( $\delta K$ ), so that  $\dot{K}$  is investment net of depreciation. Before the reform  $t_c$  is set to 0 and  $t_v$  to its pre-reform level, 11.55%

We define  $q(t)$  as the current marginal utility value of an extra unit of capital at time  $t$ , defined as :

$$q(t) = \int_t^{\infty} e^{\theta(t-s)} [r_s - \delta(1 + p_i t_v)(1 + t_c)] \frac{u'_{c(s)}}{(1 + t_v)(1 + t_c)} ds \quad (42)$$

<sup>35</sup>Or, equivalently, a large fixed number of identical, infinitely lived individuals

<sup>36</sup>Like in the previous section we normalize the price before the VAT and before the VAC to one.

Where  $u'_c$  is the partial derivative of  $u$  with respect to consumption, and  $\dot{x}$  is the instantaneous growth of variable  $x$ <sup>37</sup>. We can rewrite (42) in a more intuitive way as

$$\frac{q(t)}{(1+p_it_v)(1+t_c)} = \int_t^\infty e^{\theta(t-s)} \left[ \frac{r_s}{(1+p_it_v)(1+t_c)} - \delta \right] \frac{u'_c(s)}{(1+t_v)(1+t_c)} ds \quad (43)$$

This states that the marginal value of saving one unit of income today ( $q(t)$  divided by the price of the investment good) is equal to the discounted value of the returns to investment in each period, where the returns to savings are now written at their after tax price  $r/(1+p_it_v)(1+t_c)$  and  $(1+t_v)(1+t_c)$  is the price of consumption. We impose the following transversality condition on  $q$  and  $K$ :

$$\lim_{t \rightarrow \infty} e^{-\theta t} K(t)q(t) = 0$$

Household maximization yields the following first order condition for consumption:

$$u'_{c(t)} = q(t) \frac{1+t_v}{1+p_it_v} \quad (44)$$

This is Euler's equation, and it states that along the optimum path the household is indifferent between an extra unit of consumption at price  $(1+t_v)$  and an extra unit of capital at price  $(1+p_it_v)$ . The VAC does not appear in the equation because it does not affect the relative prices of consumption and capital.

The second first order condition for maximization is obtained by taking the derivative of  $q(t)$ <sup>38</sup>:

$$\dot{q}(t) = q(t) \left( \theta - \frac{r}{(1+p_it_v)(1+t_c)} + \delta \right) \quad (45)$$

This condition, together with Euler's equation, the instantaneous budget constraint and the transversality condition constitute necessary and sufficient conditions for an optimum because  $u(C)$  and  $F(K, L)$  are concave.

### 5.2.2 The firm

The firm's maximization program remains  $\max F(K, L) - w(1+t_l)L - rK$ , giving the following equilibrium conditions:

$$r = F_k \quad (46)$$

<sup>37</sup>Note that  $q(t)$  is also the multiplier on the budget constraint of the Hamiltonian for the household's maximization program

<sup>38</sup>Or equivalently by taking the second necessary condition for a maximum of the Hamiltonian concerning the derivative of the Hamiltonian with respect to the state variable,  $K$

$$w(1 + t_l) = F_l \quad (47)$$

Where  $F_l$  and  $F_k$  are the marginal products of factors. The second condition indicates that in the short run (when capital is fixed), because we are assuming that labor supply is inelastic, the marginal productivity of labor will not be affected by the reform so that the decrease in the payroll tax will translate exactly into an increase in the net (real) wage :  $\hat{w} = \hat{t}_l$ , where  $\hat{w}$  and  $\hat{t}_l$  are defined as before.

### 5.2.3 The state

We could specify an intertemporal or instantaneous budget constraint, but we choose to keep the same decreases in  $t_l$  (10.2 points) and the same increase in  $t_v$ ,  $t_l$ ,  $t_c$ ,  $t_{c1}$  and  $t_{c2}$  as in the previous section, so that the comparison between both types of models and assumptions is more straightforward.

Equilibrium is given by equations(41)-(44) and (45)-(??). Rearranging gives the two equations defining the dynamic path of the economy:

$$\dot{K} = F(K, L) - C(q, t_v) - \delta K \quad (48)$$

$$\dot{q} = q\left(\theta - \frac{F_k}{(1 + p_i t_v)(1 + t_c)} + \delta\right) \quad (49)$$

With  $C(q, t_v)$  defined by  $u'_{c(t)} = q(t) \frac{1 + t_v}{1 + p_i t_v}$ , which expresses consumption as a function of the marginal utility of capital, the intertemporal elasticity of consumption ( $-1/\gamma = u'_c/u'_{cc}C$ ), and the VAT. These equilibrium equations make the difference between the VAT and the VAC very clear. On the one hand both affect the marginal value of capital  $q(t)$  by decreasing the net revenue the household will get in each future period for the amount she saves today,  $F_k/(1 + p_i t_v)(1 + t_c)$ . On the other hand only the VAT affects intertemporal choices for a constant value of  $q(t)$ , by affecting the relative prices of consumption and investment in capital today. The payroll tax  $t_l$  does not appear in these equations other than implicitly, through its impact in the choice of  $K$  and  $L$  in  $F(K, L)$ .

### 5.3 The model with the CPG

The household maximization remains the same (the equations (40) to (45) are unchanged), but setting  $t_c$  levied on consumption and investment expenditure at zero before and after the reform. We introduce a new  $t_c$  - the CPG- levied on the firm, so that the firm's first order equations become:

$$r(1 + \lambda t_c) = F_k \quad (50)$$

and

$$w(1 + t_l)(1 + t_{c1}) = F_l \quad (51)$$

for the CPG1 reform,

$$w(1 + t_l + t_{c2}) = F_l \quad (52)$$

for the CPG2 reform.

The dynamic path of the economy is now defined by:

$$\dot{K} = F(K, L) - C(q, t_v) - \delta K \quad (53)$$

$$\dot{q} = q\left(\theta - \frac{F_k}{(1 + p_it_v)(1 + \lambda t_c)} + \delta\right) \quad (54)$$

Because labor supply is fixed, the only difference between the CPG1 and the CPG2 reforms will be the size of the required increase in the CPG - in other words the above-mentioned 'cost of labor' effect disappears, and only the 'tax base effect' remains.

#### 5.4 Calibration

We use the same Cobb Douglas production function as before, and use the value for  $Y$  (1174.7), and  $K_0$  (4267) found in the national accounts to get a value for  $F_{kk}$ . Two new parameters are introduced : the instantaneous elasticity of substitution  $-1/\gamma$  and the rate of time preference,  $\theta$ . It also requires that we specify a value for  $r$  the interest rate, but because we assume the economy before the reform is at the steady state, we know that  $r = (1 + p_it_v)(\delta + \theta)$ . The choice of  $r$  and  $\theta$  must therefore be done jointly.

##### The interest rate and the rate of time preference

The interest rate in our model is both the risk-free real interest rate as well as the real returns to capital. They are generally estimated at 2% and 7-8% (Krueger (2005)), annual averages, but a wide range of values can be found in the literature. Taking our model seriously<sup>39</sup> gives an interest rate (equal to the marginal value of capital) of 8.5%. This is in the high range of what can be found in the literature, but is nevertheless not implausible : in our model the interest rate is the rate of return to capital in production gross of depreciation (the values given above generally refer to the rate of return net of depreciation), so that such a high value does not seem too unrealistic.

Our choice of  $r$  must yield a value for the rate of time preference that is in line with what is found in the literature. Taking  $r = 8.6\%$  gives a  $\theta$  of 4.8%, and a discount rate ( $1/(\theta + 1)$ ) of 0.953 which is very close to the value of 0.955 which is commonly taken in the literature. Coupet and Renne (2007) take a discount rate of 0.995, which we would obtain for a value of  $r$  slightly above 4%. Krueger (2005) suggests that  $\theta$  is equal to 4% annually, which

<sup>39</sup>If we compute  $r$  as  $r = \beta Y/K_0$ .

would obtain for a value of  $r$  close to 8. We will discuss results with the value of  $r$  that takes our model seriously, 8.6%.

### The instantaneous elasticity of substitution

The elasticity of intertemporal substitution (EIS) is central to our results, as it determines how much individuals are ready to adapt their behavior to smooth consumption over time when the marginal value of capital, or wealth, changes. A value of 1 for this elasticity is common in the literature but estimated values for the EIS differ greatly. Blundell, Browning and Meghir (1994) in a study which estimates the parameters of household preferences based on a version of the life cycle model which allows for the impact of household characteristics<sup>40</sup>, find values for the EIS which range between -0.6 and -1.17. Gruber (2006) uses variation across individuals in the capital income tax rate to avoid using time series, and find a large EIS of -2 which is robust to numerous specification checks. We shall follow the existing literature in reporting results with log utility.

## 5.5 Steady State analysis

The steady state condition is given by

$$\frac{F_k}{1 + p_i t_{v1}} = \delta + \theta \quad (55)$$

for the VAT reform, where  $t_{v1}$  is the new VAT rate,

$$\frac{F_k}{(1 + p_i t_v)(1 + \lambda t_c)} = \delta + \theta \quad (56)$$

for the CPG reforms, and

$$\frac{F_k}{(1 + p_i t_v)(1 + t_c)} = \delta + \theta \quad (57)$$

for the VAC reform.

These conditions show that the net remuneration of capital is unaffected by the levels of  $t_v$  and  $t_c$  as it will always be equal to  $\delta + \theta$ . They are simply a version of the modified golden rule which states that for the household to be willing to postpone consumption the net returns to savings for each period must always compensate for the loss of value of capital in each period ( $\delta$ ) and for the household's sacrifice of immediate consumption, which she values at rate  $\theta$ . As a consequence the net return to capital will not be

<sup>40</sup>They use a time series of UK cross sections over a 17-year period. Gruber (2006) uses data from the Consumer Expenditure Survey for the US. Estimates of the IES on French data are scarce, but we are willing to assume no important national differences.

Table 13: Long term impact of the reforms in %

<i>type of reform</i>	VAT	VAC	CPG1	CPG2
output	-0.53	-1.76	-1.07	-1.39
capital	-1.60	-5.30	-3.23	-4.17
cost of capital	1.07	3.54	2.16	2.54
cost of labor	-0.53	-1.76	-1.07	-1.39
returns to savings	-4.42	-3.17	0	0
returns to labor	2.08	2.1	0.86	1.11
after tax price	4.42	3.17	0	0
tax increase	4.93	3.54	5.10	6.58

affected by either of the reforms considered. The mechanisms which lead to such a new steady state are well known : the reforms will initially decrease the net return to capital, so that savings decreases, and the stock of capital diminishes, leading to an increase in its marginal productivity, until the increase in  $r$  matches the increase in the taxes on capital, and the new steady state is reached. The stock of capital is lower, so that output is lower, and the returns to labor are lower : the long term impact of the reform on the net wage are therefore at first sight ambiguous, with both  $w(1 + t_l)$  and  $t_l$  decreasing.

Table 13 gives the long term changes in key economic variables for the four types of reforms. Appendix C describes the short run impact of the reforms, following a method pioneered by Judd (1985)

In the long run the reforms have a negative impact on the economy, with output and the capital stock decreasing. This should not come as a surprise given the type of reforms we are considering and the results of the optimal taxation literature. On the one hand we are decreasing payroll taxes which because labor supply is fixed are equivalent to lump sum taxes. They do not have an excess burden, so their decrease will lead to no efficiency gain. On the other hand both reforms implicitly increase the tax on the returns to capital, which already exists before the reforms due to persistent VAT. Chamley (1986) and Judd (1985) have shown that the optimal level of a uniform tax on capital such as the ones we are studying will always be zero in such a model<sup>41</sup>, because it introduces a distortion between the prices of consumption at different dates exponentially increasing with time. Replacing a lump sum tax with a tax on capital known to have extremely large

<sup>41</sup>When one allows for progressive capital income taxation, this result does not hold : Saez (check date) shows that for values of the intertemporal elasticity of substitution reasonably low, the optimal threshold above which capital taxation is positive converges to a finite limit. Unfortunately by definition the VAT and the VAC act as linear taxes on capital.

efficiency costs in the model we are using is thus quasi by definition going to have a negative impact on the economy proportional to the increase in capital taxation. It is therefore not surprising to see that the VAC, which taxes capital the most, has the largest negative impact, followed by the CGP2 reform, the CPG1 reform and then the VAT. If one considers the VAT reform without persistent taxation of investment the reform has no impact on the returns to savings, hence no impact on the economy. It simply consists in a lump sum transfer to workers financed by a lump sum tax on capitalists and to a lesser extent pensioners who are confronted with a permanent decrease in their income as the price of consumption in all periods increases. Thus what drives the negative impact of the reforms is really the fact that the VAC, the CPGs and that part of VAT which is persistent act as taxes on capital. Note that because the two CPG reforms only differ with respect to their tax bases, the CPG1 reform is less harmful than the CPG2 reform, in contrast to what we found in the previous section where labor market interactions were crucial.

This model's prediction concerning the impact of the reforms on growth are opposite to those of the static model but the distributional impact is fairly similar. The 5th and 6th lines sum up the long run redistributive impact, and show that the CPG reforms still perform less well than the VAT and the VAC, but that the VAT is now more redistributive than the VAC. This is due to the fact that the nominal returns to savings are necessarily unaffected by the reform (due to the golden rule explained above), so that all the impact of the reforms on capitalists will go through a possible increase in prices which will affect real returns to savings. The VAT reform increases the after tax price more than the VAC reform, and in that way it is more redistributive (the increase in real returns to labor is the same for both reforms, because the lower decrease in output and the marginal product of labor due to the VAT compensates for a higher increase in the after tax price). The redistributive impact of the CPG reforms is very small: on the one hand there is no positive labor demand effect which could increase the wage, so the net wage only increases by the difference between the decrease in the payroll tax and the increase in the CPG ; on the other hand as mentioned before nominal returns to savings are not affected by any of the reforms, so that capitalists are not hurt by reforms in which prices do not increase. This steady state analysis shows that the fears concerning the negative impact of the VAC on capital accumulation and therefore growth in the long run are justified - if we believe in the assumptions made in the model. One way to decide whether or not we believe in these assumptions may be to look at the classical predictions of the model (taking a leaf out of Friedman (1953)'s book), which are found in Chamley (1986) and Judd (1985) : this model predicts optimal capital taxation should be zero, both on efficiency and equity grounds. And yet capital taxation, whether through personal income taxation of dividends and capital gains, or through the corporate

income tax, is very much alive and kicking - and this despite an increasingly volatile tax base due to globalization. This discrepancy between this model's predictions (or recommendations) and tax policy practice around the globe suggests we may not want to agree with the model's assumptions. Moreover before considering taking its policy predictions regarding the reform of social security finance in France seriously we should notice that this model recommends the scrapping of all capital taxation, as well as preferring the VAT reform over any other option. It is a well known result of the optimal taxation literature that the assumption of perfect capital markets has an important corollary: the costs to capital taxation are so high that the optimal linear tax rate is zero. Yet there may well be good reasons for taxing capital income which are not included in our model, we know that it may even be optimal to do so if capital markets are imperfect (Chamley (2001)). Introducing capital market imperfections in the dynamic model could therefore lead to very different results, and provide a better insight as to why the suggestion of 'taxing capital rather than income' repeatedly comes back in the debates concerning the financing of the French social security system. In the absence of such a more complex dynamic model it may be more appropriate to consider the predictions of the static model when considering what would be the incidence of different scenarios of reform of social security finance in France - keeping in mind that because this model assumes an ad hoc demand for savings it cannot capture agents' reactions to the fall in returns to savings caused by the reform, and thus probably over-estimates the positive impact of the reform on economic activity.

## 6 Conclusion

This paper has three main conclusions. One is that whilst all types of reform decrease the tax wedge between the cost of labor and returns to labor and include part of capital income in the tax base - so that workers gain and capitalists loose-, the losses may well be shared between capitalists and those receiving government transfers in the case of the VAT reform. This will happen if the increase in VAT is not calibrated to compensate for the real losses transfer incomes will experience as the after tax price increases. Our second conclusion is that though this compensation necessitates a higher increase in the VAT than when nominal transfers are kept constant the VAT reform remains more favorable to growth than either the CPG or the VAC options, with the differences between the reforms being very small : the static model leads us to expect all these reforms to create between 150,000 and 200,000 jobs, and a growth in output of 0.6-0.75% points. Finally we find that the VAT redistributes more between workers and capitalists in both types of models used, and we discuss how we might expect a change in our assumptions to affect this result.

The use of two different models with very different conclusions regarding the efficiency of the reforms points to a limit of our analysis. On the one hand the dynamic model assumes an ad hoc desire for savings and that capitalists do not react to a change in the returns to savings, therefore probably over-estimating the positive impact of the reforms. On the other hand introducing microeconomic foundations for savings behavior in our second infinitely lived agent model brings us to the well known conclusion that, in such a model with perfect capital markets, there should be no capital taxation so none of the reforms considered would ever be advisable, and all existing fiscal reforms (which include some form of capital taxation) should be re-organized. The problem is that in one model capitalists are assumed to be static, and in the other their reactivity to changes in the returns to savings is such that any capital taxation yields infinite efficiency losses : it seems neither model captures the impact of the reforms on capital accumulation in a way which is both coherent with the theory of rational intertemporal choices and yields tax policy conclusion which are not light-years away from current practices. We have more confidence in the conclusions of the static model, for the reasons outlined above, but more work needs to be done to include realistic behaviors of capital accumulation in a model capable of handling complex fiscal reforms such as the ones we have considered.

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## A Calibration, the French economy in 2007

The aggregates used for calibration of the models are defined in 14, which also explains how these aggregates differ from their equivalents in the French economy for 2007, due to the restriction of the scope of the analysis explained in section 2.

### The allocation of 'mixed income' between labor and capital income

The payroll tax is levied on the net remuneration of wage earners, but unincorporated firm owners also pay some contribution towards social security expenditure in the form of 'contribution of non wage earners'. The tax base for the payroll tax therefore includes net remuneration of wage earners and that part of unincorporated firm's profits that correspond to labor remuneration. The French national accounts do not distinguish between the part of unincorporated firm owners' profit that corresponds to remuneration of their own labor and that which corresponds to pure profits, or capital income.

Following Poterba (1997) we compute the share of those profits which correspond to labor income by assuming that the marginal productivity of labor is on average the same in the non wage earners population as in the wage earners population and using the cost of labor as a proxy for marginal productivity. Using data for France from 2006<sup>42</sup> we find that the remuneration of wage earners, gross of all payroll taxes,  $w(1 + t_l)L_w$ , is equal to 935,671 billion. The wage earning labor force  $L_w$  amounts to 23436.5 thousands individuals, which gives us the average gross yearly wage, or cost of labor, for wage earners in 2006:

$$w(1 + t_l) = \frac{w(1 + t_l)L_w}{L_w} = 39923,66608 \text{ (in euros)}$$

The non wage earning labor force  $L_n$  was 2288.8 thousands in 2006. Applying the wage rate found above we find the gross labor remuneration for non wage earners:

$$w(1 + t_l)L_n = L_n w(1 + t_l) = 91,37728692 \text{ (in billion euros)}$$

The mixed income of unincorporated firm earners in 2006 was 117.811 billion, so that labor remuneration made up 77.6% of this income. Applying this proportion to mixed income for 2007, 123.883 billion, we find a gross labor income of non wage earners equal to 96.1 billion euros, out of which 22.6 billion were paid in social contributions.

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<sup>42</sup>Data on the size of the labor force for 2007 is not yet available

Table 14: The 'Private sector' in the French Economy in 2007 (in billion euros)

	In the whole economy	In the private sector
GDP	1892.2	1290.5
<b>Production</b>		
Value Added	1695	1174.7
VAT (A)	135.7	115.75
<b>Demand</b>		
Household Consumption	1047.4	948.6
Public Administration Consumption	438	0
Household Investment	114.2	114.2
Firm Investment	227.7	227.7
Public Administration Investment	64.5	0
Exports	501.9	0
Imports	538.3	0
<b>Income</b>		
Labor income (wage earners)	976.3	690.4
<i>Of which, net labor income</i> (B)	695.1	470.0
<i>Of which, payroll taxes</i> (C)	281.2	220.4
Capital Income (D)	537.6	360.4*
Mixed Revenue	123.9	123.9
<i>Of which, net labor income</i> (E)	71.7	71.7
<i>Of which, payroll taxes</i> (F)	22.6	22.6
<i>Of which, capital income</i> (G)	29.6	29.6

\*Most of the difference between the whole economy and the private sector with respect to capital income corresponds to the rents received by households (whether from renters or from themselves- imputed rents) who own real estate. These are reported as remuneration of capital in national accounts as no labor is used in their production.

Source : Comptes nationaux (National Accounts) - Base 2000, Insee, and author's calculations

Table 15: Sources of Disposable Income

	In billion euros	In % of total disposable income
Labor income (B+E)	541.7	41.97
Capital income (D+G)	390.1	30.22
Transfer income (A+C+F)	358.8	27.8

Source : Comptes nationaux (National Accounts) - Base 2000, Insee, and author's calculations

Table 16: Repartition of Value Added

	In billion euros	In % of Value Added
Labor income (B+C+E+F)	784.7	66.8
Capital income (D+G)	390.10	33.2

Source : Comptes nationaux (National Accounts) - Base 2000, Insee, and author's calculations

## B Persistent VAT

As we have seen above investment expenditure and intermediate consumption by firms (respectively 230.3 and 1620.7 billion euros for 2007) are in practice subject to some VAT. The French tax Council (Conseil des Impôts (2001)) estimates that 11.8% of total VAT receipts are levied on firms' intermediate consumption, and 4.2% on firms' investments. It also specifies that this persistent VAT is due to two sources, with different implications for our calibration. One is due to the technical difficulties in collecting VAT from very small firms, which for this reason have been exempted from paying the VAT they receive on the goods they sell to public administration. As a consequence they cannot deduct their own VAT expenses on investment and intermediate consumption from the VAT they pay to the state, so that they pay VAT on the goods they buy, like consumers. The VAT they pay therefore corresponds to VAT that is paid by consumers on the goods they sell but that is not collected by the state. It cannot be considered as an extra source of fiscal receipts from VAT, as it is the consequence of a loss of fiscal resources relative to the theoretical VAT receipts. It is estimated that 68% of the VAT paid on firm's intermediate consumption comes from this specific source. The report gives no such estimates for persistent VAT on investments coming from this particular source. Because it only concerns very small firms, whose investments represent a minuscule fraction of total investment, we assume all persistent VAT to be coming from the other source, which is simply that some goods (like energy consumption) are not eligible for VAT deduction, so that firms which use these goods for production have to pay them at the after tax price. Table 17 gives the repartition of VAT receipts according to the tax base on which they are levied.

In our models however we do not include intermediate consumption by firms, as we only consider total value added. Because most of persistent VAT on intermediate consumption cannot, as explained above, be understood as extra fiscal revenues nor indeed as a distortion on the choices taken by firms (as the price at which they sell goods remains the same as the price at which they buy goods) we decide to ignore persistent VAT on intermediate

Table 17: Repartition of VAT according to the tax base

Tax Base	In billion euros	In % of total VAT
Public administration expenses	20	14.7
Investment by firms	5.7	4.2
Intermediate consumption by firms	16	11.8
Consumption	98.15	69.3

Source : Comptes nationaux (National Accounts) - Base 2000, Insee, and author's calculations

consumption. In what follows it is part of the VAT paid on consumption. We compute the share of investment subject to persistent VAT, following Gauthier (2008).

VAT receipts on investment expenditures (I) constitute 4.2% of the total, so that  $tp_i I = 4.2\% * 135.7 = 5.7$

Taking out VAT paid by public administrations (14.7%) we find total VAT paid on consumption:  $t_v C = 135.75 - 20 - 5.7 = 110.05$

We know that  $(1 + t_v)C = 1062.8$ , so the average  $t_v$  is 11.55%.

Using  $(1 + p_i t_v)I = 227.7$  we find  $p_i = 0.22218$ <sup>43</sup>

Adding the share of investment subject to persistent VAT ( $p_i I$ ) and consumption we find a tax base for the VAT of 1002.07 billion euros.

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<sup>43</sup>Taking into account intermediate consumption or treating VAT paid by public administrations differently does not affect these results much. Gauthier (2008), using this method but on slightly different definitions of the tax base, finds  $p_i = 0.275$  and  $t_v = 0.107$ .

## C The short run impact of the reforms in the dynamic model

This section considers the short run impact of the reforms using the model of section 5.

### C.1 The VAT reform

We will concentrate on analyzing a simple perturbation of the steady state due to a change in fiscal policy to look at the short run impacts. Suppose that the government has been taxing at constant rates  $t_v$  and  $t_l$  -  $t_c$  is originally set to zero- and redistributing  $T$ , and that the economy is initially in the steady state. At  $t = 0$  the government announces that at  $t \geq 0$ ,  $t_v$  will be  $\epsilon h_v(t)$  greater, and  $t_l$  will be  $\epsilon h_l(t)$  smaller.

The timing of the reform announcement is determined by  $\epsilon$  which switches from 0 to 1 the day the reform is announced, and the timing of the reform is determined by the  $h(t)$  functions, which is the difference between the tax rate at time  $t$  and the tax rate before the reform was announced<sup>44</sup>. In order to ensure the existence of a new steady state we have to impose that  $h_l(t)$  and  $h_v(t)$  are eventually constant functions of time (Judd, 1985)<sup>45</sup>. Equilibrium is now solution to the following equations:

$$\dot{K} = F(K, L) - C(q, t_v + \epsilon h_v(t)) - \delta K \quad (58)$$

$$\dot{q} = q\left(\theta - \frac{F_k}{1 + p_i t_v + \epsilon h_v(t)} + \delta\right) \quad (59)$$

What we are interested in is the impact of the change in  $\epsilon$  on the critical variables. We write

$$\frac{\partial x}{\partial \epsilon}(t, 0) \equiv x_\epsilon \quad \text{and} \quad \frac{\partial}{\partial \epsilon} \left( \frac{\partial x}{\partial t} \right) (t, 0) \equiv \dot{x}_\epsilon(t) \quad (60)$$

Differentiation of the equilibrium system yields a system of linear differential equation in the variables  $K_\epsilon$  and  $q_\epsilon$  :

$$\begin{pmatrix} \dot{K}_\epsilon(t) \\ \dot{q}_\epsilon(t) \end{pmatrix} = \begin{bmatrix} F_k - \delta & C \\ -\frac{q F_{kk}}{1 + p_i t_v} & 0 \end{bmatrix} \begin{pmatrix} K_\epsilon(t) \\ q_\epsilon(t) \end{pmatrix} + \begin{pmatrix} \frac{C}{\gamma} \left( \frac{1}{1 + t_v} - \frac{p_i}{1 + p_i t_v} \right) \\ \frac{q(t) F_k p_i}{(1 + p_i t_v)^2} \end{pmatrix} h_v(t) \quad (61)$$

<sup>44</sup>If the reform is announced at time  $t = 0$  but only takes place at time  $T$ , we have  $h(t) = 0 \quad \forall t < T$

<sup>45</sup>This assumption is not restrictive, since the date of eventual constancy is arbitrarily distant, and because we are interested in reforms during which taxes immediately reach their new levels

Where  $\gamma$  is the inverse of the (limit of) the intertemporal elasticity of substitution, and  $F_{kk}$  is the second derivative of production with respect to capital. The matrix in (61) is the Jacobian matrix  $A$  of the equilibrium differential equations and has constant coefficients since we are initially in the steady state. The vector  $B$  of coefficients for  $h_v(t)$  is also constant, so the system (61) is linear with constant coefficients and can be solved with Laplace transforms<sup>46</sup>, reducing the differential equations to linear algebraic equations.

Let  $\mathbf{Q}_\epsilon(s)$ ,  $\mathbf{K}_\epsilon(s)$  and  $\mathbf{H}_v(s)$  be the Laplace transforms of respectively  $q_\epsilon(t)$ ,  $K_\epsilon(t)$  and  $h_v(t)$ , . The system (61) can be rewritten as:

$$\begin{pmatrix} s\mathbf{K}_\epsilon(s) \\ s\mathbf{Q}_\epsilon(s) \end{pmatrix} = A \begin{pmatrix} s\mathbf{K}_\epsilon(s) \\ s\mathbf{Q}_\epsilon(s) \end{pmatrix} + B\mathbf{H}_v(s) + \begin{pmatrix} K_\epsilon(0) \\ q_\epsilon(0) \end{pmatrix} \quad (62)$$

Note that  $K_\epsilon(0) = 0$  as the stock of capital cannot react immediately to a change in policy variables, so that once  $q_\epsilon(0)$  is known, the values for  $K_\epsilon$  and  $\dot{Q}_\epsilon$  are found from system (61) . The Jacobian matrix  $A$  has two eigenvalues, given by the formula:

$$\lambda_1, \lambda_2 = \frac{F_k - \delta}{2} \pm \sqrt{\frac{(F_k - \delta)^2 - 4\frac{CF_{kk}}{\gamma(1+p_itv)}}{2}} \quad (63)$$

Clearly  $\lambda_2 > 0 > \lambda_1$  and both are real as long as  $F_{kk}$  is negative. Our steady state is therefore saddle point stable. From now on we write

$$\begin{pmatrix} \mathbf{K}_\epsilon(s) \\ \mathbf{Q}_\epsilon(s) \end{pmatrix} = \mathbf{X}_\epsilon(s) \quad (64)$$

Since investment  $K$  is a state variable, it cannot jump initially :  $K_\epsilon(0) = 0$ . We can write :

$$(sI - A)\mathbf{X}_\epsilon(s) = B\mathbf{H}_v(s) + \begin{pmatrix} 0 \\ q_\epsilon(0) \end{pmatrix} \quad (65)$$

We need to find the value of the initial change  $q_\epsilon(0)$  to determine  $\mathbf{X}_\epsilon(s)$ . We suppose  $A$  can be diagonalized by a transform  $V$ ,  $A = V^{-1}\Lambda V$ , where  $V$  is a 2x2 matrix whose rows are linearly independent left-eigenvectors of  $A$ ,  $\Lambda$  is a diagonal matrix whose diagonal elements are the characteristic roots of  $A$ . Because the steady state is saddle point stable the number of eigenvalues

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<sup>46</sup>The Laplace transform of a function  $f(t)$  defined for  $t$  positive is a function  $L(f(t)) = \mathbf{F}(s)$  defined for  $s$  positive, where  $\mathbf{F}(s) = \int_0^\infty e^{-st} f(t) dt$ .  $f(t)$  must be bounded, Judd (1985, Lemma 1 p328) provides the proof that all variables in the model are indeed bounded. Thus  $\mathbf{F}(s)$  is the value of  $f(t)$  from now till the end of times, discounted at the rate  $s$ . The property of Laplace transforms which makes them useful in solving systems of differential equations is the following :  $L(f(t)) = s\mathbf{F}(s) - f(0)$

with negative real part is the same as the number of state variables .  
Substituting  $A = V^{-1}\Lambda V$  into (65)and left multiplying by  $V$  we have :

$$(sI - \Lambda)V\mathbf{X}_\epsilon(s) = V \left( B\mathbf{H}_v(s) + \begin{pmatrix} 0 \\ q_\epsilon(0) \end{pmatrix} \right) \quad (66)$$

The Laplace transforms are definite for positive  $s$ . We write  $\lambda_2$  the positive eigenvalue of  $\Lambda$ . Because  $\lambda_2 I - \Lambda = 0$ , if we take  $s = \lambda_2$  we find the expression for  $q_\epsilon(0)$  :

$$q_\epsilon(0) = -\mathbf{H}_v(s) \begin{pmatrix} z_2 \\ w_2 \end{pmatrix} e - f \quad (67)$$

Where  $v_2 = (z_2, w_2)$  is the left eigenvector associated with  $\lambda_2$ , and we have written the coefficients in  $B$  as :

$$B = \begin{pmatrix} e \\ f \end{pmatrix} \quad (68)$$

Having found the initial value  $q_\epsilon(0)$  we can go back to our original system of differential equations (61)

$$\begin{pmatrix} \dot{K}_\epsilon(t) \\ \dot{q}_\epsilon(t) \end{pmatrix} = \begin{bmatrix} F_k - \delta & \frac{C}{\gamma q} \\ -\frac{qF_{kk}}{1 + p_it_v} & 0 \end{bmatrix} \begin{pmatrix} K_\epsilon(t) \\ q_\epsilon(t) \end{pmatrix} + \begin{pmatrix} \frac{C}{\gamma} \left( \frac{1}{1 + t_v} - \frac{p_i}{1 + p_it_v} \right) \\ \frac{qF_k p_i}{(1 + p_it_v)^2} \end{pmatrix} h_v(t),$$

And find the expression for  $\dot{K}_\epsilon(0)$ , the impact of the reform on investment in the first period :

$$\dot{K}_\epsilon(0) = \frac{C}{\gamma q} q_\epsilon(0) + h_v(0) \frac{C}{\gamma} \left( \frac{1}{1 + t_v} - \frac{p_i}{1 + p_it_v} \right)$$

Finally using the Euler equation (44) which implicitly defines  $C$  as a function of  $q$  we find the expression for the change in consumption:

$$\frac{C_\epsilon(0)}{C(0)} = \frac{-q_\epsilon(0)}{q(0)} \frac{1}{\gamma} - \frac{dtv}{\gamma} \left( \frac{1}{1 + t_v} - \frac{p_i}{1 + p_it_v} \right) \quad (69)$$

Substituting for the values taken by the coefficients the short run impact of the policy change on the marginal value of capital at time  $t = 0$  is given by:

$$q_\epsilon(0) = -\mathbf{H}_v(\lambda_2)q(0) \left[ \lambda_2 \left( \frac{1}{1 + t_v} - \frac{p_i}{1 + p_it_v} \right) + \frac{F_k p_i}{(1 + p_it_v)^2} \right] \quad (70)$$

The impact of the reform on consumption can be written as:

$$\frac{C_\epsilon(0)}{C(0)} = \frac{-q_\epsilon(0)}{q(0)} \frac{1}{\gamma} - \frac{dtv}{\gamma} \left( \frac{1}{1 + t_v} - \frac{p_i}{1 + p_it_v} \right) \quad (71)$$

And the impact on investment is then simply given by :

$$K_{\epsilon}'(0) = (F_k - \delta)K_{\epsilon}(0) - C_{\epsilon}(0) \quad (72)$$

Because  $K_{\epsilon}(0) = 0$ , all the change in consumption is translated into a change in investment of the opposite sign.

The first thing to note regarding these result is that they depend on both  $h_v(0)$ , the value of the increase in the VAT at the present period, and  $\mathbf{H}_v$ , the discounted value of the future changes in VAT. The terms in  $h_v(0)$  capture the immediate impact of the tax change on the variables, whereas the terms in  $\mathbf{H}_v$  captures the anticipation effect of having a VAT rate that is higher forever. In order to keep the policy question addressed by this model as close to the one addressed by the previous model as possible we shall concentrate our analysis of the results on an increase in the VAT which is both immediate and unique, so that  $h_v(t) = dtv \quad \forall t \geq 0$  and  $\mathbf{H}_v(s) = dtv/(s)$ . Clearly  $q_{\epsilon}(0)$  is negative, as is to be expected of a reform which increases the tax on capital. How large this decrease is depends on the coefficient for  $\mathbf{H}_v(s)$ . The first term in this coefficient is the impact of the increase in VAT on the relative prices of consumption and investment today : the expression  $1/(1+t_v) - p_i/(1+p_it_v)$  shows how the price of consumption increases with respect to the price of the investment good, and it is clear from Euler's equation that if  $q$  is fixed this will lead to a fall in consumption. This term therefore captures a short run negative impact on consumption, which tends to increase the marginal utility of consumption and so makes the marginal value of capital today larger in absolute value. The second term captures the impact of the reform on the returns to savings, which naturally has a negative impact on the marginal value of capital.

The interpretation of equation (71) for the change in consumption is very intuitive. The first term shows that as the marginal value of capital decreases the household has less incentives to save so consumes more. The second term is the same relative price impact as in the expression for  $q_{\epsilon}$  and tends to decrease consumption today, because the price of the investment good decreases with respect to that of the consumption good. Plugging in the expression for  $q_{\epsilon}$  in this equation shows that this short term relative price effect is dominated by the impact of  $q_{\epsilon}$  so that consumption increases. The presence of the term  $-1/\gamma$  - the intertemporal elasticity of substitution in consumption - just shows that the more the household is willing to transfer consumption over time, the more it will react to a change in either the marginal value of capital or the relative prices of consumption and investment goods.

## C.2 The VAC reform

Suppose now that at  $t = 0$  the government has announced that at  $t \geq 0$ ,  $t_c$  will be  $\epsilon h_c(t)$  greater, and  $t_l$  will be  $\epsilon h_l(t)$  smaller. We keep the same notations as for the VAT case, but notice that  $h_c(t)$  is simply equal to  $t_c$ , the VAC rate chosen by the government. We still impose that  $h_c(t)$  and  $h_l(t)$  are eventually constant functions of time, and as before the change in taxes is immediate.

Equilibrium is now solution to the following equations:

$$\dot{K} = F(K, L) - C(q, t_v) - \delta K \quad (73)$$

$$\dot{q} = q\left(\theta - \frac{F_k}{(1 + p_i t_v + \epsilon h_c)} + \delta\right) \quad (74)$$

Keeping the same notations as before, differentiation of the equilibrium system yields a system of linear differential equation in the variables  $K_\epsilon$  and  $q_\epsilon$  :

$$\begin{pmatrix} \dot{K}_\epsilon(t) \\ \dot{q}_\epsilon(t) \end{pmatrix} = \begin{bmatrix} F_k - \delta & \frac{C}{\gamma q(t)} \\ -\frac{q F_{kk}}{1 + p_i t_v} & 0 \end{bmatrix} \begin{pmatrix} K_\epsilon(t) \\ q_\epsilon(t) \end{pmatrix} + \begin{pmatrix} 0 \\ \frac{q(t) F_k}{(1 + p_i t_v)^2} \end{pmatrix} h_c(t) \quad (75)$$

The Jacobian matrix  $A$  is the same as in the VAT case, but the vector of coefficients for the discounted value of the tax change,  $H_c(s)$  has changed : there is no more direct impact of the increase in the tax on  $C$  as the VAC does not appear in the Euler equation. We call this vector  $B_c$ . Let  $\mathbf{H}_c(s)$  be the Laplace transforms of  $h_c(t)$ . Taking Laplace transforms the system (75) can be rewritten as:

$$\begin{pmatrix} s\mathbf{K}_\epsilon(s) \\ s\mathbf{Q}_\epsilon(s) \end{pmatrix} = A \begin{pmatrix} s\mathbf{K}_\epsilon(s) \\ s\mathbf{Q}_\epsilon(s) \end{pmatrix} + B_c \mathbf{H}_c(s) + \begin{pmatrix} K_\epsilon(0) \\ q_\epsilon(0) \end{pmatrix} \quad (76)$$

This system is solved using the same method as for the VAT, replacing  $B$  by  $B_c$ . The equation for the change in the marginal value of capital is now :

$$q_\epsilon(0) = -\mathbf{H}_v(\lambda_2) q(0) \left( \frac{F_k}{(1 + p_i t_v)^2} \right) \quad (77)$$

And that for the change in consumption is simply

$$\frac{C_\epsilon(0)}{C(0)} = \frac{-q_\epsilon(0)}{q(0)} \frac{1}{\gamma} \quad (78)$$

Notice that the term  $1/(1 + t_v) - p_i/(1 + p_i t_v)$  has dropped out of the equations, because the VAC does not affect the relative price of investment and consumption today : there is no immediate negative impact of the reform on consumption as there is with the VAT.

Table 18: Short term impact of the reforms in %

<i>type of reform</i>	VAT	VAC	CPG1	CPG2
consumption	0.44	2.09	1.22	1.58
investment	-3.03	-13.58	-8.40	-10.86
after tax price	4.42	3.17	0	0
output	-0.03	-0.16	-0.09	-0.12
capital	-0.10	-0.48	-0.29	-0.38
cost of capital	0.07	0.32	0.19	0.25
cost of labor	-0.03	-0.16	-0.09	-0.12
returns to savings	-5.42	-6.40	-1.96	-2.53
returns to labor	2.58	2.46	1.83	2.36
tax increase	3.45	3.07	5.10	6.58

### C.3 The CPG reforms

The Jacobian matrix remains the same for the CPG reforms, but the vector  $B$  becomes

$$B_{cg} = \begin{pmatrix} 0 \\ q_t F_k \lambda \\ 1 + p_i t_v \end{pmatrix} \quad (79)$$

. The change in the marginal value of capital is :

$$q_\epsilon(0) = -\mathbf{H}_c(\lambda_2)q(0)\left(\frac{F_k \lambda}{1 + p_i t_v}\right) \quad (80)$$

Where  $\mathbf{H}_c$  is now the Laplace transform of  $t_{c1}$  for the CPG1 reform, and  $t_{c2}$  for the CPG2 reform. The expression for the change in consumption as a function of  $q_\epsilon(0)/q(0)$  is the same as for the VAC reform.

### C.4 Short run results

Table 18 shows the short run impact of the reforms. The first two rows are the results obtained by the above method : in the short run both capital and output are fixed, and revenue is allocated between consumption and investment depending on the marginal value of capital, which is negatively affected by the reform. The following rows depict a 'second run' impact of the reform : we use our values for the fall in investment to find the fall in the capital stock in output, which then determines the changes in incomes from labor and capital.

Note that the ranking of the reforms with respect to their effect on output growth is the same in the long and the short run : even in the short run the VAT's lesser taxation of capital makes it the reform which has the least negative impact on the economy. The short run impact of the reform is the

start of the capital de-accumulation phase predicted by the long run impact : capital falls, but by less than 0.5% in all cases (always less than a tenth of the long term fall in the capital stock), which leads to a small decline in output. The VAC reform is the most redistributive one however : in the short run the marginal product of capital has not had time to increase to compensate for the increase of the tax on the nominal returns to capital, so that the inclusion of all investment expenditure in the VAC makes it, in the short run, more redistributive than the VAT. For the same reason all reforms are more redistributive in the short run than in the long run.