

**IMF WORKING PAPER**

© 1990 International Monetary Fund

This is a working paper and the author would welcome any comments on the present text. Citations should refer to an unpublished manuscript, mentioning the author and the date of issuance by the International Monetary Fund. The views expressed are those of the author and do not necessarily represent those of the Fund.

WP/90/96

INTERNATIONAL MONETARY FUND

European Department

European Fiscal Harmonization and the French Economy

Prepared by W.R.M. Perraudin and T. Pujol 1/

Authorized for distribution by Michael C. Deppler

October 1990

Abstract

This paper examines the implications of European fiscal harmonization for the French economy using a general equilibrium model. The latter extends the overlapping generations simulation model of Auerbach and Kotlikoff in three ways. A well-developed external sector is included. Households face constraints in their borrowing. The population comprises "rich" and "poor" households with different labor productivities. The harmonization policy that involves cuts in VAT and savings taxes leads to welfare losses for both rich and poor approximately equivalent to one percent of GDP.

JEL Classification Numbers:

323, 423

---

1/ The authors would like to thank Christer Andersson, Alan Auerbach, Didier Maillard, Cuong Le Van and numerous Fund colleagues for helpful comments on different versions of this paper.

<u>Contents</u>	<u>Page</u>
Summary	iii
I. Introduction	1
II. Fiscal Harmonization in France	5
III. The Model	9
a. Household Behavior	9
b. The Behavior of Firms	10
c. Government and Welfare Analysis	11
d. The Closure of the Model	12
e. Parameterization of the Model	13
IV. Long Run Results	13
a. The Superiority of VAT Over Wage Taxes	14
b. Savings Tax vs. Wage Tax: The Influential Role of Government Debt	16
c. The Treatment of the External Sector	17
d. Credit Constraints	18
e. Lump Sum Financing of the Reforms	18
f. Sensitivity Analysis	23
V. Short Run Results	25
a. Welfare Effects	25
b. The Source of the Dynamics	25
c. Announcement Effects	26
VI. Conclusions	26
Text Tables:	
1. Tax Revenue Comparisons as a % of GDP in 1985	6
2. Revenue Losses	7
3. Model Parameters	14
4. Long Run Results	20
5. Small Country Results	21
6. Results with Unrestricted Borrowing	22
7. Sensitivity Analysis	24
Appendix I: Model Description	28
Appendix II: Choice of Parameters	32
Appendix III: The Solution of the Model	35
Appendix Tables:	
8. Participation Elasticities of Married Women	32
9. The Hierarchy and Evolution of Wages	33
References	37
Figure 1. Steady State Algorithm	36a

Summary

This paper develops a general equilibrium overlapping-generations simulation model and then uses it to gauge the impact on the French economy of harmonizing VAT and savings tax rates with those of other European countries. The model generalizes previous work, first, by introducing nontradables, imports, and exports, second, by allowing for constraints on consumer borrowing, and, third, by including rich and poor households with different labor productivities.

The main findings of the study are that a 2 1/2 percent cut in VAT financed by higher wage taxes generates significant welfare losses for French consumers, approximately equivalent to 1/2 of 1 percent of GDP in the steady state. French output, employment and the capital stock are also reduced.

The simulations suggest that cuts in savings taxes equal to those either already enacted or currently envisaged lead to utility losses equivalent to 1/3 of 1 percent of GDP in the steady state. The primary implication of these results is not that harmonization is per se undesirable, but that current proposals that involve EC member countries adjusting VAT rates toward some European average are likely to be inferior to a plan under which countries with low VAT rates took the opportunity to level their rates upward.



## I. Introduction

This paper uses a general equilibrium simulation model to gauge the impact of European fiscal harmonization upon the French economy. As far as France is concerned, harmonization as currently envisaged will involve two main elements, first, a downward adjustment in VAT rates compensated for by an increase in direct taxation, and, second, a general reduction in the level of savings taxes.

As discussed in Section 2, the pace at which the harmonization of rates is achieved will depend upon the detailed design of the tax system itself. Different systems for levying VAT taxes place different degrees of pressure upon member states to bring their tax rates into line with those of their neighbors. Nevertheless, the goal of fiscal harmonization has now been accepted by all EC members and the long term convergence of VAT and savings tax rates has therefore effectively been decided.

To gain some idea of the magnitude of the tax reforms such convergence would entail, note that to bring French VAT rates into line with German rates would mean an overall cut approaching three percentage points. The change in effective savings tax rates that will emerge from current discussions is harder to estimate, but a reasonable guess is that the general level of taxation on income from savings will fall by 10%. The total revenue losses associated with these tax cuts could amount to over 2% of GDP.

Despite the scale of these changes, relatively little attention has been paid to their possible economic impact upon EC member countries. Initially, tax harmonization was viewed simply as a prerequisite to the broader movement towards a post-1992 Single Market. Studies such as those in Cecchini (1988) emphasized the economic implications of this integration of markets while ignoring the independent impact of tax harmonization.<sup>1</sup>

In fact, the planned harmonization raises broad questions concerning the desirability of different tax bases. Given that VAT rates in member states are to be brought into line, the question is should indirect taxes in countries with high rates be lowered or should those in countries with low rates be raised? Assuming that income and possibly other taxes are adjusted so that the VAT harmonization is revenue neutral, the answer will necessarily turn upon the relative advantages of different tax bases, in particular, consumption versus income or wages.

On the first comparison, there is a long tradition in public finance, associated with such authors as Fisher (1937), Kaldor (1957) and Meade (1978), of recommending the use of a consumption tax or VAT rather than income taxes. The basic argument is that taxes on consumption, like taxes on labor income, impose no burden on capital income and, therefore, do not distort a household's intertemporal choice between consumption in different periods. Furthermore, the introduction of a new consumption tax effectively

---

<sup>1</sup> Thus, the Cecchini report concentrates overwhelmingly on the gains from increased competition and economies of scale due to the removal of barriers between national markets.

imposes a once and for all tax on existing wealth which is equivalent to a lump sum tax.

Interest in these issues was reawakened by a series of papers beginning with Boskin (1978) which suggested, on the basis of empirical estimates, that the elasticity of savings with respect to the real interest rate was much higher than had previously been thought. If this were the case, then the dead-weight losses involved in taxing capital income, or of relying on income rather than consumption taxes, would be higher.

As Feldstein (1978) pointed out, however, it is not the absolute level of savings elasticities which matters but rather their magnitude relative to labor supply elasticities. While savings taxes distort the choice between consumption at different dates, levying consumption taxes in their place increases the wedge between the prices of goods and leisure (the wage), and thereby exacerbates the distortionary impact of the tax system upon labor supply decisions. Only if labor supply elasticities are very low is it possible to say unambiguously that the switch to consumption taxes will be welfare-enhancing.<sup>1</sup>

Since the relative benefits of a consumption versus an income tax system depend in a more or less complex way upon the level of agents' demand elasticities, more recent work in this area has concentrated, firstly, upon trying to refine estimates of the relevant elasticities and, secondly, upon using general equilibrium simulation models to unravel the various ways in which different tax bases affect welfare.<sup>2</sup>

The above literature is relevant to evaluating the impact of savings tax cuts. However, it sheds little light on the relative merits of VAT and wage taxation. It is easy to show in a static closed economy model that VAT is superior to a tax on wages. Consumers' budget constraints mean that consumption equals the sum of labor income and lump sum endowments such as bequests, non-means-tested transfers from the government, and income tax allowances. For rational agents, a proportionate tax on consumption is equivalent to a similar proportional tax on wage income plus a lump sum tax. Since lump sum taxes are non-distortionary, a consumption tax will generally be preferable to a wage tax raising the same revenue.

However, there are two important qualifications to the above argument. First, in an open economy model, it is possible to show (Perraudin and Pujol (1990)) that with inelastic demand for the country's exports, terms of trade effects may be sufficient to reverse the conventional result in such a way that lower VAT actually increases welfare. The mechanism that brings this about is as follows. Lower VAT with higher wage taxes increases the relative price of leisure inducing consumers to curtail their supply of labor. Domestic output falls faster than demand, leading to a reduction in the supply of exports. If export demand elasticities are sufficiently small, this provokes an appreciation in the domestic currency.

---

<sup>1</sup> Even then, the presence of liquidity constraints may reduce or even reverse the welfare gain, as we note below.

<sup>2</sup> Some authors such as Pechman (1990) also question the underlying life cycle framework which assumes that all income is eventually consumed by households. If this is not the case, then income will represent a broader tax base and a better indicator of ability to pay than consumption.

A second qualification to the superiority of VAT concerns the timing of consumption and wage tax liabilities over the life cycle. As Summers (1981) has pointed out, in a steady state with over-lapping generations, a government may levy taxes on young or old and still raise the same amount of revenue. However, households will prefer taxes to be levied late in the life cycle since they have positive discount rates. If wage income should be earned later in the life cycle than consumption expenditures are incurred (which is possible, in principle, though perhaps unlikely), then a switch towards wage taxes could be welfare improving.

These arguments mean that while the overall presumption must be that wage taxes are inferior to VAT in the excess burden they impose, in a particular case, such as the current French economy, this inferiority remains to be demonstrated. This paper develops a general equilibrium over-lapping simulation model in which such questions may be analyzed.

Early papers that used such models, like Summers (1981), calculated the steady state utilities of overlapping generations of households under various tax regimes. Summers argued strongly that the potential gains from switching to consumption taxes were extremely large. Unfortunately, steady state calculations of this kind ignore the burden that policies may impose upon households alive during the transition path. Moreover, they do not take into account the adjustment costs borne by firms which have to revise their investment strategies. As a result, welfare gains may be significantly overstated.

The analysis of Auerbach and Kotlikoff (1987), confirms this criticism of studies that concentrate upon steady state results alone. As they show, the increases in economic welfare apparently demonstrated by Summers that follow from a switch to VAT from income are, in fact, largely the consequence of welfare transfers between generations. The utility gains of households in the terminal steady state are accompanied by large utility losses for households in current generations. On the other hand, according to Auerbach and Kotlikoff, switching to income from labor income taxes does produce a genuine Pareto improvement in that it is possible to adjust transfers so that all households are better off including those alive during the transition period.

The approach taken in this study builds upon the work of Auerbach and Kotlikoff. The model we develop extends their framework in three important ways. Firstly, given that French product and capital markets are closely integrated with those of its neighbors, it makes sense to incorporate a well-developed external sector. The model, therefore, incorporates three commodities<sup>1</sup> including a domestically-produced nontradeable, an imported good, and a domestically produced export that is also consumed by domestic households. The demand for exports and the supply of savings from the rest of the world are assumed to be imperfectly elastic.<sup>2</sup>

---

<sup>1</sup>Auerbach and Kotlikoff assume a single homogeneous output good.

<sup>2</sup>Hence, we do *not* make the commonly-adopted small country assumption.

Secondly, we assume that a fraction of the households in the model are limited in their ability to borrow against future labor income. A substantial body of empirical work has accumulated over the last few years pointing to the presence of such borrowing constraints in markets for consumer loans.<sup>1</sup> This assumption may, therefore, be seen as realistic. It is a desirable assumption to make given the questions posed by the present study since, as Hubbard and Judd (1987) have stressed, liquidity constraints directly affect the relative dead-weight losses associated with consumption and income taxes. If agents earn income late in life while their desired consumption has, say a flat time profile, then switching from income taxes to VAT is likely to aggravate liquidity constraints leading to a reduction in welfare.

The third extension of Auerbach and Kotlikoff's work is to incorporate two sorts of households, differing in their levels of labor productivity. Since an important feature of VAT,<sup>2</sup> is that it is typically less progressive than income taxes, comparisons of the relative merits of consumption versus income tax bases should ideally take distributional issues into account. To do this, it is of course essential to have a model that includes heterogeneous households.

Of the three extensions described above, the assumption of an open economy with variable terms of trade is the one which turns out to influence our results the most.<sup>3</sup> To understand why this is the case, consider the effects of cutting VAT and savings taxes to a degree consistent with European harmonization and financing this through increases in lump sum taxation. The primary effect is to make consumption goods more attractive compared to leisure, leading to an increase in labor supply and a significant boost in production. Selling the additional output in international markets necessitates a worsening in the terms of trade which lowers domestic welfare despite the fact that domestic output has risen.

Results of this kind signal the considerable importance of addressing tax policy questions within an open economy framework. The implications of open economy effects for the relative attractiveness of different tax bases have only recently begun to receive their due recognition. Dixit's (1985) survey of the theory of tax policy for open economies simply translates the results of Ramsey-Diamond-Mirrlees optimal tax theory into a version applicable to countries with trade. Such an approach ignores the dynamic impact of taxation upon savings and investment that have been the primary focus of the literature on consumption and income tax bases described above. More recent contributions by Frenkel and Razin (1987) and Frenkel, Razin and Symansky (1989) have begun to analyze these topics but more work in this area is an urgent research priority.

---

<sup>1</sup>See, for example, Hall and Mishkin (1982), Hayashi (1982) and Zeldes (1989).

<sup>2</sup>As stressed by Peckman (1990).

<sup>3</sup>As discussed in Perraudin and Pujol (1990), allowing for imperfectly elastic supplies of savings and demand for exports from the rest of the world may radically alter the traditional ranking of different tax bases from the point of view of their impact upon economic welfare. For example, substituting distortionary value added taxes for a lump sum tax may raise domestic welfare by improving the terms of trade.



It is important to note that the analysis presented in this paper does not imply that harmonization *per se* is necessarily welfare reducing.<sup>1</sup> The problem is that harmonization, as currently envisaged, involves EC member countries adjusting their tax rates towards some overall average. The results suggest that if harmonization were achieved by tax changes that included more of a levelling up of VAT rates in particular, with offsetting reductions in wage income tax, then the benefits to the Community would be distinctly greater.

The remainder of this paper is organized as follows. Section 2 describes the discussions within the European Community concerning fiscal harmonization and the design of VAT systems. The likely direct impact of the movement towards harmonization upon French public finances is then analyzed. Section 3 provides a brief summary of the model used in the simulations. (Appendix I gives a more detailed technical description.) Section 4 reports the results of steady state simulations of the model under a variety of assumptions about financing and the degree of openness of the economy. Section 5 provides information upon the short term impact of tax harmonization by describing the economy's transition path to the new long run equilibrium. Section 6 states the conclusions. Appendices I to III give more information about the structure and parametrization of the model and the algorithm we use in its solution.

## II. Fiscal Harmonization in France

The last few years have seen a lively debate within the European community concerning the need for tax harmonization within the projected post-1992 single market. At present there exist wide disparities in the degree to which different EC countries rely upon indirect as opposed to direct tax bases. Before the process of tax harmonization began, the disparities were even more striking (see Table 1).<sup>2</sup> The tax treatment of savings in different EC member states also varies widely.

To a large extent the need for harmonization depends upon the design of the tax system itself. In the case of Value Added Taxes (VAT) two alternative approaches have been suggested.<sup>3</sup> Under the so-called 'destination principle',<sup>4</sup> taxes depend upon where a good is consumed rather than where it is produced. By implication, such taxes do not distort a consumer's choice between foreign and domestic goods.

---

<sup>1</sup>As argued by Keen (1987), since deadweight losses depend upon the square of tax rates, one would expect a Pareto improvement from a harmonization of EC rates to the average compensated by lump sum transfers at an international level.

<sup>2</sup>One might note that divergences in excise duties such as those on alcohol or tobacco across different EC member states are in many cases larger than those in VAT rates. In this study, we focus attention upon appropriate levels for VAT rates. To a large extent, excise duties are determined on public health rather than strictly economic grounds so it is natural to limit the enquiry in this way.

<sup>3</sup>The following discussion of VAT harmonization and its effects upon the French economy of this section owes much to the detailed study of this issue by Boiteux (1988).

<sup>4</sup>Which broadly follows the provisions of the GATT relating to commodity taxation.

Table 1: Tax Revenue Comparisons as a % of GDP in 1985

	Fra	Ger	UK	Ita	Bel	Hol	Spa	Lux	Gre	Por	Irl	Den
Taxes on Goods	13.4	9.7	12.0	8.8	11.4	11.6	7.6	10.2	15.2	13.2	17.4	16.8
Taxes on Income*	25.7	24.6	16.6	21.4	31.5	28.5	18.5	22.1	17.1	n.a.	18.1	26.6

Source: OECD (1987). \*Includes social security contributions.

Although favored by economists, a destination principle system is difficult to implement. It requires either that firms apply the different tax rates appropriate to the different national markets in which they operate, or that exports be tax exempt and VAT be levied on importers in the country of destination. The first possibility involves firms in fairly onerous administrative expenses and requires a complicated clearing house of tax revenues between member states at a national level. The second possibility creates a need for elaborate border controls.

The alternative to a destination-principle VAT system is an 'origin principle' system under which tax rates depend upon the country of production. Such an approach has the disadvantage of introducing a distortionary wedge between the prices of domestic and foreign goods faced by consumers but the administrative costs imposed upon firms are likely to be significantly lower and border controls are not necessary.<sup>1</sup>

The implications of destination-principle or origin-principle VAT systems for harmonization are quite different. If adopted, the origin-principle would make it much more difficult for countries to maintain different VAT rates. Imposing a high rate would effectively mean discriminating against one's own domestic industry and creating large incentives for shopping across borders for tax-bearing purchasers. For countries like France, cross-border shopping on the part of households is of limited significance and would exist whatever the design of the VAT system. VAT-exempt entities, however, such as hospitals, financial institutions and local government bodies which cannot subtract VAT charged on their purchases from charges for the goods they supply represent a large group of potential arbitrageurs and are likely to create problems for high tax countries.<sup>2</sup>

The European Commission initially argued strongly in favor of the adoption of an origin-style VAT system contending that this would reduce firms' costs, further promote the single market, and allow the elimination of customs tolls. Some member countries, including France, have resisted such a move, arguing that the cost of border controls could be significantly cut from present levels and that the competition between European firms that an origin system would bring, would be distorted.<sup>3</sup> The outcome of this debate is that, at least in the short run, the destination principle system will persist. In the longer

<sup>1</sup> Though a clearing house for tax revenues is required.

<sup>2</sup> In France, 30% of VAT receipts currently comes from the purchases of such organizations.

<sup>3</sup> Some EC members might have been worried by the intricacies of and the lack of control on the clearing-house system suggested by the Commission. Note again that the distortions referred to here concern tax exempt firms.

term, the commitment by all EC members to equalize tax rates means that the distinction is not important.

Although the overall design of the VAT system has still not been agreed, EC member states have decided to reduce the number of VAT rates to two (a normal and a reduced rate). Moreover, the classification of goods into these two categories will be the same in each member state. Thus, for example, cars will bear the normal tax rate in all countries even though the level of this rate could differ among countries.

Turning now to the impact of harmonization upon France, one may identify four kinds of adjustment to the French tax system that are likely to prove necessary. First, if the origin principle were to apply, the French authorities would hardly accept that the tax differential with a close neighbor and competitor such as Germany, could exceed two percentage points. Assuming that Germany maintains her current rates, this would imply a reduction in the normal French VAT rate of 2.6%. Second, special rates such as those on luxury goods like cars and perfumes will be abolished.

Third, the French VAT rate on energy will be lowered. As a large net importer of energy, France has in the past tried to discourage energy consumption through high VAT rates, whereas the current EC proposals suggest that energy should be taxed at the reduced VAT rate. Fourth, a number of other special features of the French system will disappear. For instance, part of the VAT paid by firms cannot be deducted from taxes on final sales. The VAT payments in question are mainly those on goods which could represent an implicit perk for employees such as company cars, business travel allowances, etc..<sup>1</sup>

As some indication of the scale of these tax harmonization changes, Table 2 gives the French authorities' estimates of the potential loss in revenues. According to these estimates, the total revenue loss would equal approximately 1.6% of GDP.

Table 2: Revenue Losses

	In % of Tax Revenues	In % of GDP
Normal rate cut from 18.6 to 16%	3.8	0.95
Abolition of the special rate	1.0	0.25
Changes to energy tax	1.5	0.4
Others changes	0.7	0.2
Total	7	1.6

Source: Staff calculations.

The other major area of fiscal harmonization currently which has been under discussion within the EC is that of savings taxation.<sup>2</sup> The removal of capital controls which will

<sup>1</sup>The planned excise harmonization is not considered here since its effects on France are minor.

<sup>2</sup>For a more detailed account of this issue and how it affects France, see Lebegue (1988)

largely be complete by 1990 raises important issues for savings taxation. The availability of foreign tax havens has obliged EC member governments to cut the level of taxation on savings quite substantially.

In France, where income on capital has in the past borne a comparatively heavy burden of taxation, two measures have been taken to reduce the outflow of savings to tax havens within the EC. First, incentives, in the form of specific tax allowances, have been provided for French households conditional upon the fact that they hold their savings in domestic financial institutions. The implicit market segmentation implied by these measures partially offsets the liberalization of capital flows.

Second, capital income tax rates have been substantially cut from a range of 25 to 30% in the past, to a unified rate of 15%. Indeed, it is possible that the effective reduction could be even greater leading to decreases in revenue of around 0.5% of GDP. Moreover, new financial instruments such as the "Sicav de Capitalisation" will allow investors to avoid taxation on capital income up to twice the average net wage.

One should note that, like the VAT harmonization discussed above, various aspects of savings tax harmonization are still unresolved. EC proposals for a 15% withholding taxation have been shelved but other policy initiatives are possible. Even if further EC-wide reforms are not forthcoming, arbitrage by households and firms has already and will continue to provide a strong impetus for tax cuts in high tax countries. Harmonization could therefore result from competition between tax systems rather than from coordination.

A final though important question is the likely reaction of the French authorities to the substantial revenue losses involved in harmonization as currently intended. One possibility would be to increase the deficit. However, this would run counter to the government's firm announced intention of deficit reduction and hence seems unlikely. A second possibility is that the establishment of the Single Market will lead to rapid growth which will then help to finance cuts in VAT and savings taxation. Close examination of the expenditure side of the French budget suggests, however, that the government has already boxed itself in through past commitments.<sup>1</sup>

Thus, it is highly likely that direct taxes will have to be raised or will be lowered to a lesser extent than they would have been if the costs of harmonization were not present. In the simulations that we report below, we consider cases in which the harmonization tax cuts are financed either by adjustments in labor income taxes or in lump sum taxes.<sup>2</sup> The latter would be equivalent to, say, increases in income tax allowances which would have no impact upon marginal net wage rates and therefore influence labor supply decisions only through lump sum income effects.

---

<sup>1</sup>Specifically, to increase expenditure on education and public wages.

<sup>2</sup>Note that in our model broadening the income tax base is equivalent to a reduction in lump-sum taxation.

### III. The Model

The model developed in this paper is similar to the overlapping generations model employed by Auerbach and Kotlikoff in their studies of the United States economy. However, three major extensions of the Auerbach-Kotlikoff model are incorporated. First, the model describes an open economy, facing both a demand curve for its exports and a supply curve for savings from the rest of the world.<sup>1</sup> Second, two categories of households are introduced so that it becomes possible to address redistributional issues in a more realistic way. Third, one of the categories of household is assumed to face constraints in borrowing against future labor income.

#### a. Household Behavior

In modeling households, we follow the usual life cycle approach. We assume that there are two different kinds of household distinguished by their differing labor productivities, and consequently, by the level of wages they receive. For simplicity, we refer to these two groups as the Rich (R) and the Poor (P). One may think of the higher productivity of the Rich as reflecting a larger initial endowment of human capital.<sup>2</sup> Since each household is assumed to be adult for ten periods,<sup>3</sup> at any given time, the household sector includes 20 representative households. In each period, one household in each cohort dies and is replaced by a new young household. Thus, the population remains constant over time.

Each household's utility function is assumed to be a time separable, nested constant elasticity of substitution (C.E.S.) function defined upon leisure, a non-tradeable denoted  $C_{1,t}$ , and a composite tradeable good  $C_{T,t}$ . In turn, the composite tradeable is assumed to be a CES function of an imported good  $C_{2,t}$  and a domestically produced good  $C_{3,t}$ . Thus, for a given household, preferences are represented by:

$$U \equiv \frac{1}{(1 - \frac{1}{\alpha})} \sum_{t=1}^T \frac{1}{(1 + \delta)^{t+1}} u_t^{1 - \frac{1}{\alpha}}$$

$$\text{where : } u_t \equiv \left[ C_t^{1 - \frac{1}{\rho}} + \alpha_0 l_t^{1 - \frac{1}{\rho}} \right]^{\frac{1}{(1 - \frac{1}{\rho})}}$$

---

<sup>1</sup>The commonly-adopted 'small-country assumption' under which interest rates and the prices of traded goods are exogenously given from abroad is a special case of this model.

<sup>2</sup>Since households cannot adjust their levels of human capital through, for example, education, this analogy is of only partial relevance. It might be interesting in future work to allow for investment in human capital or alternatively to allow households to switch from one category to another.

<sup>3</sup>Given average life expectancies in industrialized countries, one should regard each period of time in the model as representing approximately five years.

$$C_t \equiv \left[ \alpha_1 C_{1,t}^{1-\frac{1}{\rho_1}} + (1 - \alpha_1) C_{T,t}^{1-\frac{1}{\rho_1}} \right]^{\frac{1}{1-\frac{1}{\rho_1}}}$$

$$C_{T,t} \equiv \left[ \alpha_2 C_{2,t}^{1-\frac{1}{\rho_2}} + (1 - \alpha_2) C_{3,t}^{1-\frac{1}{\rho_2}} \right]^{\frac{1}{1-\frac{1}{\rho_2}}}$$

We assume that all households retire at the start of their ninth period. This assumption is highly plausible in the case of French households given the uniformity of retirement ages allowed for by pension schemes.<sup>1</sup> Households' marginal labor productivities depend, as mentioned above, on the group to which they belong but also upon their ages. Within each group, productivity and therefore wages are assumed to increase initially, peaking at period 4 and declining slightly thereafter.<sup>2</sup>

Poor households are assumed to face liquidity constraints that prevent them from borrowing against their future labor income. Since poor households' wages rise relatively rapidly over time<sup>3</sup>, these constraints are likely to bind in the first few periods of their lives.

Taxation and transfers affect households behavior through their influence upon both income and prices. Lump-sum transfers have a direct impact upon income while VAT affects consumer prices and direct taxation (including social security contributions) influence interest rates and wages. By optimizing the utility function, households determine labor supply and the respective demand for goods. Appendix A provides a mathematical derivation of the households' optimal decisions.

#### b. The Behavior of Firms

The economy in the model contains two domestic industries denoted 1 and 3 producing a non-tradeable and a tradeable goods respectively in a perfectly competitive manner. Each sector comprises a representative firm possessing a constant returns-to-scale C.E.S. production function of capital,<sup>4</sup>  $K_t$ , and labor,  $L_t$ :

$$F_t(K_t, L_t) \equiv \epsilon_1 \left[ \epsilon_0 K_t^{1-\frac{1}{\epsilon}} + (1 - \epsilon_0) L_t^{1-\frac{1}{\epsilon}} \right]^{\frac{1}{(1-\frac{1}{\epsilon})}}$$

Since firms are assumed to face quadratic costs of adjusting their inputs, returns-to-scale are decreasing in the short-run, however.

The long-run constant returns-to-scale of the production function has various well-known implications. First, in the long run, profits equal zero. Second,

---

<sup>1</sup>Since retirement payments are contingent upon withdrawal from the labor market, then the shadow cost of leisure may be expected to fall dramatically leading to a sharp drop in the participation rate.

<sup>2</sup>For a justification of this, see Appendix II.

<sup>3</sup>Compared with those of the Rich.

<sup>4</sup>Capital is, in fact, a composite good made up of fixed shares of domestic and imported goods.

profit-maximization leads to the so-called 'factor-price frontier', a relation between the real costs of inputs, dependent upon the parameters of the production function but independent of quantities.<sup>1</sup>

Taxation affects firms' decisions in various ways. Social security contributions increases the relative cost of labor, thereby reducing labor demand. This tax is assumed to be paid exclusively by employers at a constant rate denoted  $tx_t$ . In fact, as long as households behavior depends only on net wages, it is immaterial whether contributions are borne by employers or employees.

By adopting simplifying assumptions, we ensure that profit taxes do not distort firms' behavior. These assumptions include, first, the supposition that scrapping is tax-deductible and that the fiscal depreciation rate  $d'$  equals the amortization rate  $d$ .<sup>2</sup> Second, we assume that, at the margin, investment is financed using bonds and that interest payments are tax-deductible. It follows (see Auerbach (1983) and Appendix I), that the steady state user cost of capital, denoted  $uc$ , equals the sum of the scrapping rate and the interest rate divided by the gross interest rate and is, therefore, independent of profit taxes.

### c. Government and Welfare Analysis

In this neoclassical framework, the government performs various tasks including expenditure on goods, the operation of a system of transfers, the collection of taxes and the issuance of debt. The treatment also implicitly assumes that the government owns the firms and consequently receives their profits in the form of dividends.

The government faces an intertemporal budget constraint which, for given time paths of nominal public expenditures  $\{G_t\}_{t=0}^{\infty}$  and tax receipts  $\{T_t\}_{t=0}^{\infty}$ , can be written as:

$$\sum_{t=0}^{\infty} \pi_t T_t = \sum_{t=0}^{\infty} \pi_t G_t + D_0$$

where  $\pi_t \equiv \prod_{s=1}^t \frac{1}{(1+r_s)}$  is the discount rate.

The fact that government expenditure on goods does not contribute to households' utility or to firms' production means that any cut in public expenditure allows an uncompensated tax cut and therefore results in increased welfare. The model is therefore inappropriate for studying such questions as the optimal design of expenditure programs. The level of government debt,  $D_0$ , primarily affects the distribution of wealth across

<sup>1</sup>When this condition holds, the level of production is determined by demand and any change in the real price of one input must be offset by an opposite change in the real price in the other input.

<sup>2</sup>One may justify the latter assumption by saying that an overestimated fiscal rate ( $d' > d$ ) offset the distortions due to the nominal tax regime prevailing in the French system.

different generations. Since we do not incorporate a social welfare function capable of evaluating such distributions, the model is ill-equipped to study questions of optimal debt levels.

We therefore concentrate in the analysis on tax and transfer policies that can improve social welfare for given levels of public expenditure and given steady state debt. A policy is said to 'improve welfare' if it satisfies the Pareto criterion of making some agents better off and no agents worse off. The policies we consider may involve changes in the government debt and deficits during the transition path to steady state equilibrium as transfers are implemented to maintain the utility levels of agents who would otherwise lose out.

#### d. The Closure of the Model

The model we develop includes several departures from the commonly-adopted 'small country assumption'.<sup>1</sup> On the real side, it appears quite unrealistic to assume that medium-size industrialized countries can sell unlimited quantities of their exports at constant prices. In modeling international capital flows, the assumption that interest rate and borrowing requirements are positively correlated also seems more sensible.

We therefore suppose first that the imported good, which is consumed by households and used by firms in their constant coefficient production of capital, has a price,  $P_2$ , which is assumed to be exogenously fixed in terms of foreign currency. Second, the export good, which is also consumed by domestic households and used as an input to capital by firms, is assumed to be demanded by the rest of the world according to a constant elasticity demand function,  $X_3 = X_0 P_3^{\omega'}$ , where  $X_3$  and  $P_3$  are export quantities and their foreign currency prices respectively.

Third, the supply of savings from the rest of the world is taken to depend positively on the gross interest rate<sup>2</sup> according to the equation:  $W_{ROW} = \omega(r_t - \bar{r})$ . When  $\omega = \infty$ , the interest rate is internationally given and the small country assumption holds for capital markets while if  $\omega' = \infty$  the same is true of the goods market. When  $\omega = 0$ , the autarky case, the interest rate adjusts to give current account equilibrium with constant capital flows between the domestic economy and the rest of the world. The relevance of these different cases depends upon the degree of liberalization of capital flows. The base case value for  $\omega$  reflects the view that interest rates do not react markedly to an increase in the country's overall net indebtedness.

Given these closure assumptions, solution of the model requires finding an equilibrium in five different markets (labor, bonds and the three goods). Choosing the

---

<sup>1</sup>See De Melo and Robinson (1989) for a careful examination of the treatment of the external sector in general equilibrium models.

<sup>2</sup>The correct tax treatment of foreign bondholders is not obvious. For simplicity, we assumed that they found ways of avoiding taxation.



non-traded commodity, good 1, as numeraire, one must determine four prices (wage, interest rate, exchange rate and export prices) in each period.

e. Parameterization of the Model

We chose tax parameters for the base case simulations in accordance with the tax rates faced by French households and firms in 1985.<sup>1</sup> Households' labor supply and savings elasticities,  $\rho$  and  $\alpha$ , were calibrated using the results from a number of microeconomic studies of households behavior. The elasticity of substitution between tradeables and nontradeables,  $\rho_1$ , was chosen on the basis of published estimates of import demand equations. Households' subjective rate of time preference,  $\delta$  was set to 2%. All these parameters were assumed to be identical across households.

The basic time profile of household labor productivity was obtained from a study of wages over the life cycle in France. The two types of household in the model were assumed to have time profiles for productivity equaling the basic profile plus trend components specific to the two types.

The firms in the two domestic production sectors were assumed to have identical production function and adjustment cost parameters. The capital-labor substitution elasticity was selected using a combination of micro and macroeconomic studies and the adjustment cost parameter was fixed at what appears a reasonable value. More details of the selection of household, firm and government parameters may be found in Appendix II. A summary of the levels of the most important parameters is provided in Table 3 below.

Given these parameter values, a calibration program was used to fix the levels of the remaining parameters. The program worked by varying the undetermined parameters until solution of the steady state version of the model yielded income shares and production and consumption levels equaling those observed in 1985.<sup>2</sup>

#### IV. Long Run Results

In this section, we describe the long run implications for the French economy of the tax changes associated with European fiscal harmonization. Table 4 gives the percentage changes in a range of economic variables that follow a cut in VAT from 12.5% to 10% and a halving of the 20% tax on interest income. As argued in a previous section, the resulting short-fall in government revenues is likely to be made up by a rise in labor income taxes

---

<sup>1</sup> Recall that the model is formulated so that one period is equivalent to five years. Given that the tax changes will mostly take effect in the period 1990 to 1995, it seemed reasonable to take 1985 as the base.

<sup>2</sup> Choosing some other adjacent year as base would probably not have affected the results since most of the basic economic magnitudes that affected the parametrization were reasonably stable.

Table 3: Model Parameters

AGENT	PARAMETER	VALUE
Firms	Elasticity of substitution	0.3
	Capital/Labor ratio	0.56
Households	Discount rate	0.02
	Leisure/consumption elasticity	2.2
	Savings elasticity	0.80
	Traded/non-traded elasticity	0.8
Tax Rates	Wage marginal tax rate	0.2
	Interest marginal tax rate	0.2
	Taxation of profits	0.4
	Value added taxes	0.125
	Social security taxes	0.30

and this is what we assume in the majority of our simulations.<sup>1</sup> However, for completeness, we shall also discuss the consequences of financing the harmonization reforms by adjustments in lump sum taxes.

The basic findings of the analysis are the results of simulation (1) reported in the fourth column of Table 4. Household utility falls by the equivalent of around 0.6% of GDP, while the impact on real variables is quite substantial, with output, employment and the capital stock falling by around 3%. In order to analyze these results, it is helpful to consider separately the VAT and savings tax cuts that make up the harmonization package. We shall do this in the next two sub-sections before going on to discuss the sensitivity of the findings to such assumptions as the treatment of the external sector, the presence of borrowing constraints upon households and the assumption of wage tax rather than lump sum financing of the VAT and savings tax cuts.

#### a. The Superiority of VAT Over Wage Taxes

As Table 4 shows, with labor income tax financing, VAT harmonization leads to declines in domestic welfare (see simulation (4)). This result, which is consistent with the findings of Auerbach and Kotlikoff (1987), amounts to saying that consumption taxes distort economic behavior less than wage taxes. An analysis of the household budget constraint sheds some light upon the reasons for this ranking. The budget constraint may be written as follows:

$$\sum_{t=1}^T \sum_{i=1}^3 \pi_t P'_{i,t} C_{i,t} = \sum_{t=1}^T \pi_t W_t (1 - T_{1,t}) (1 - l_t) + Tr$$

<sup>1</sup> What is actually held constant by adjusting labour income taxes in the simulations is the level of the government debt.

where  $Tr$  is the discounted value of transfers and  $T_{1,t}$  represent taxes on labor income,  $P'_{i,t}$  are commodity prices inclusive of consumption taxes, and  $\pi_t$  represents a discount factor. It is clear from this identity that wage and consumption taxes play, broadly speaking, a similar role. The main difference, however, is that consumption taxes reduce the real value of transfers thereby imposing a non-distortionary lump-sum tax. As the discounted value of transfers is positive, one may expect a Pareto deterioration to result from a shift to wage taxation.

As emphasized by Summers (1981), another possible explanation for the decline in welfare is the time pattern of taxes. As the above budget constraint clearly shows, a given household is better off if taxes are levied later in the life cycle. On the other hand, if the population is constant, the amount of revenue collected by the government does not depend upon the period in which a given individual pays the tax. To delay tax collection, shifting the burden onto the old is therefore Pareto improving. As income typically precedes consumption over the life cycle (even though the Rich dissave slightly for the first two periods of their lives), a consumption tax is preferable to a wage tax. This argument obviously has even more force when agents face binding liquidity constraints. Note that another consequence of such timing arguments is that since the major part of transfers is paid as pensions after retirement reductions in interest rates are welfare improving.

One indicator of the degree of tax distortions is the ratio  $(1 - \text{marginal wage tax}) / (1 + \text{VAT rate})$ . This ratio may be thought of as the tax wedge between in the real net wage faced by households and the wage cost faced by firms. Including social security contributions in the calculation of the effective marginal wage tax, this expression equals 0.5 in the base case, falling to 0.46 in simulations (1) and (5) (see Table 4).

The decline in the ratio induces households to switch their consumption from goods to leisure, leading to a drop in the supply of labor. To restore labor market equilibrium, wages rise leading to a reduction in output in both nontradeable and exportable sectors, together with a substitution of capital for labor. The reduction in export supply leads to an increase in foreign prices or, equivalently, to an exchange rate appreciation. This, in turn, induces households to switch consumption from domestic to foreign goods. However, because of a marked drop in imports of investment goods, imports fall overall. The terms of trade improvement or, put differently, the effective transfer from the rest of the world to the home economy, is insufficient to offset the initial welfare loss.

As a final point, one should bear in mind that this model probably underestimate the negative impact of wage taxes. A lack of data regarding the distribution of marginal tax rates prevented us from analyzing the impact of the progressivity of income tax. However, it is well-known that distortions grow more than linearly with tax rates.<sup>1</sup> In the case of France, such nonlinearities could be important given the narrowness of the wage tax base.<sup>2</sup>

<sup>1</sup>Chamley (1981) proves that distortions depend upon the square of marginal tax rates.

<sup>2</sup>The proportion of households paying income tax only slightly exceeds one half.

b. Savings Tax vs. Wage Tax: The Influential Role of Government Debt

An important element in the tax harmonization reforms is the substantial cut in the effective rate of tax on savings. In this subsection, we shall discuss the long run impact of such cuts financed by increasing labor income taxes. As we shall show, the impact of such a policy depends in a complex way upon the relative size of households' intertemporal substitution and labor supply elasticities and upon the initial level of the public debt.

It is often argued that since taxes on interest income amount to levies on future consumption, if the government also imposes a conventional consumption tax, then savings suffer double taxation. Such double taxation, the argument continues, almost certainly represents an excessive burden. However, as Feldstein (1978) argues, the argument, as stated, ignores a crucial point. If taxes on savings are cut, thereby reducing the distortionary wedge between current and future consumption, some other tax must be increased if the government deficit and spending are to remain fixed.

If the increased tax is, say, a wage or a consumption tax, then the effect will in general be to create another distortionary wedge between the prices of consumption and leisure. In some simple cases, one may show that eliminating savings taxes is nevertheless optimal. For instance, if the utility function is of the form:

$U \equiv U( U_1(l_1, \dots, l_T), U_2(C_1, \dots, C_T) )$ , i.e. separable in consumption and leisure, where the sub-function  $U_2(\dots)$  is homothetic in consumption, then Atkinson and Stiglitz (1976) have shown that the optimal savings tax is zero.

In contrast to the above case, however, the utility functions employed in this study imply no simple rules concerning the optimal level of savings taxes. Nevertheless, one may still gain a better understanding of the results through drawing parallels with the usual Ramsey-Boiteux optimal commodity tax analysis. Very roughly, this analysis implies a recommendation to levy relatively high taxes on goods with low demand elasticities.<sup>1</sup> Thus, the finding (see simulation (5) in Table 4) that cuts in savings taxes financed by higher wage taxes lowers welfare may be seen as hinging in part on the assumption of an elasticity of intertemporal substitution that is low in relation to the elasticity of substitution between labor and consumption. In other words, a higher intertemporal elasticity would improve the relative efficiency of wage tax. We shall not report the sensitivity analysis of this point since a similar analysis has already been performed by Auerbach and Kotlikoff. We, like they, find that within an acceptable range of parameter values, saving taxes are preferable to a wage tax.

Instead, we shall focus upon the importance of initial government debt levels in determining the impact upon welfare of switching from savings to wage taxes. In the steady state, positive government debt implies that the government must run a primary budget surplus in order to meet interest payments. We assume in the simulations that the

---

<sup>1</sup>Such a caricatured description of the Ramsey rule ignores the influence of cross elasticities between goods.

value of the debt, i.e. minus the ratio of public surplus to net interest rate, is the same before and after the policy change. Increases in the gross interest rate, or, equivalently in the current instance, cuts in savings taxation, imply that the government must increase the size of its surplus in the new steady state. To do this requires raising either wage or lump sum taxes depending upon the assumptions about financing. These tax increases will leave households worse off.

Given this discussion, it is natural to wonder just how reliable is the assumption regarding the initial debt level and what implications the assumption will have for the welfare changes that follow savings tax cuts. Auerbach and Kotlikoff (1987) simplify their analysis by assuming a zero level of government debt. Since the French public debt is probably not zero,<sup>1</sup> we did not wish to follow their example in the baseline simulation. However, to gauge the importance of this assumption, we did simulate the model for the basic package of VAT and savings tax cuts with labor income tax financing assuming a zero initial level of public debt. The results may be found in the sixth column of Table 4. The analysis shows that with zero public debt, the real impact of the tax changes is to some degree muted (apart from import consumption which grows by more). Utility falls by somewhat less than in the base case which, on the basis of the arguments above, one could interpret as showing that much of the negative impact on utility of the balanced budget savings tax reduction is due to the initial indebtedness of the government and the assumption of unchanged debt level.

### c. The Treatment of the External Sector

To assess the sensitivity of the results to the assumptions about the external sector, we performed a series of simulations in which the elasticities of savings supply and export demand were effectively infinite, or equivalently, foreign prices and interest rates are internationally determined.<sup>2</sup> The results of these simulations are given in Table 5. In almost all cases the different parameterization led to greater welfare losses for domestic households. In the standard case of combined VAT and savings tax cuts financed by higher wage taxes, the decreases in households' lifetime utility were roughly twice as high as in the baseline simulation (1) given in Table 4. for both Rich and Poor.

Two factors may be seen as contributing to this result. First, in fixing the exchange rate,<sup>3</sup> the small country assumption prevents domestic households from partially shifting onto foreigners the welfare losses due to the tax cuts through an improvement in the terms

---

<sup>1</sup> Estimating the 'true' level of government debt is far from easy given the existence of offsetting items on the government's balance sheet such as public corporations and share holdings.

<sup>2</sup> In the baseline simulation, these elasticities were set to 5 and -1 respectively.

<sup>3</sup> Strictly speaking, the real exchange rate is not pegged since changes could in general take place in the relative price of tradeables and nontradeables. However, in the case, such price adjustments do not occur since the production functions in the two sectors are identical. This means that if firms in sector 1 are on their factor price frontiers, so are firms in sector 3. This explains why the exchange rate does not change in the simulations reported in Table 5.

of trade. Second, the small country assumption also implies a fixed gross interest rate determined by the rates available in world capital markets. Lower savings taxes raise the after-tax interest rate leading to a reduction in the present value of households' transfer payments. As already noted, the timing of income and particularly the concentration of transfers in the retirement period means that interest declines are welfare improving. In the baseline case of Table 4, gross interest rates fell partly offsetting this effect, but with the small country assumption fixing the pretax rate, this can no longer happen. Partially offsetting this second effect, as one can see by a comparison of (6) and (8) is the fact that the higher net interest rate implies that the government does not need to run such a large steady state surplus to finance its fixed stock of debt and therefore steady state taxes on households are lower.

Apart from the impact upon welfare, the most interesting aspect of the small country results of Table 5 is the scale of the changes in the real economy that follow the tax cuts. Output, labor supply, the capital stock and consumption fall in the basic simulation (6) by around 5%, with the consumption of leisure rising by approximately 7%. By fixing some prices, the small country assumption reduces the ability of the price system as a whole to equilibrate tax changes and thus leads to quantity responses on this scale.

#### d. Credit Constraints

In Table 6, we report the results of repeating the basic simulations of Table 4 but without imposing credit constraints upon poor households. The results are mainly interesting because of the quite small difference that the change makes. It is interesting to note, although clearly to be expected, that poor households are able to reduce the welfare losses they suffer following the tax changes when borrowing constraints are absent (utility changes for poor households in simulations (11) to (15) are uniformly lower than the utility changes in the corresponding base simulations (1) to (5)). Nevertheless, the magnitude of the differences between the results in Tables 4 and 6 are minor, and the relaxation of borrowing constraints makes no qualitative difference to the welfare impact of the policy changes which remains uniformly negative.

In their study of the relative efficiency of different tax bases in the presence of borrowing constraints, Hubbard and Judd (1987) argue that such constraints may radically affect the welfare impact of altering levels of savings taxation. Clearly, such effects will depend on a number of factors including the degree to which the borrowing constraints actually bite. In this setup, because unconstrained consumption only exceeds income by a slight amount, the reduction in distortion is fairly small.

#### e. Lump Sum Financing of the Reforms

Despite the discussion of Section 2, there might still remain some grounds for

questioning the basic assumption that the package of fiscal harmonization reforms will be financed with higher wage taxes. For example, certain changes in income tax rules (e.g. a general change in tax allowances or a broadening in the tax base) or in expenditures taxes may be better represented as changes in lump-sum taxation. Accordingly, it may be interesting to analyze the results of the reforms under such alternative financing.

In fact, the channels through which the VAT and savings tax cuts affect the economy turn out to be very different under lump sum as opposed to labor income tax financing. As we discussed above, a shift from VAT to wage taxes may be thought of as increasing the degree of distortion in the economy while one would naturally suppose the opposite in the case of a shift to lump-sum transfers. It may therefore seem quite paradoxical that the net effect of cutting VAT and savings taxes financed in a lump sum fashion is still a *reduction in utility*. This result stems, first, from the relaxation of the small country assumption and, second, from the presence of a nonzero government debt.

As one may see in column 4 of Table 4, with lump sum financing, labor supply actually rises. Together with large increases in saving this stimulates the investment and output of domestic industry. With production outpacing domestic consumption, exports increase. To maintain balance of payments equilibrium, the terms of trade must deteriorate. Though household incomes have benefited from the expansion in domestic output, the worsening in the terms of trade is sufficient to lead to an overall decrease in households' welfare.<sup>1</sup>

In the small country case given in Simulation 7 (i.e. with constant terms of trade), the package of tax cuts still involves a reduction in welfare but this time rather more because of the savings tax cut component. Simulations not reported in the paper show that with constant terms of trade, switching from savings taxes to lump sum taxation lowers welfare significantly when government debt is nonzero but has a negligible impact if the stock of debt is small.

---

<sup>1</sup> Interested readers may find a more detailed analysis of this result in Perraudin and Pujol (1990).





Table 5: SMALL COUNTRY RESULTS

Agent	Variable	Base Level	(6) % Chg	(7) % Chg	(8) % Chg	(9) % Chg	(10) % Chg
Household 1	Consumption 1	5.77	-5.0	4.5	-0.7	-2.3	-2.0
	Consumption 2	1.28	-5.0	4.5	-0.7	-2.3	-2.0
	Consumption 3	1.28	-5.0	4.5	-0.7	-2.3	-2.0
	Leisure	3.65	7.1	-1.5	4.3	1.5	5.0
	Savings	10.51	-0.4	8.6	7.4	-4.3	4.8
	Utility†	-49.78	-1.1	0.2	-0.4	-0.3	-0.6
Household 2	Consumption 1	3.23	-6.6	0.7	-2.2	-2.0	-4.0
	Consumption 2	0.72	-6.6	0.7	-2.2	-2.0	-4.0
	Consumption 3	0.72	-6.6	0.7	-2.2	-2.0	-4.0
	Leisure	4.59	6.6	-4.4	4.0	1.7	4.3
	Savings	2.99	3.2	9.3	13.9	-3.9	7.9
	Utility†	-54.65	-0.6	-0.5	-0.3	-0.1	-0.4
Firm 1	Production	12.50	-4.4	2.4	-1.1	-1.7	-2.2
	Capital Stock	7.14	-4.4	2.4	-1.1	-1.7	-2.2
	Employment	8.57	-4.4	2.4	-1.1	-1.7	-2.2
Firm 3	Production	5.00	-5.9	-0.1	-7.4	0.3	-6.0
	Capital Stock	2.86	-5.9	-0.1	-7.4	0.3	-6.0
	Employment	3.43	-5.9	-0.1	-7.4	0.3	-6.0
Government	Tax	3.38	3.2	3.2	-	0.0	3.3
	Surplus	0.88	12.5	12.5	-	0.0	12.5
Aggregate Variables	Consumption 1	9.00	-5.6	3.1	-1.2	-2.2	-2.7
	Consumption 2	2.00	-5.6	3.1	-1.2	-2.2	-2.7
	Consumption 3	2.00	-5.6	3.1	-1.2	-2.2	-2.7
	Labor Supply	12.00	-4.8	1.9	-2.9	-1.1	-3.3
	Capital Stock	10.00	-4.8	1.9	-2.9	-1.1	-3.3
	Exports	2.50	-6.4	-2.9	-13.2	2.6	-9.1
	Trade Balance*	0.00	-0.1	-0.8	-1.6	0.7	-0.9
Prices	Wage (gross)	1.08	0.00	0.00	0.00	0.00	0.00
	CPI	2.44	-2.22	-2.22	-2.22	-2.22	0.00
	Exchange Rate	1.00	0.00	0.00	0.00	0.00	0.00
	Interest Rate**	0.25	0.00	0.00	0.00	0.00	0.00
Memorandum Items							
Item	Variable	Base	(1)	(2)	(3)	(4)	(5)
Rate	Wage Tax	0.20	0.30	0.20	0.26	0.24	0.26

(6) to (10) are identical to (1) to (5) except that the export demand and savings supply elasticities of the rest of the world  $\omega$  and  $\omega'$  are set to infinity.

†Utility changes are Money Metric, i.e. GDP equivalent.

\* As a percentage of GDP.

\*\* Note that a 5% change in the interest rate is equivalent to an annual change of 25 basis points.

Table 6: RESULTS WITH UNRESTRICTED BORROWING

Agent	Variable	Base Level	(1) % Chg	(2) % Chg	(3) % Chg	(4) % Chg	(5) % Chg
Household 1	Consumption 1	5.69	-2.5	3.2	-0.2	-1.7	-0.6
	Consumption 2	1.27	2.0	1.7	2.3	-0.6	2.5
	Consumption 3	1.27	-2.5	3.2	-0.2	-1.7	-0.6
	Leisure	3.60	3.9	-1.9	1.4	1.7	1.9
	Savings	9.65	0.3	6.3	1.2	-2.6	3.2
	Utility†	-46.98	-0.6	0.0	-0.1	-0.3	-0.2
Household 2	Consumption 1	3.31	-2.4	0.9	-0.96	-1.21	-0.7
	Consumption 2	0.74	2.0	-0.5	-0.06	0.48	2.3
	Consumption 3	0.74	-2.4	0.9	-0.96	-1.21	-0.7
	Leisure	4.72	4.1	-4.2	2.04	1.84	1.7
	Savings	3.85	6.6	6.3	0.87	0.14	7.3
	Utility†	-50.91	-0.2	-0.0	-0.09	-0.10	-0.1
Firm 1	Production	12.50	-1.9	1.9	0.0	-1.3	-0.4
	Capital Stock	7.14	-0.9	2.3	1.6	-1.5	0.8
	Employment	8.57	-2.3	1.7	-0.5	-1.2	-0.8
Firm 3	Production	5.00	-3.9	2.1	-1.8	-1.5	-2.1
	Capital Stock	2.86	-2.9	2.5	-0.3	-1.7	-0.8
	Employment	3.43	-4.2	1.9	-2.3	-1.4	-2.6
Government	Tax	3.38	2.2	2.3	0.00	0.5	1.6
	Surplus	0.88	8.5	8.8	-	2.0	6.2
Aggregate Variables	Consumption 1	9.00	-2.5	2.4	-0.1	-1.6	-0.6
	Consumption 2	2.00	2.0	0.9	-3.0	-0.6	2.4
	Consumption 3	2.00	-2.5	2.4	-0.1	-1.6	-0.6
	Labor Supply	12.00	-2.8	1.8	-1.0	-1.3	-1.3
	Capital Stock	10.00	-2.8	2.8	0.1	-1.9	-0.6
	Exports	2.50	-5.5	1.8	-3.7	-1.3	-3.7
	Trade Balance*	0.00	-0.2	-0.2	-0.4	-0.1	-0.3
Prices	Wage (gross)	1.08	1.2	0.5	1.8	-0.3	1.4
	CPI	2.44	-3.1	-2.0	-2.8	-2.4	-0.6
	Exchange Rate	1.00	-5.4	1.8	-3.7	-1.3	-3.7
	Interest Rate**	0.25	-3.6	-3.3	-7.4	2.0	-5.7
Memorandum Items							
Item	Variable	Base	(1)	(2)	(3)	(4)	(5)
Rate	Wage Tax	0.20	0.28	0.20	0.25	0.24	0.24

(6) to (10) are identical to (1) to (5) except that Poor households' borrowing is unrestricted.  
†Utility changes are Money Metric, i.e. GDP equivalent.  
\* As a percentage of GDP.  
\*\* Note that a 5% change in the interest rate is equivalent to an annual change of 25 basis points.

#### f. Sensitivity Analysis

An important question to ask is the sensitivity of the results described above to the value of certain key parameters.<sup>1</sup> In comparing VAT with wage taxes, it is reasonable to expect that elasticities of substitution between leisure and consumption goods will be important. In evaluating savings tax cuts financed by higher wage taxation, one may expect elasticities of intertemporal substitution, of consumption-leisure substitution and of world savings supply to play significant roles. Table 7 shows the percentage changes in GDP and in the lifetime utilities of the two representative steady state households (in terms of percentages of GDP i.e. Money Metric form).

The following observations are suggested by the results in Table 7. First, under all sets of parameter values the VAT cuts and the combined VAT and savings tax cuts lower GDP and the utility of both households. Second, while the declines in GDP vary widely, the magnitudes of the utility changes tend to be more robust. Third, as one might expect, the welfare costs of cutting VAT are increasing in the leisure-consumption elasticity. However, this effect is remarkably small, only affecting the second decimal place of the percentage changes in utility for the baseline levels of the other parameters. Fourth, the welfare costs of VAT cuts are decreasing in the coefficient of intertemporal substitution,  $\alpha$ . The reason for this effect is the asymmetry between the impact of the tax cut upon welfare before and after the date of retirement. Lower VAT clearly improves welfare in the post-retirement period but the policy lowers lifetime utility overall so welfare before retirement is reduced. The magnitude of the coefficient of intertemporal substitution,  $\alpha$ , determines the extent to which the former effect offsets the latter. Fifth, the welfare costs of the combined tax cuts decline quite steeply as  $\alpha$  increases, presumably because of impact on the VAT cuts distortion just referred to and because the reduction in intertemporal distortions thanks to the cut in savings taxation will be all the greater.

---

<sup>1</sup> Feldstein (1978) stresses that the commonly supposed superiority of wage taxes to the taxation of savings may not hold if labor supply elasticities are large and elasticities of intertemporal substitution small.

Table 7: SENSITIVITY ANALYSIS

2.5% Cut in VAT and 10% Cut in Savings Tax with Wage Tax Financing									
$\rho = 2.2$									
	$\alpha = 0.5$			$\alpha = 0.8$			$\alpha = 1.1$		
	$\Delta GDP$	$\Delta U_1$	$\Delta U_2$	$\Delta GDP$	$\Delta U_1$	$\Delta U_2$	$\Delta GDP$	$\Delta U_1$	$\Delta U_2$
$\omega = 5$	-1.8	-0.9	-0.6	-1.1	-0.6	-0.4	-0.8	-0.6	-0.3
$\omega = 15$	-1.7	-0.9	-0.6	-1.1	-0.6	-0.4	-0.8	-0.5	-0.3
$\omega = 30$	-1.7	-1.0	-0.6	-1.1	-0.6	-0.4	-0.8	-0.4	-0.2
$\rho = 1.2$									
	$\alpha = 0.5$			$\alpha = 0.8$			$\alpha = 1.1$		
	$\Delta GDP$	$\Delta U_1$	$\Delta U_2$	$\Delta GDP$	$\Delta U_1$	$\Delta U_2$	$\Delta GDP$	$\Delta U_1$	$\Delta U_2$
$\omega = 5$	-0.9	-0.7	-0.6	-0.5	-0.5	-0.4	-0.3	-0.4	-0.3
$\omega = 15$	-0.8	-0.7	-0.7	-0.5	-0.5	-0.4	-0.3	-0.4	-0.3
$\omega = 30$	-0.8	-0.8	-0.7	-0.5	-0.5	-0.4	-0.4	-0.3	-0.3
2.5% Cut in VAT with Wage Tax Financing									
$\rho = 2.2$									
	$\alpha = 0.5$			$\alpha = 0.8$			$\alpha = 1.1$		
	$\Delta GDP$	$\Delta U_1$	$\Delta U_2$	$\Delta GDP$	$\Delta U_1$	$\Delta U_2$	$\Delta GDP$	$\Delta U_1$	$\Delta U_2$
$\omega = 5$	-0.7	-0.3	-0.2	-0.5	-0.3	-0.1	-0.5	-0.3	-0.1
$\omega = 15$	-0.7	-0.4	-0.2	-0.5	-0.3	-0.2	-0.5	-0.3	-0.1
$\omega = 30$	-0.6	-0.5	-0.2	-0.5	-0.4	-0.2	-0.5	-0.4	-0.2
$\rho = 1.2$									
	$\alpha = 0.5$			$\alpha = 0.8$			$\alpha = 1.1$		
	$\Delta GDP$	$\Delta U_1$	$\Delta U_2$	$\Delta GDP$	$\Delta U_1$	$\Delta U_2$	$\Delta GDP$	$\Delta U_1$	$\Delta U_2$
$\omega = 5$	-0.4	-0.3	-0.2	-0.3	-0.2	-0.2	-0.2	-0.2	-0.1
$\omega = 15$	-0.3	-0.3	-0.2	-0.3	-0.3	-0.2	-0.2	-0.3	-0.1
$\omega = 30$	-0.3	-0.4	-0.3	-0.2	-0.3	-0.2	-0.2	-0.3	-0.2

Note:  $\omega \equiv$  interest derivative of world savings supply,  
 $\rho \equiv$  elasticity of substitution between leisure and consumption,  
 $\alpha \equiv$  elasticity of intertemporal substitution.  
All changes are in percentage terms while utility changes are expressed in units of GDP (i.e. Money Metric).

## V. Short Run Results

This section describes the transition path behavior of the economy following cuts in VAT and savings taxes financed by higher wage income taxes. Three important points emerge from these simulations. First, even when one takes account of the welfare of generations alive when the policy is implemented, the package of tax cuts is undesirable, i.e represents a potential Pareto reduction in welfare. Second, the simulations show that the dynamics of the model are influenced primarily by the fact that the existing wealth of households reflects past savings decisions made under the previous tax system. Third, prior announcement of the tax cuts elicits a very different dynamic response from the economy than that obtained if the policy is implemented immediately.

### a. Welfare Effects

The charts given below show the lifetime utilities of the ten cohorts alive when taxes are cut and of the first eighteen cohorts households born thereafter. Each chart shows three simulations, a base case simulation without input adjustment costs for firms, a simulation which assumes adjustment cost parameters of 5%, and a simulation in which an announcement is made in the first period that the policy will be implemented in the second.

Since the utility levels from the original steady state were -49.78 for the Rich and -54.65 for the Poor, one may see that one cohort of poor households and six cohorts of rich are marginally better off following the policy. The reason is intuitively obvious. Switching from VAT to wage taxation benefits households which have built up a stock of savings out of earlier wage income. Given the minor nature of these utility gains, it is clear<sup>1</sup> that transferring resources from gainers to losers in such a way as to stabilise the lifetime utilities of the former at their previous steady state levels will leave some worse off and none better off than before the tax cuts took place. The policy, therefore, constitutes a potential Pareto reduction in welfare.

### b. The Source of the Dynamics

The second point to emerge from the simulations is that, given our parametrization, firms' costs of adjusting inputs play a small role in determining the dynamics. The adjustment cost parameters in the model were set at 5 %. Though it is difficult to see *a priori* what value one should choose, this value seemed reasonable. As one may see from the charts for output and labor supply, the differences between the base simulation and the one with adjustment costs are quite minor. Instead, the major source of dynamics in the model is the fact that when policies are implemented, households currently alive

---

<sup>1</sup> And may easily be shown numerically.

possess stocks of savings that reflect decisions made under the relative prices of the old steady state. The charts for output, for example, show that it takes approximately eighty years for prices and stocks to adjust to such a point that the economy is close to its new steady state, though the bulk of the adjustment is achieved within forty years.

c. Announcement Effects

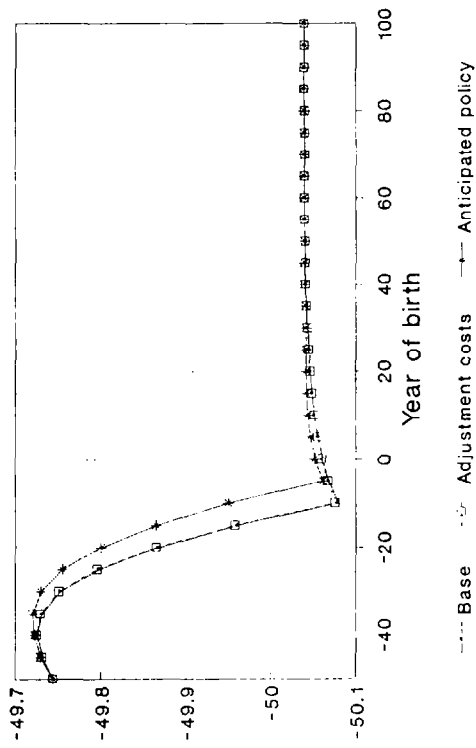
The third point to note is that the announcement of policies in advance of their implementation leads to very different short term results. As one may see from the charts, prior announcement of the policy means that all households experience lower lifetime utility than in the initial steady state. Thus, the tax cuts represent a Pareto worsening rather than just a potential Pareto welfare reduction. Turning to the impact on real demand and supply in the economy, prior announcement of the policy leads to a 1 1/2 % increase in labor supply in the first period in contrast to the 3 1/2 % fall observed in the base case with instantaneous implementation. When the tax cuts are actually carried out in the second period, labor supply falls precipitately by around 5 %.

One would expect, from a preannounced reform, an increase in labor supply and a reduction in consumption reflecting households' expectations about lower net wages and after-tax prices. This intertemporal substitution does take place on the labor side but does not happen for consumption because of price changes which offset the impact of the tax reform. Output by domestic firms is boosted by the temporarily higher labor supply, and consumption spending, while lower than in the initial steady state, falls by much less than it does in the first period of the base case simulation. Prices in the economy react to these real shocks in the following way. The temporary escalation in labor resources boosts potential output leading to an exchange rate depreciation so as to induce foreigners to absorb the increased net supply of good 3 from the domestic economy. Thus, households substitute domestic consumption for imports (substitution effect), while reducing overall consumption (income effect). The interest rate falls sharply because of the extra savings by households out of their transitorily higher real income. It may seem paradoxical, given this interpretation of the results, that the wage rate in the simulation with prior announcement rises slightly in the first period. The reduction in interest rates and hence in the user cost of capital allows firms to pay higher wages while remaining on the 'factor price frontier'. This, in turn, reinforces the incentive for households to supply labor.

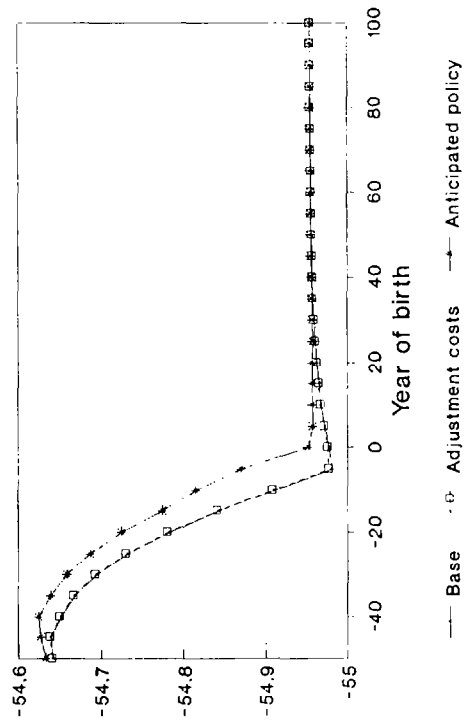
VI. Conclusions

In this paper, we have used simulation models to analyze the package of measures that France will have to adopt in order to bring her VAT and savings taxes into line with those of her European Community neighbors. According to our calculations, these measures could entail significant long run welfare losses for French households. Tax

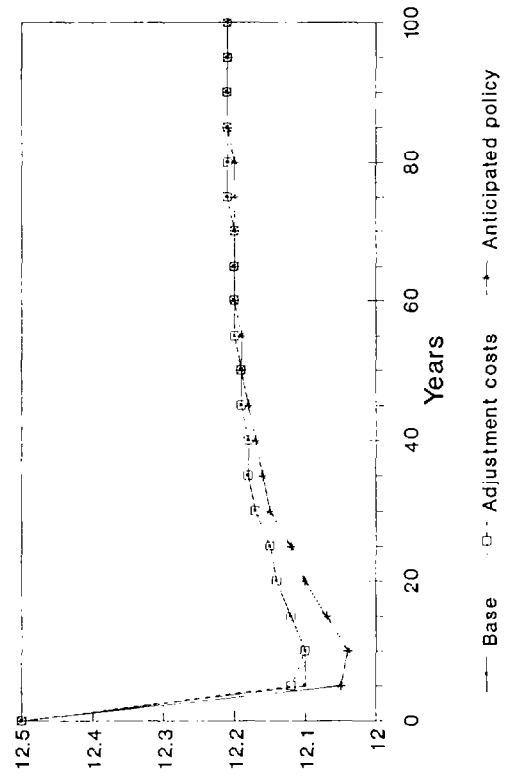
### Utility: Household 1



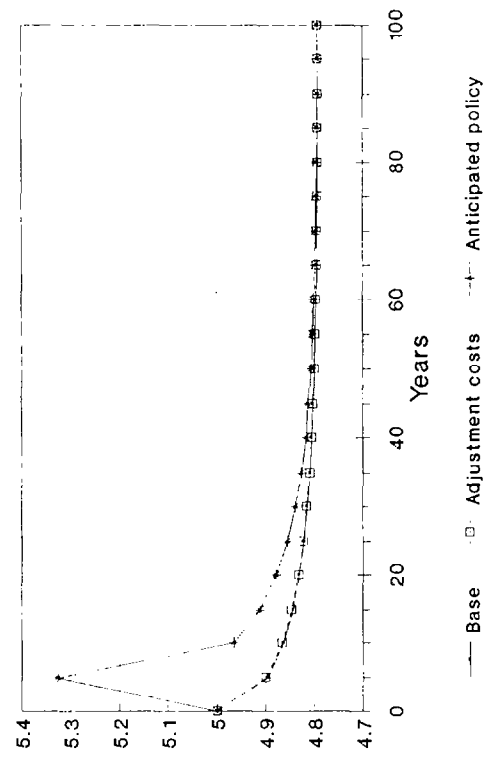
### Utility: Household 2



### Output Firm 1



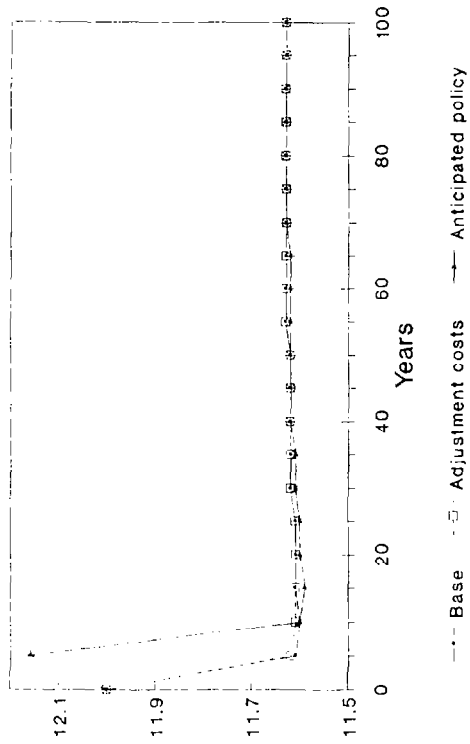
### Output Firm 3



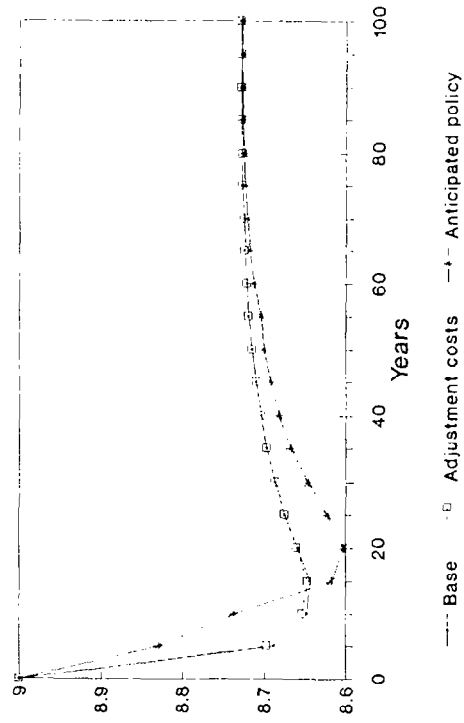




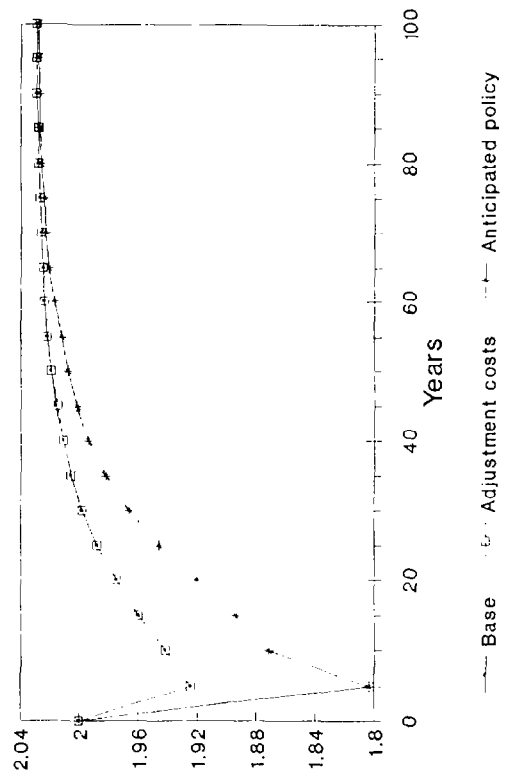
## Labor Supply



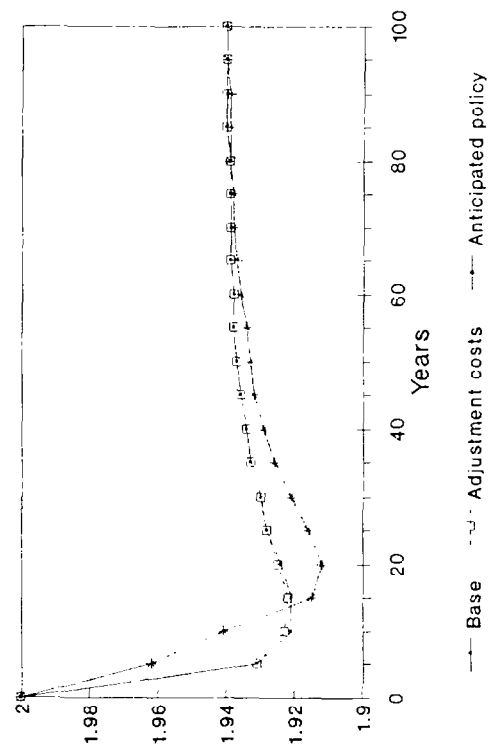
## Consumption - Good 1



## Consumption - Good 2

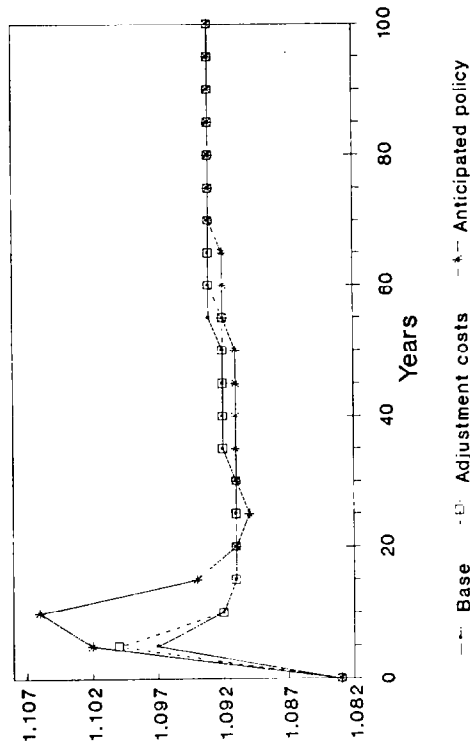


## Consumption - Good 3

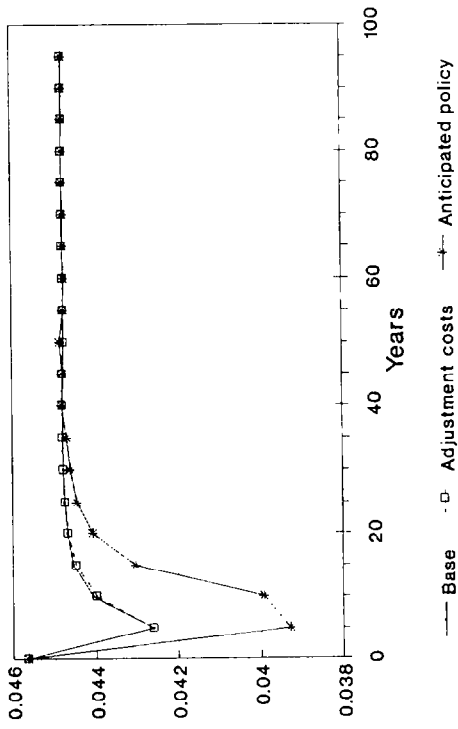




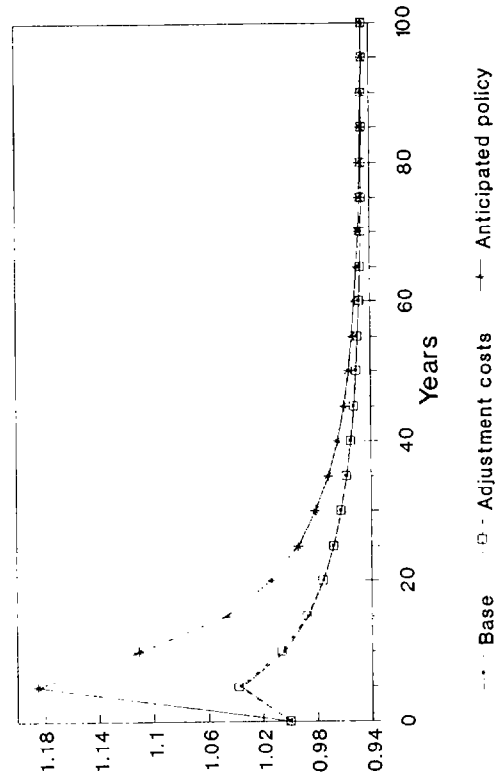
Wage rate



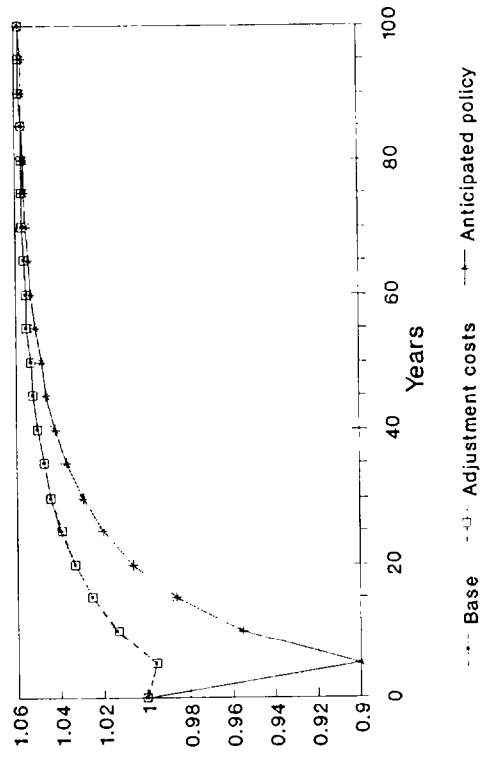
Interest rate



Exchange rate



Export price





harmonization may still remain a worthwhile objective for the EC since, for example, it will permit the virtual removal of frontier controls. However, the results suggest that current proposals that involve EC members all adjusting their different VAT rates towards some over all average rate may be seriously misguided.

Instead, it may well be preferable for countries which currently impose relatively heavy direct taxes to use the harmonization as an opportunity to shift their tax systems towards greater reliance upon indirect taxes. Countries like France, on the other hand could then maintain their VAT tax rates at reasonably close to current levels.

An important topic for future research in this area is study of the impact of harmonization on other countries in the European Community. If the gains from harmonization for these other countries were sufficiently pronounced, then the currently-envisaged policy of averaging existing VAT rates might still be desirable provided that transfer payments could be arranged to compensate losers. A systematic examination of this issue could be performed within a multicountry version of the model described in the present paper.

As a final point, one should note that the conclusions of this study are not sensitive to whether or not it turns out that VAT tax cuts can be financed out of higher than expected revenues due to, say, fiscal drag. Firstly, such fiscal drag may involve agents moving into higher wage income tax bands due to increases in the real value of their earnings, which from an economic point of view is somewhat similar to a rise in wage income tax rates. Secondly, the most important message of the study concerns differences in tax rates rather than levels. In other words, if revenues grow due to an unforeseen shock, the study suggests that the extra budgetary room for manoeuvre should be used to lower wage income taxes rather than VAT.

### Model Description

This Appendix provides a derivation of the principal behavioural equations of the model. As mentioned in the text, agents are assumed to possess utility functions of the form:

$$\begin{aligned}
 U &\equiv \frac{1}{(1 - \frac{1}{\alpha})} \sum_{t=1}^T \frac{1}{(1 + \delta)^{t+1}} u_t^{1 - \frac{1}{\alpha}} \\
 u_t &= \left[ C_t^{1 - \frac{1}{\rho}} + \alpha_0 l_t^{1 - \frac{1}{\rho}} \right]^{\frac{1}{1 - \frac{1}{\rho}}} \\
 C_t &= \left[ \alpha_1 C_{1,t}^{1 - \frac{1}{\rho_1}} + (1 - \alpha_1) C_{T,t}^{1 - \frac{1}{\rho_1}} \right]^{\frac{1}{(1 - \frac{1}{\rho_1})}} \\
 C_{T,t} &= \left[ \alpha_2 C_{2,t}^{1 - \frac{1}{\rho_2}} + (1 - \alpha_2) C_{3,t}^{1 - \frac{1}{\rho_2}} \right]^{\frac{1}{(1 - \frac{1}{\rho_2})}}
 \end{aligned}$$

where  $C_{i,t}$  ( $i = 1, 2, 3$ ) represents the consumption of the three goods in period  $t$ . Households face budget constraints given by:

$$\begin{aligned}
 W_t &= W_{t-1}(1 + r_t) - \sum_{i=1}^2 P_{i,t} C_{i,t} + I_t - T(w_t(1 - l_t), r_t W_{t-1}) \\
 I_t &\equiv w_t(1 - l_t) + r_t W_{t-1}
 \end{aligned}$$

where  $T(.,.)$  is a differentiable function giving the level of taxes. We also assume that leisure is constrained to equal unity in the last two periods of the household's life and that the household cannot borrow against its anticipated future labor income:<sup>1</sup>

$$l_t = 1 \quad t = 9, 10 \quad W_t \geq 0 \quad t = 1, 2, \dots, 10$$

Since there are no bequests,  $W_0 = 0$ . The Lagrange multipliers associated with the budget, retirement and liquidity constraints are:  $\Omega_t$ ,  $\mu_t$  and  $\nu_t$  respectively. The household's first order conditions may be rearranged to give:

$$\frac{1}{(1 + \delta)^{t+1}} u_t^{\frac{1}{\rho} - \frac{1}{\alpha}} C_t^{-\frac{1}{\rho}} = \Omega_t P_t (1 + t_t)$$

---

<sup>1</sup>In the model simulations, we assume that only poor households face such liquidity constraints. The utility maximization problem of Rich households is the same as that described here except that the Lagrange multipliers for the borrowing constraints are identically zero.

$$\begin{aligned} \frac{1}{(1+\delta)^{t+1}} u_t^{\frac{1}{\rho}-\frac{1}{\sigma}} \alpha_0 l_t^{-\frac{1}{\rho}} &= \Omega_t (w_t(1-T_{1,t}) + \mu_t) \\ \Omega_{t+1} &= \frac{(\Omega_t + \nu_t)}{(1+r_{t+1}(1-T_{2,t+1}))} \\ \frac{P_{1,t}(1+t_{1,t})}{P_{2,t}(1+t_{2,t})} &= \frac{\alpha_1}{1-\alpha_1} \left( \frac{C_{1,t}}{C_{2,t}} \right)^{-\frac{1}{\rho_1}} \end{aligned}$$

where  $T_{i,t}$  denotes the partial derivative of function  $T$  with respect to the  $i$ th variable in period  $t$ , and where the tax-inclusive price index,  $P_t(1+t_t)$ , is defined as:

$$\begin{aligned} P_t(1+t_t) &\equiv \left[ \alpha_1^{\rho_1} (P_{1,t}(1+t_{1,t}))^{1-\rho_1} + (1-\alpha_1)^{\rho_1} (P_{T,t}(1+t_{T,t}))^{1-\rho_1} \right]^{\frac{1}{(1-\rho_1)}} \\ P_{T,t}(1+t_{T,t}) &\equiv \left[ \alpha_2^{\rho_2} (P_{2,t}(1+t_{2,t}))^{1-\rho_2} + (1-\alpha_2)^{\rho_2} (P_{3,t}(1+t_{3,t}))^{1-\rho_2} \right]^{\frac{1}{(1-\rho_2)}} \end{aligned}$$

In formulating the model, the following properties of CES utility functions proves useful:<sup>1</sup>

$$\begin{aligned} P_t(1+t_t)C_t &= P_{1,t}(1+t_{1,t})C_{1,t} + P_{T,t}(1+t_{T,t})C_{T,t} \\ P_{T,t}(1+t_{T,t})C_{T,t} &= P_{2,t}(1+t_{2,t})C_{2,t} + P_{3,t}(1+t_{3,t})C_{3,t} \end{aligned}$$

Note that it is not possible to solve the above system analytically because the shadow wage or Lagrange multiplier to the retirement constraint is not known.

The economy we examine has two production sectors producing goods 2 and 3 using capital and labor inputs. Each industry consists of identical firms with C.E.S. production functions of the form:

$$F_t(K_t, L_t) \equiv \epsilon_1 \left[ \epsilon_0 K_t^{1-\frac{1}{\epsilon}} + (1-\epsilon_0) L_t^{1-\frac{1}{\epsilon}} \right]^{\frac{1}{(1-\frac{1}{\epsilon})}}$$

Firms face convex costs of adjusting their inputs:

$$\begin{aligned} CK(I_t, K_{t-1}) &\equiv \frac{b(I_t - dK_{t-1})^2}{K_{t-1}} \\ CL(L_t, L_{t-1}) &\equiv \frac{a(L_t - L_{t-1})^2}{L_{t-1}} \end{aligned}$$

---

<sup>1</sup> See Dixit and Stiglitz (1977).

Each firm has a rate of capital depreciation  $d$  which is assumed to be constant over time. Given these assumptions, the long run equilibrium will be independent of the adjustment costs.

Though French firms face many different taxes, the most important are the profits tax (whose rate we denote  $\tau_t$ ) and social security contributions (with rate  $tx_t$ ). We assume that social security contributions are paid exclusively by employers. So long as household behavior depends only on after-tax wages, this involves no loss of generality.

We further assume that the fiscal depreciation rate  $d'$  is equal to the rate of economic depreciation  $d$ . Although the actual fiscal rate almost certainly exceeds the economic rate, one may reasonably argue that the benefits to firms are counterbalanced by the fact that the calculation of depreciation allowances is based on nominal values. If  $r'_t$  represents the discount rate for the firm,<sup>1</sup> then, for each dollar of investment, the discounted value of the tax deduction implied by the depreciation allowance equals:<sup>2</sup>

$$Z_t = \tau d \sum_{s=0}^{\infty} \frac{(1-d)^s}{\pi'_t} \quad \text{where} \quad \pi'_t = \prod_{j=0}^t (1+r'_j)$$

Since interest costs paid by firms are tax deductible, the Miller-Modigliani theorem does not hold and it is necessary to specify the financial behavior of the firm. Assume that, at the margin, the percentage of investment financed by debt is  $\theta$  and the interest rate on this debt is  $r'_t$ . The expression for  $Z_t$  should then be modified by multiplying by  $\frac{(d+\theta r'_t)}{d}$ . The firm's profit maximization may then be stated as:

$$\max \sum_{t=0}^{\infty} \pi_t ((1-\tau)(p_t Y_t - w_t(1+tx_t)L_t) - q_t(1-Z_t)I_t)$$

subject to  $K_t = (1-d)K_{t-1} + I_t$ , where  $q_t$  is the price of capital goods. Accordingly, we obtain the first order conditions :

$$\begin{aligned} p_t F'_K &= -\frac{b}{2} p_t \left[ \left( \frac{K_{t+1}}{K_t} \right)^2 - 1 \right] + (1+r_t) b p_{t-1} \left[ \frac{K_t}{K_{t-1}} - 1 \right] + uc_t \\ p_t F'_L &= w_t(1+tx_t) + (1+r_t) a p_t \left[ \frac{L_t}{L_{t-1}} - 1 \right] - \frac{a}{2} p_t \left[ \frac{L_{t+1}^2}{L_t^2} - 1 \right] \end{aligned}$$

The implicit user cost of capital is:

<sup>1</sup>This will not, in general, equal that of households.

<sup>2</sup>In this calculation, we implicitly ignore the potential nonlinearity resulting from different tax treatment of negative profits.



$$uc_t = \frac{1}{(1-\tau)} \left( q_t(1-\tau Z_t)(1+r_t) - q_{t+1}(1-\tau Z_{t+1})(1-d)\frac{\pi_t}{\pi_{t+1}} \right)$$

It follows that in a steady state  $uc_t = \frac{q(1-\tau Z)(r+d)}{(1-\tau)}$  with the two polar cases:  $uc_t = q(r+d)$  if  $\theta = 1$ , and  $uc_t = q\frac{(r'+d)}{(1-\tau)}$ , if  $\theta = 0$ . Only if  $\theta = 1$  will firms' incentives to invest be unaffected by taxation. In the simulations reported in the text, we will assume that marginal investment is debt financed and hence profit taxes are non-distortionary. We assume that profits are paid to the Government, which therefore becomes the implicit owner of the firm. This assumption removes the need to include a market in equities and, as we show below, does not necessarily affect households' budget constraints. Moreover in the long run, returns to scale are constant so that profits equal zero.

### Choice of Parameters

#### 1. Households

This appendix summarizes the results of empirical studies of the French economy which justify the choice of parameters values. Uncertainty over the values of some key parameters means that sensitivity analysis plays an important role.

For households, the main parameters required are the coefficients of the utility function and the distribution of wages. Intertemporal elasticity of substitution  $\alpha$  and the discount rate  $d$ . Empirical evidence concerning the value of the former parameter for the French economy is scanty (see Charpin (1989) for a discussion). In our baseline simulations, we set  $\alpha$  equal to 0.8. Given this parameter, the rate of time preference  $\delta$  is obtained by a calibration procedure which inverts the households' program so as to yield the consumption levels observed in 1985. The baseline value for  $\delta$  is 2.0% a year.

Now consider the elasticity of substitution between total consumption and leisure,  $\rho$ . Recent econometric studies have found that labor supply by women is highly responsive to wages, husbands' income and demographic variables. By contrast, labor supply by men appears to be largely independent of most economic variables. Following Dagsvik et al. (1988), we summarize the main results concerning women's labor supply in Table 3.

Table 8: PARTICIPATION ELASTICITIES OF MARRIED WOMEN

Elasticity w.r.t.	Dagsvik et al(1988)	Blundell Laisney (1988)	Riboud (1985)	Bourguignon (1986)
Own Wage	1.41	1.68	1.15	1.0
Husband's Income*	-0.3	-0.59	-0.29	-0.35
* Some of these studies do not take into account taxes and benefits.				

The studies cited all estimated labor supply elasticity within a narrow range. Since in the model, a household represents a couple, these estimates are broadly consistent with a global wage elasticity of 0.4. In the baseline simulations, we therefore set  $\rho = 2.2$ . Note that the narrow range of the above estimates does not imply that this parameter is known with accuracy. Among other problems, the studies listed above throw no light on the dynamic behavior of households since they are based on cross-sectional data.

Studies of import equations provide information about elasticity of substitution between tradeables and nontradeables,  $\rho_1$ . The price elasticities they typically estimate are less than 1. Although it is often argued that equations of this sort overestimate long run revenue elasticities and underestimate the impact of prices, we set  $\rho_1 = 0.8$ .

A strength of the model is that it captures some of the more obvious features of actual labor markets. By introducing two kinds of household and letting their productivities vary over time, we allow for the fact that household earnings vary according to age and initial human capital endowment.

A 1988 survey of private sector salaries, shows that wages and wage changes differ sharply across occupations and age-groups. Factors such as seniority and promotion have lead to an increase in the average wage of 2% a year over the last decade. This increase has generally been higher among the young and the lower income wage earners.

Table 9: THE HIERARCHY AND EVOLUTION OF WAGES

	AVERAGE WAGE INDEX	% OF LABOR FORCE	AVERAGE ANNUAL INCREASE
SENIOR EXECUTIVES	240	7.4	1.0
EXECUTIVES	128	15.0	2.4
SKILLED WORKERS	90	27.9	1.5
SUBTOTAL	123	50.3	1.6
CLERKS	83	21.9	3.0
UNSKILLED WORKERS	68	20.8	2.3
OTHERS	76	7.0	3.2
SUBTOTAL	76	49.7	2.8
TOTAL	100	100	2.0

AGE	17-25	26-33	34-41	42-49	50-57	58-65
WAGE INCREASE	4.5	3.1	1.9	1.0	0.4	1.1
Source : J.-Y. FOURNIER (1988)						

The U-shaped curve of wage increases during an individual's working life reflects peculiarities of French pension schemes. In France, wages in the last five or ten years of work are crucial in determining retirement benefits. In consequence, firms have tended to bestow additional wage increases and fringe benefits upon workers close to retirement.

In the model, cohort 1 represents unskilled workers and cohort 2 higher wage-earners. The labor force is more or less equally divided between the two groups. Cohort 1 is assumed to face liquidity constraint. Clearly, the more their wages increase over the life cycle, the more likely it is that the liquidity constraint will be binding.

## 2. The Government

The level of transfers is automatically adjusted so that the state is a net debtor. Its debt represents one fourth of the value of the private capital stock. This determines the level of net transfers but without any precision about the timing<sup>1</sup> and the distribution among cohorts of the transfers. According to the Social Security accounts, more than 40% of the transfers are dedicated to retirement schemes (see Insée (1987)). Consequently, it is assumed that one half of all transfers are received by retired people and that retirement payments are indexed to wages.

The conflicting objectives of the French tax-benefit system make its redistributive properties somewhat confusing. The dependence of tax rates on family size (through the so-called 'quotient familial') benefits wealthier households and lessens the progressivity of marginal tax rates. Moreover, social security contributions are small for those with high incomes because of the system of ceilings. Consequently, we assume that marginal tax rates do not differ for Rich and Poor.

## 3. Firms

During the last decade, estimation of production functions at a macroeconomic level has produced more puzzles than firm results. The main findings may be summarized as follows. The elasticity of substitution between capital and labor appears to be very weak (less than 0.1), although highly sensitive to assumptions about the production function (particularly its flexibility and the number of inputs). The speed with which inputs adjust to desired levels is extremely low. This result suggests that the costs of adjustment must be very high, which one might explain at least in the case of labor by institutional constraints on hiring and firing.

However, recent microeconomic studies have provided a different view of the French productive sector. For instance, a study by Dormont (1983) using panel data estimated price elasticities to be much higher. The discrepancy could stem from the accuracy of data which tends to be bad for inputs (capital and labor) at a macro level and for prices at a micro level.

Consequently, we take the base case value of the elasticity of substitution to be 0.3, a figure which is intermediate between typical macro and micro estimates. For the dynamic simulations, adjustment costs will be taken to equal 0.1, a value which is rather high given that each period represents five years. The calibration program computes values for the other parameters in such a way that the share of capital in each sector equals 23 %. The production parameters are assumed to be the same in both sectors.

---

<sup>1</sup>This issue appears because of the discrepancy between the discount rate for government and households and the introduction of a liquidity constraint.

### The Solution of the Model

Several approaches to solving static non-linear general equilibrium models have been discussed in the literature. These include, first, the Scarf algorithm either in its original form or in one of the more recent improved versions. This algorithm is convergent but numerically inefficient according to Dervis et al. (1982). Second, standard numerical methods for solving non-linear systems, such as Gauss-Seidel, Gradient or optimization approaches have been applied.<sup>1</sup> Third, as advocated by Dervis et al. (1982), one may adopt techniques that exploit the structure of the particular model concerned.

The solution of multiperiod models presents additional difficulties since the number of variables for which it is necessary to solve is effectively multiplied by the number of periods. The approach that is generally adopted consists of, firstly, solving for the initial steady state, secondly, computing the final steady state after policy changes, and, lastly, solving the transition path between the two steady states. If one assumes perfect foresight and rational expectations on the part of agents, it will not in general be possible to solve the model recursively over the transition path since current behavior will depend on variables in future periods, which depend in turn upon lagged variables (for instance, capital accumulation). Techniques to deal with this problem have been discussed by Fair and Taylor (1983) (the Fair-Taylor algorithm), by Lipton et al. (1982) (Multiple Shooting Methods), and by Spencer (1985), (Optimization Techniques).

For an application such as ours, the main difficulty is the combination of a nonrecursive dynamic structure and the nonlinear implicit form of many of the equations in the model. In particular, solving the household program with liquidity constraints is computationally costly. For this reason, it seems to be more efficient to solve for the transition path of the model directly rather than attempting to use the model's dynamic structure as suggested by, for example Fair (1984) and Laitner (1984).

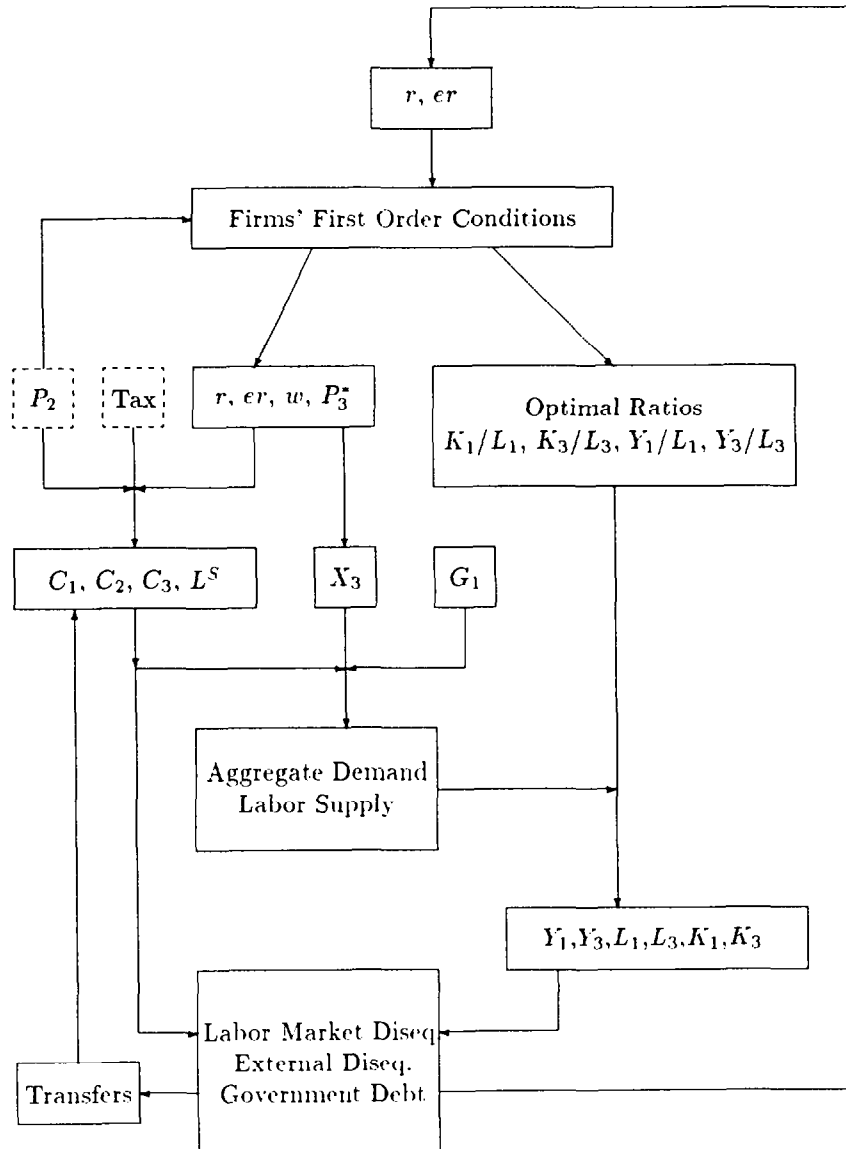
Figure 1 shows the algorithm for the steady state solution of the model. Since prices are constant in the steady state, we only need to find the level of wages, the exchange rate, export prices and the interest rate. Beginning with a guess for the interest rate, exchange rate and the level of transfers to households, the optimality conditions of firms are used to establish both relative prices (via the factor price frontier) and the ratios of capital stocks and output to labor demands. Given relative prices, we solve the intertemporal optimization problem of households including retirement and liquidity constraints and then aggregate to obtain the aggregate levels of consumption and labor supply. Together with export demand (given by the exchange rate) and the exogenously determined level of government spending, we then have total goods demands and labor supply. Combining these with the capital stock and output ratios mentioned previously yields total output and labor demand in the two domestic industries. Given the total demands for domestic goods, we are then able to calculate the disequilibria in the labor market and the balance

---

<sup>1</sup>For more discussion and a comparison with the other methods mentioned here, see Harris (1988).

of payments and the degree to which government debt diverges from the initially assumed level. Using a Newton procedure, we then perturb the interest rate, exchange rate and the level of transfers to households in order to reduce these three discrepancies.

Figure 1: STEADY STATE ALGORITHM







References

- Atkinson, A.B. and J.E. Stiglitz (1976) - "The Design of Tax Structure: Direct Versus Indirect Taxation," *Journal of Public Economics*, 6, 55-75.
- Auerbach, A.J. - "Taxation, Corporate Financial Policy and the Cost of Capital," *Journal of Economic Literature*, 21, (1983), 905-940.
- and L.J. Kotlikoff - *Dynamic Fiscal Policy*, Cambridge: Cambridge University Press, 1987
- Blundell, R. and F. Laisney - "A Labour Supply Model for Married Women in France: Taxation, Hours Constraints and Job Seekers," *Annales d'Économie et de Statistique*, 11, (1988), 41-72.
- Boiteux, M. - *Fiscalité et Marché Unique Européen*, Rapport d'Etape de la Commission présidée par M. Boiteux, Paris: Documentation Française, 1988.
- Boskin, M.J. - "Taxation, Saving, and the Rate of Interest," *Journal of Political Economy*, 86, (1978), S3-S27.
- Bourguignon, F. - "Female Participation and Taxation in France," in R. Blundell and I. Walker (eds.), *Unemployment, Search and Labour Supply*, Cambridge: Cambridge University Press, (1986), 243-266.
- Cecchini, P. - *The European Challenge 1992: The Benefits of a Single Market*, Brookfield, Vermont: Gower, 1988.
- Chamley, C. - "The Welfare Cost of Capital Income Taxation in a Growing Economy," *Journal of Political Economy*, 89, (1981), 468-496.
- Charpin, F. - "Les Contraintes de Liquidité dans la Théorie du Cycle de Vie," *Annales d'Economie et de Statistique*, 14, (1989), 65-102.
- Dagsvik, J.K., F. Laisney, S. Strom and J. Ostervold - "Female Labor Supply and the Tax Benefit System in France," *Annales d'Économie et de Statistique*, 11, (1988), 5-40.
- De Melo, J. and S. Robinson - "Product Differentiation and the Treatment of Foreign Trade in Computable General Equilibrium Models of Small Economies," *Journal of International Economics*, 27, (1989), 47-67.
- Dervis, K., J. De Melo and S. Robinson - *General Equilibrium Models for Development Policy*, Cambridge: Cambridge University Press, 1982.
- Dixit, A.V. - "Tax Policy in Open Economies," in A.J. Auerbach and M. Feldstein (eds.), *Handbook of Public Economics*, Amsterdam: North Holland, 1985.
- Dixit, A.V., and J.E. Stiglitz - "Monopolistic Competition and Optimum Product Diversity," *American Economic Review*, 67, (1977), 297-308.
- Dormont, B. - "Substitution et Coût des Facteurs: Une Approche en Terme de Modèles à Erreurs sur les Variables," *Annales de l'Insee*, 50, (1983), 73-91.
- Fair, R.C. and J.B. Taylor - "Solution and Maximum Likelihood Estimation of Dynamic Nonlinear Rational Expectations Models," *Econometrica*, 51, (1983), 1169-1196.
- Fair, R.C. - *Specification, Estimation and Analysis of Macroeconomic Models*, Cambridge, Mass.: Harvard University Press, 1984.

- Feldstein, M. - "The Welfare Cost of Capital Income Taxation," *Journal of Political Economy*, 86, (1978), S29-S51.
- Fisher, I. - "Income in Theory and Income Taxation in Practice," *Econometrica*, 5, (1937), 1-55.
- Fournier, J.-Y. - "Les Salaires dans le Secteur Privé de 1968 à 1982," *Économie et Statistique*, 210, (1988), 33-60.
- Frenkel, J.A. and A. Razin - *Fiscal Policies and the World Economy*, Cambridge, Mass.: M.I.T. Press, 1987.
- Frenkel, J.A., A. Razin, and S. Symansky - "International Spillovers of Taxation," Unpublished mimeo, May, 1989.
- Hall, R.E. and F.S. Mishkin - "The Sensitivity of Consumption to Transitory Income: Estimates from Panel Data on Households," *Econometrica*, 50, 461-481.
- Harris, R.G. - "Alternative Solution Methods in Applied General Equilibrium Analysis," O.E.C.D. Working Paper No. 53, 1988.
- Hayashi, F. - "The Permanent Income Hypothesis: Estimation and Testing by Instrumental Variables," *Journal of Political Economy*, 90, 895-918.
- Hubbard, R.G., and K.L. Judd - "Liquidity Constraints, Fiscal Policy and Consumption," *Brookings Papers on Economic Activity*, (1986), 1-59.
- Insee - *Données Sociales 1987*, Paris, 1987.
- Kaldor, N. - *An Expenditure Tax*, London: Allen and Unwin, 1957.
- Keen, M. (1987) - "The Welfare Effects of Commodity Tax Harmonization," *Journal of Public Economics*, 33, 107-114.
- Laitner, J. - "Transition Time Paths for Overlapping-Generations Models," *Journal of Economic Dynamics and Control*, 7, (1984), 111-129.
- Lebegue, D. - *La Fiscalité de l'Épargne dans le Cadre du Marché Intérieur Européen*, Rapport du Conseil National du Crédit, Paris: Direction des Journaux Officiels, 1988.
- Lipton, D., J. Poterba, J. Sachs, and L.H. Summers - "Multiple Shooting in Rational Expectations Models," *Econometrica*, 50, (1982), 1329-1333.
- Meade Committee - *The Structure and Reform of Direct Taxation*, Institute for Fiscal Studies, London: Allen and Unwin, 1978.
- O.E.C.D. - *Revenue Statistics of O.E.C.D. Member Countries, 1965-1986*, Paris: O.E.C.D., 1987.
- Pechman, J. - "The Future of the Income Tax," *American Economic Review*, 80, (1990), 1-21.
- Perraudin, W.R.M. and T. Pujol - "Tax Policy and the Terms of Trade," I.M.F. mimeo, 1990.
- Riboud, M. - "An Analysis of Women's Labor Force Participation in France: Cross-Section Estimates and Time Series Evidence," *Journal of Labor Economics*, 3, (1985), 177-200.
- Spencer, P.D. - "Bounded Shooting: A Method for Solving Large Nonlinear Econometric Models

Under the Assumption of Consistent Expectations," *Oxford Bulletin of Economics and Statistics*, 47, (1985), 79-82.

Summers, L.H. - "Capital Taxation and Accumulation in a Life Cycle Growth Model," *American Economic Review*, 71, 1981, 533-544.

Zeldes, S. - "Optimal Consumption with Stochastic Income: Deviations from Certainty Equivalence," *Quarterly Journal of Economics*, 114, (1989), 275-299.

