Effectiveness versus reliability of policy actions under government budget constraint: the case of France

Bianchi, Carlo and Brillet, Jean-Louis and Calzolari, Giorgio

Centro Scientifico IBM, Pisa, INSEE, Paris, Service des Programmes

17 August 1985

EFFECTIVENESS VERSUS RELIABILITY OF POLICY ACTIONS UNDER GOVERNMENT BUDGET CONSTRAINT: THE CASE OF FRANCE[1]

by Carlo BIANCHI[2], Jean-Louis BRILLET[3]
and Giorgio CALZOLARI[2]

[1] This paper is still preliminary, and should not to be cited without permission. The underlying research has been carried out in partial fulfillment of a joint research project between INSEE and the IBM Scientific Center of Pisa. Comments are welcome.

[2] Centro Scientifico IBM, via S.Maria 67, 56100 Pisa (Italy), tel. 47383.

[3] Service des Programmes, I.N.S.E.E., 18 Boulevard Adolphe Pinard, 75675 Paris Cedex 14 (France), tel. 5401212.

CONTENTS

1. INTRODUCTION

The evaluation of policy actions by means of a large scale macroeconomic model often begins with the analysis of multipliers. A large value of a multiplier, with the right sign, suggests that the policy instrument should be very effective in moving up or down the given target variable. A rough analysis should therefore recommend the use of those instruments that exhibit multipliers larger than others (provided that appropriate scale adjustment have been made, so that multipliers have comparable size).

However, government budget usually imposes some constraints on the policy action, so that the important criterion should not be the raw multiplier $\pi = \partial y/\partial x$, but a *trade-off* criterion which measures the effect of a variation of the instrument associated with a given cost in terms of government deficit: in other words a *trade-off* criterion $\pi/\pi_1 = (\partial y/\partial x)/(\partial y_1/\partial x)$ where x is the instrument, y is the target endogenous variable which we want to modify and y_1 is the government balance. Computation does not raise particular difficulties: for a linear model it is the ratio of two reduced form coefficients; for a nonlinear model it is the ratio of two impact multipliers, each of which can be simply computed using finite differences as in Evans and Klein (1968, p.49); extension to the multiperiod dynamic case is straightforward (sustained multipliers).

The larger the *trade-off* criterion, the more effective is expected to be the policy action. Effectiveness cannot, however, be the only guideline for the decision maker. Being risk averting, he will certainly be concerned with the problem of reliability of the instrument he is using. The *trade-off* criterion which is computed from the macroeconomic model is obviously affected by uncertainty to some extent; a criterion which appears to be strongly effective might at the same time be affected by such an high degree of uncertainty as to recommend against its use.

The problem of uncertainty, which depends both on the numerator and the denominator of the *trade-off* criterion, will be investigated in this paper through experiments on the Mini-DMS model of the French economy (see Fouquet et. al., 1978, and Brillet, 1981). The results seem able to give to the policy maker indications much more practical and simple than those obtained from analysing the raw multipliers as in a previous work of the authors (1984).

Two of the most interesting ways the results can be used are the following:

1) We can consider the *trade-offs* associated with government deficit and one particular target variable. First we get, through the point estimate of the *trade-offs*, a rank order on the average effectiveness of each instrument (provided they are effective, having the right sign); then we see for which instruments the effectiveness can be considered significant, and what changes on the rank ordering are induced by replacing the point estimate by a guaranteed value which takes into account the dispersion (e.g. the lower bound of a confidence interval).
2) We can observe the set of *trade-offs* associated with one particular instrument, looking at which ones can be considered significant, and compare them with the multipliers associated with the same targets. The introduction of the government balance in most cases considerably increases the uncertainty; the increase appears to be even larger than what we would expect from the assumption of independence between the two multipliers, thus suggesting that correlation among multipliers should be taken carefully into account.

When the policy is sustained for several periods (years), the analysis must be performed looking at the effectiveness of the *cumulated trade-offs*. In this context two major points could be focussed: some instruments become less reliable and the rank order of the instruments is

not the same as in the one-period (impact) case.

2. THE GUARANTEED EFFECTIVENESS OF THE INSTRUMENTS

We begin with examination of the problem in case of a linear system of simultaneous equations. Let the model be

$$(1) \qquad Ay_t + Bx_t = u_t \qquad\qquad t = 1,2,\dots,T$$

where y_t is the $m\times m$ vector of endogenous variables at time t, x_t is the $m\times n$ vector of predetermined variables and u_t is the $m\times 1$ vector of random error terms at time t.

Provided that the system satisfies standard regularity conditions, we may get estimates of the $m\times m$ and $m\times n$ matrices of structural coefficients, $\hat{A}$ and $\hat{B}$, such that asymptotically for $T\to\infty$

$$(2) \qquad \sqrt{T}\begin{bmatrix} vec\,(\hat{A} - A) \\ vec\,(\hat{B} - B) \end{bmatrix} \sim N(0,\Psi).$$

The reduced form of the system is

$$(3) \qquad y_t = \Pi x_t + v_t; \qquad \Pi = -A^{-1}B; \qquad v_t = A^{-1}u_t$$

and if the j-th predetermined variable, x_{jt}, is a policy instrument, the i,j-th element of the matrix Π is the impact multiplier of such an instrument with respect to the target (i-th) endogenous variable: $\pi_{ij}=\partial y_{it}/\partial x_{jt}$. The model is supposed to have government balance among its endogenous variables; without loss of generality we may put it at the first place in the endogenous vector, y_{1t}, and $\pi_{1j}=\partial y_{1t}/\partial x_{jt}$ will be the related multiplier.

If our policy action moves the instrument x_{jt}, the expected change in the target endogenous corresponding to an expected unit change in the government balance is the *trade-off*

(4) $$\pi_{ij} / \pi_{1j} = (\sum_k a^{ik} b_{kj}) / (\sum_k a^{1k} b_{kj}).$$

Being the structural form coefficients usually unknown, the policy action must be based on the available estimates of coefficients and corresponding *trade-offs* $\hat{\pi}_{ij}/\hat{\pi}_{1j}$. Investigating the exact distribution of these estimates in small samples is presumably very hard. We can, however, obtain a large sample approximation by resorting to a well known and widely adopted theorem on the limiting distribution of sample statistics (δ-method, see Rao, 1973, p.388): given (2), the estimate of the *trade-off* will be asymptotically normally distributed as

(5) $$\sqrt{T}\,(\hat{\pi}_{ij}/\hat{\pi}_{1j} - \pi_{ij}/\pi_{1j}) \sim N(0, g'\Psi g),$$

g being the vector of first order derivatives

(6) $$g = \begin{bmatrix} \partial(\pi_{ij}/\pi_{1j}) \;/\; \partial(vec\ A) \\ \partial(\pi_{ij}/\pi_{1j}) \;/\; \partial(vec\ B) \end{bmatrix}.$$

Reminding the expression of the *trade-off* given in (4), the elements of the above vector of first derivatives can be computed as follows:

(7) $$\partial(\pi_{ij}/\pi_{1j})/\partial a_{pq} = (1/\pi_{1j}^2).[(\partial\pi_{ij}/\partial a_{pq})\pi_{1j} - (\partial\pi_{1j}/\partial a_{pq})\pi_{ij})]$$

$$= (\sum_k a^{ip} a^{qk} b_{kj})/\pi_{1j} - (\pi_{ij}/\pi_{1j}^2) \sum_k a^{1p} a^{qk} b_{kj}$$

$$= -(\pi_{qj}/\pi_{1j})\, a^{ip} + (\pi_{ij}\pi_{qj}/\pi_{1j}^2) a^{1p}$$

and

(8) $$\partial(\pi_{ij}/\pi_{1j})/\partial b_{rs} = (1/\pi_{1j}^2).[(\partial\pi_{ij}/\partial b_{rs})\pi_{1j} - (\partial\pi_{1j}/\partial b_{rs})\pi_{ij})]$$

$$= \begin{cases} 0 & [\text{if } s \neq j] \\ (1/\pi_{1j}^2).(\pi_{ij} a^{1r} - \pi_{1j} a^{ir}) & [\text{if } s = j]. \end{cases}$$

We may compute (7) and (8) at $(\hat{A}, \hat{B})$, then order them in a column vector $\hat{g}$ as in (6). Then, according to (5), we may compute $(\hat{g}'\hat{\Psi}\hat{g}/T)^{\frac{1}{2}}$ as an estimate of the asymptotic standard error of the *i,j-th trade-off*.

Extension to nonlinear models is straightforward using numerical simulation: carefully selected finite differences, as in Bianchi et al. (1981), allow the computation of the *trade-offs* and of their asymptotic variances and standard errors. It must be remarked that $\hat{\Psi}/T$ is a standard outcome of system estimation methods. For example, in case of FIML estimation, $\hat{\Psi}/T$ may be the inverse of the Hessian (with minus sign) of the concentrated log-likelihood, calculated at the point which maximizes the likelihood. When limited information estimation methods are applied, as in our case, this matrix must be built block by block, after coefficients have been estimated. Of course, according to the representation (6), since $\hat{A}$ and $\hat{B}$ include restricted structural coefficients (zeroes and ones, for example), $\hat{\Psi}/T$ would be a very large but sparse matrix. If we consider only the coefficients of the model which must be estimated, the matrix becomes a smaller full (but not necessarily full rank) matrix. In our case, Mini-DMS for the French economy model involves *155* unknown structural coefficients, so that $\hat{\Psi}/T$ is a *155×155* full matrix (symmetric, of course). Unknown coefficients and the blocks of their asymptotic covariance matrix have been computed as in Brundy and Jorgenson (1971, p.215).

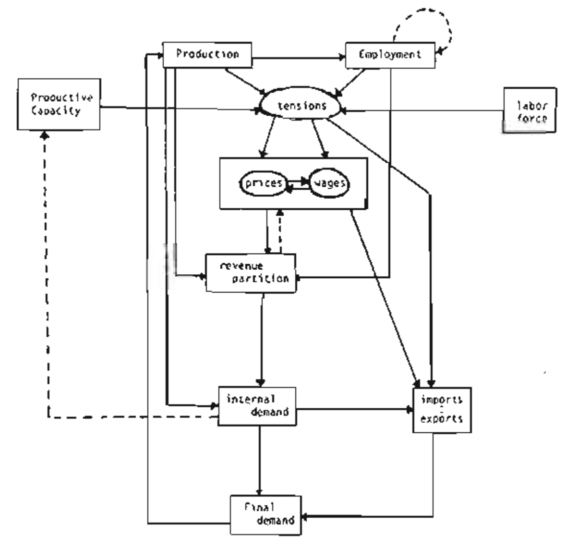
Let us now suppose to perform a simple policy experiment. The policy maker aims at changing the target y_{it} moving the instrument x_{jt}, without forgetting that his action will have a cost for the government balance. He will first check if the estimated multiplier, $\hat{\pi}_{ij}$, has the *right* sign. Also the estimate of the multiplier of x_{jt} with respect to the government balance $\hat{\pi}_{1j}$ must have the *right* sign, otherwise the model cannot be considered an appropriate tool for evaluating the effects of the planned policy action.

If both conditions are fulfilled, he will consider the point estimate $\hat{\pi}_{ij}/\hat{\pi}_{1j}$ as an average *trade-off* between the (expected) gain in the target and the (expected) loss for the government balance: or, in other words, as the expected gain in the target corresponding to a unit loss for the government balance. However, he cannot trust completely on $\hat{\pi}_{ij}/\hat{\pi}_{1j}$, since it is affected by errors in the estimated coefficients. To get some indication about the guaranteed effectiveness of the policy action he will build a confidence interval around the available estimate of the *trade-off* (for example using $\pm\sigma_{ij}$ if he is only moderately risk averting, $\pm 2\sigma_{ij}$ if he needs stronger warranties). If the confidence interval does not include the zero point (that is the *trade-off* is significantly non-zero), the lower bound (in absolute value) of the interval will indicate to the policy maker some kind of minimum guaranteed effectiveness of his policy action.

3. A BRIEF NOTE ON MINI-DMS MODEL FOR THE FRENCH ECONOMY

The Mini-DMS model (Brillet 1981) constitutes a smaller version of the Dynamic Multi Sectorial model of the French economy (Fouquet et al., 1978) built in 1974-1976 at INSEE (National Institute for Statistics and Economic Studies) to be used as a medium term forecasting tool, in particular for national planning studies conducted through the Commissariat General au Plan (General Planning Agency). Largely reduced in size (the present version contains 220 equations, 65 of which are behavioral, as compared to more than 2400 for the larger version) Mini-DMS nevertheless preserves the same economic structure as well as most of the theoretical mechanism of the original model. The economic

equilibrium is reached through two simultaneous iterative processes: a Keynesian process on demand (a given value of demand induces a level of production from which a new value is determined as the given of its individual elements) and the price wage rate loop.



SIMPLIFIED ARCHITECTURE OF THE MINI-DMS MODEL

(dotted lines are associated with lagged iteration)

Fig.1

The figure gives a very schematic view of the process: from final demand the model deduces production and desired employment level, to which the effective level adjusts only partially; comparison between availabilities (predetermined production capacity, labor force, job supply) and the quantities actually used produces disequilibrium or tension variables, which determine the level reached by the iterative loop between wage rate and price index; the subsequent partition of the revenue between business firms and households gives their respective demand elements: investment (through an accelerator-profit formulation) and consumption, thus global domestic demand which, corrected of the external trade elements (influenced, besides demand itself, by available productive capacity and competitivity), produces a new value for final demand, allowing a reinitialization of a process which hopefully leads to an equilibrium value after some iterations.

In its present state, the Mini-DMS model can be considered as being half way between an operational-forecasting tool: its acceptable forecasting qualities, as well as its rather detailed set of decisional variables, can lead to its use for simple enough macro-economic studies, and for carrying out mathematical economic experiments, some of which have already been made in the near past, concerning in particular multiplier analysis, optimal control problems or dynamic properties of alternate formulations.

Estimates of the structural coefficients the model have been obtained by means of a straightforward extension of Brundy and Jorgenson's (1971) instrumental variables method (limited information) to the case of nonlinear models. The method has been applied iteratively, till convergence has been reached, so that the final estimates of coefficients are not affected by the choice of the initial coefficients values. In each iteration, the instrumental variables are computed as deterministic solution values of the system (which is the simplest choice, although not the *best* in the class of nonlinear estimators as well explained in Amemiya, 1983). Since the number of stochastic equations in the model is considerably larger than the sample period length, the estimate of the covariance matrix of the disturbance process would be singular, and the standard system estimation methods could not be applied.

4. EXPERIMENTAL RESULTS IN THE ONE-PERIOD CASE

We consider in this and in the following sections the *trade-offs* between government balance (CFG) and the main target endogenous variables of the model, using eight possible instruments :

TCSS	= social security rate for workers
TCSE	= social security rate for business firms
AG	= government consumption and investment
TACP	= VAT rate on consumption
TAI	= VAT rate on investment.
XTM	= tax rate on household revenue
XPSOCT	= social benefits
XIS	= tax rate on business firms profits.

Each of the tables below is related to one of the main macroeconomic endogenous variables (targets):

Q	= added value
Q1	= added value sector 1 (industrial sector)
Q2	= added value sector 2 (non-industrial sector)
C	= consumption
I	= investment
M	= imports
X1	= exports
PDRE	= unemployment
PC	= consumption prices
CFX	= trade balance
CFXSUM	= cumulated trade balance (multiperiod case only).

We are first considering the impact effect of one-period policy action. 1981 has been chosen, being the first year outside the sample estimation period (1962-1980).

Trade-offs criteria are displayed in the tables with their sign. A negative sign, as for the case of the added value (Q), indicates that a policy action which is expected to increase the target is also expected to lower the government balance (that is to increase the public deficit). A positive sign indicates that a decrease in the target is expected to be accompanied by a decrease in the government balance (that is still an increase of the deficit).

Trade-off between Q and government balance CFG
Impact *trade-off* at 1981

	Trade -off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* +σ	Rank order	*Trade-off* +2σ	Rank order
TCSS	-.089	6	.024	-3.69	-.065	6	-.041	7
AG	-.322	3	.043	-7.49	-.279	3	-.236	1
TCSE	-.542	2	.218	-2.49	-.324	2	-.106	4
TACP	-.570	1	.215	-2.65	-.355	1	-.140	2
TAI	-.237	4	.052	-4.56	-.185	4	-.133	3
XTM	-.089	5	.024	-3.69	-.065	5	-.041	6
XPSOCT	-.089	7	.024	-3.68	-.065	7	-.040	8
XIS	-.070	8	.014	-5.00	-.056	8	-.042	5

Trade-off between Q1 and government balance CFG
Impact *trade-off* at 1981

	Trade -off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* +σ	Rank order	*Trade-off* +2σ	Rank order
TCSS	-.020	7	.006	-3.15	-.014	7	-.007	7
AG	-.055	4	.015	-3.54	-.039	4	-.024	4
TCSE	-.240	1	.102	-2.35	-.138	1	-.035	3
TACP	-.222	2	.093	-2.39	-.129	2	-.036	2
TAI	-.097	3	.025	-3.85	-.072	3	-.047	1
XTM	-.020	6	.006	-3.15	-.014	6	-.007	6
XPSOCT	-.020	8	.006	-3.15	-.014	8	-.007	8
XIS	-.024	5	.006	-3.98	-.018	5	-.012	5

Trade-off between Q2 and government balance CFG
Impact *trade-off* at 1981

	Trade -off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* +σ	Rank order	*Trade-off* +2σ	Rank order
TCSS	-.069	6	.019	-3.63	-.050	6	-.031	6
AG	-.267	3	.028	-9.49	-.239	1	-.211	1
TCSE	-.301	2	.116	-2.59	-.185	3	-.069	4
TACP	-.348	1	.124	-2.82	-.224	2	-.101	2
TAI	-.140	4	.028	-5.04	-.112	4	-.084	3
XTM	-.069	5	.019	-3.62	-.050	5	-.031	5
XPSOCT	-.069	7	.019	-3.62	-.050	7	-.031	7
XIS	-.046	8	.008	-5.59	-.037	8	-.029	8

Trade-off between C and government balance CFG
Impact *trade-off* at 1981

	Trade -off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* +σ	Rank order	*Trade-off* +2σ	Rank order
TCSS	-.186	5	.052	-3.60	-.134	5	-.082	5
AG	-.097	7	.019	-5.21	-.079	7	-.060	7
TCSE	-.394	2	.144	-2.74	-.251	2	-.107	3
TACP	-.582	1	.180	-3.24	-.403	1	-.223	1
TAI	-.218	3	.034	-6.41	-.184	3	-.150	2
XTM	-.187	4	.052	-3.60	-.135	4	-.083	4
XPSOCT	-.185	6	.052	-3.59	-.134	6	-.082	6
XIS	-.027	8	.006	-4.36	-.021	8	-.015	8

Trade-off between I and government balance CFG
Impact *trade-off* at 1981

	Trade -off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* +σ	Rank order	*Trade-off* +2σ	Rank order
TCSS	-.018	7	.006	-2.99	-.012	7	-.006	7
AG	-.066	5	.019	-3.48	-.047	5	-.028	5
TCSE	-.277	2	.113	-2.45	-.164	2	-.051	4
TACP	-.285	1	.117	-2.44	-.168	1	-.051	3
TAI	-.123	4	.031	-3.94	-.091	4	-.060	2
XTM	-.018	6	.006	-2.99	-.012	6	-.006	6
XPSOCT	-.018	8	.006	-2.99	-.012	8	-.006	8
XIS	-.152	3	.025	-6.08	-.127	3	-.102	1

Trade-off between M and government balance CFG
Impact *trade-off* at 1981

	Trade -off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* +σ	Rank order	*Trade-off* +2σ	Rank order
TCSS	-.082	6	.023	-3.61	-.059	7	-.036	7
AG	-.209	3	.027	-7.63	-.181	3	-.154	1
TCSE	-.366	2	.149	-2.45	-.216	2	-.067	4
TACP	-.422	1	.156	-2.71	-.266	1	-.111	2
TAI	-.171	4	.038	-4.52	-.133	4	-.095	3
XTM	-.082	5	.023	-3.61	-.060	6	-.037	6
XPSOCT	-.082	7	.023	-3.60	-.059	8	-.036	8
XIS	-.079	8	.014	-5.82	-.066	5	-.052	5

Trade-off between X1 and government balance CFG
Impact *trade-off* at 1981

	Trade-off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* ±σ	Rank order	*Trade-off* ±2σ	Rank order
TCSS	.033	5	.011	3.10	.022	4	.012	7
AG	.082	8	.011	7.28	.071	1	.059	2
TCSE	-.117	1	.078	-1.49	-.039	8	.040	3
TACP	-.035	2	.057	-.61	.022	6	.079	1
TAI	-.025	3	.024	-1.05	-.001	7	.023	4
XTM	.033	6	.011	3.10	.023	3	.012	6
XPSOCT	.033	4	.011	3.10	.022	5	.012	8
XIS	.037	7	.008	4.87	.030	2	.022	5

Trade-off between PDRE and government balance CFG
Impact *trade-off* at 1981 (multiplied by 10^2)

	Trade-off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* -σ	Rank order	*Trade-off* -2σ	Rank order
TCSS	.026	6	.012	2.11	.014	7	.001	4
AG	.085	4	.047	1.81	.038	4	-.009	6
TCSE	.220	1	.117	1.87	.103	1	-.015	7
TACP	.215	2	.115	1.87	.100	2	-.015	8
TAI	.092	3	.036	2.54	.056	3	.019	1
XTM	.026	5	.012	2.11	.014	6	.001	3
XPSOCT	.026	7	.012	2.11	.014	8	.001	5
XIS	.025	8	.010	2.42	.014	5	.004	2

Trade-off between PC and government balance CFG
Impact *trade-off* at 1981 (multiplied by 10^5)

	Trade-off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* -σ	Rank order	*Trade-off* -2σ	Rank order
TCSS	.006	7	.007	.87	-.001	6	-.008	5
AG	.022	4	.025	.89	-.003	8	-.028	8
TCSE	.438	2	.201	2.18	.237	2	.037	3
TACP	.685	1	.246	2.79	.439	1	.194	1
TAI	.177	3	.047	3.80	.130	3	.084	2
XTM	.006	6	.007	.87	-.001	7	-.008	4
XPSOCT	.006	8	.007	.88	-.001	5	-.008	6
XIS	.007	5	.007	.94	-.000	4	-.008	7

Trade-off between CFX and government balance CFG
Impact *trade-off* at 1981

	Trade-off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* -σ	Rank order	*Trade-off* -2σ	Rank order
TCSS	.285	6	.078	3.67	.207	7	.129	7
AG	.748	3	.084	8.90	.664	2	.580	1
TCSE	1.061	2	.400	2.65	.661	3	.260	4
TACP	1.296	1	.450	2.88	.846	1	.396	2
TAI	.518	4	.101	5.14	.417	4	.316	3
XTM	.287	5	.078	3.66	.208	6	.130	6
XPSOCT	.284	7	.078	3.65	.206	8	.129	8
XIS	.265	8	.045	5.92	.220	5	.175	5

These tables are completed, (see figures 2 and 3), by histograms allowing a visual comparison of the trade-off values, stressing in particular the evolution of their rank order when uncertainty is considered.

Using the same data as the associated tables, they display the point estimate of the *trade-offs* as the top of the blank surface, the same value minus one standard error as the top of the light surface, and the same value minus two standard errors as the top of the darker surface (the sign can change from one value to another).

First, let us consider the point estimates of the *trade-offs*: we can see that, whatever the instruments used, the sign of the *trade-off* is almost always the same, and that it can be considered as coherent with common sense; one has to spend (in terms of *government balance* CFG) to increase *consumption* (C) or *investment* (I); one also has to spend to decrease *prices* (PC), whether price decrease comes from firms behavior or from the direct effect of a decrease of the added value tax component (TACP or TAI); on the whole, *government spending* always increases *activity* (Q) and *employment*, but also *imports* (M). As to *exports* (X1), *trade-offs* show a variable sign: if government action primarily increases demand, exports decrease (due to an inflationary effect, and to the rising

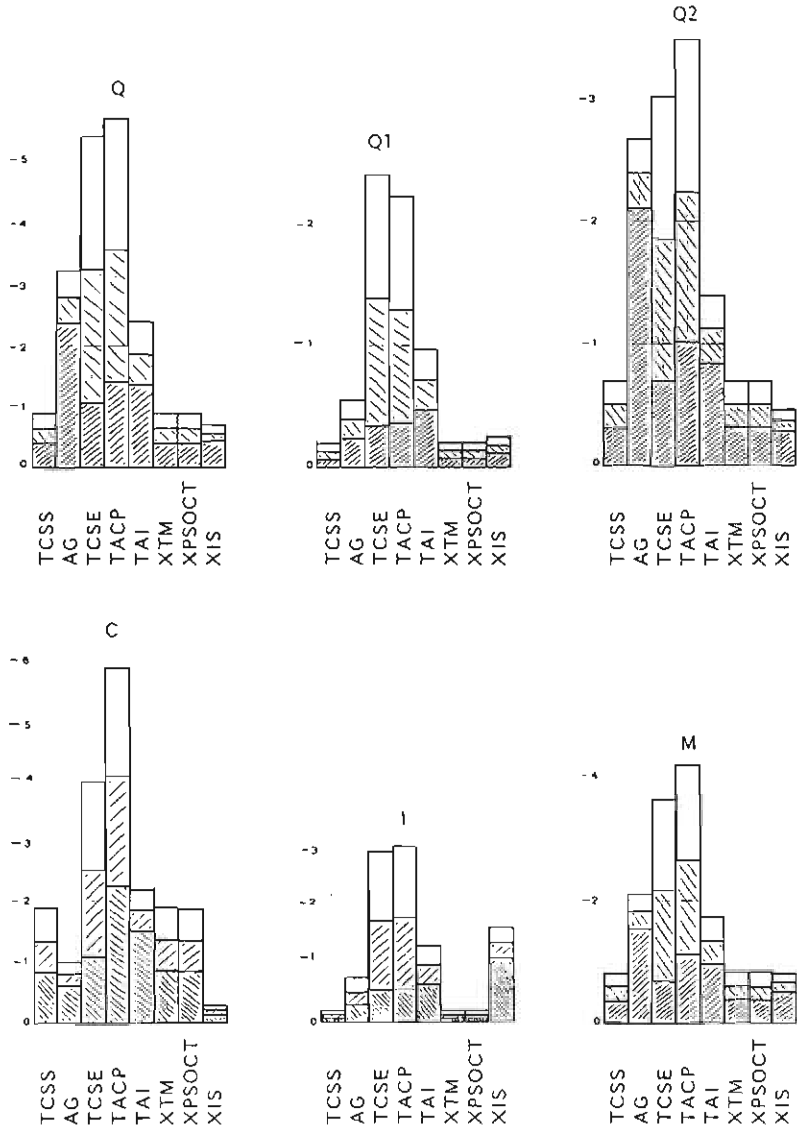

Q
Q1
Q2
C
I
M
TCSS
AG
TCSE
TACP
TAI
XTM
XPSOCT
XIS

Fig.2

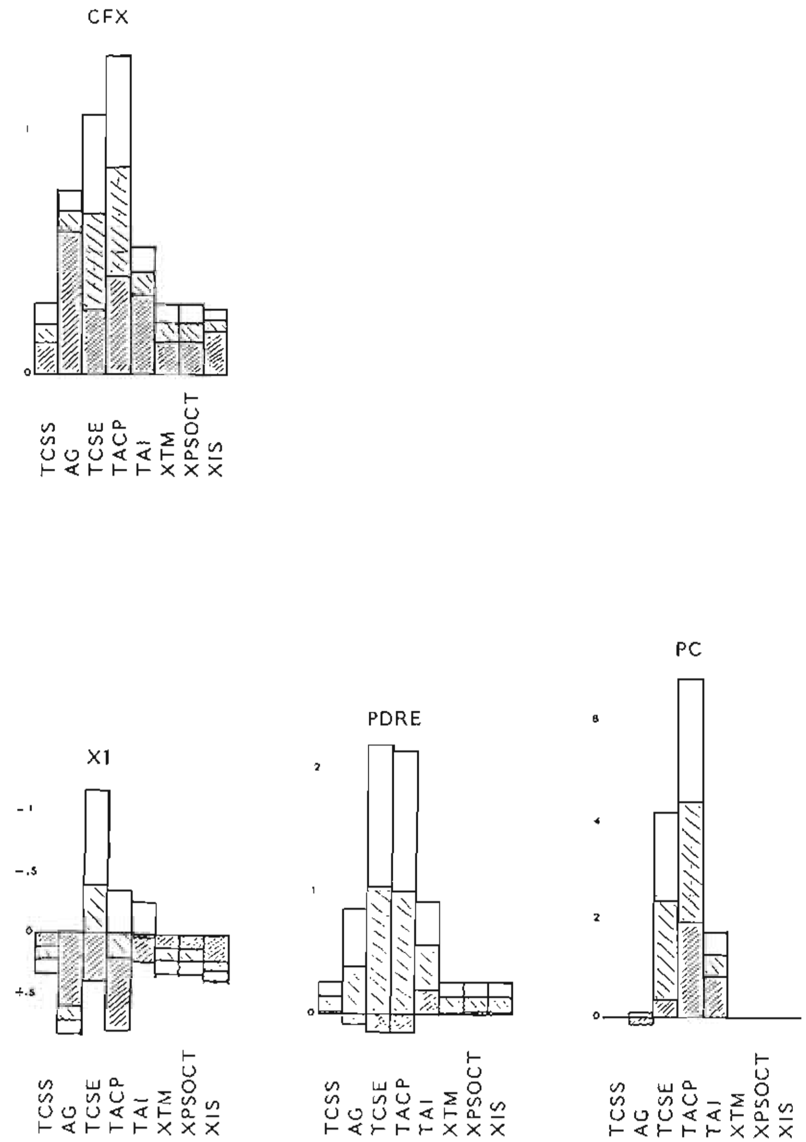

CFX
X1
PDRE
PC
TCSS
AG
TCSE
TACP
TAI
XTM
XPSOCT
XIS

Fig.3

tensions on internal production capacity); but if government action primarily decreases prices, exports increase (due to the growth of price competitivity of French firms); lastly, the value obtained for *trade balance* shows that each time the use of an instrument increases *government deficit*, it also has a negative effect on *trade balance*.

So, according to the model, whichever instrument is used, *government spending* affects all the elements of the macroeconomic equilibrium in the same direction; but we can also see that the level of the effect is quite variable; we will now try to explain its rank order.

First, one simplifying remark: the instruments affecting directly household revenue -*social benefits* (XPSOCT), *social securities paid by workers* (TCSS), *income tax* (XTM)- have a value so similar in all cases that they can be treated as a single instrument; this could be expected. The tables show that the second order effects are not significant.

Now, if we first consider *global activity* (Q) we can see that the most efficient instruments (in terms of *government spending*) are clearly the ones concerning *prices* (the VAT rates and the social securities of the firms) and *government demand*; then we find the ones affecting *households*, then *taxes on profits*. This rank order is better explained using the different elements of demand:

- *Investment*, influenced by the profit rate, is mostly affected by the decrease of firms taxes, but also by the increase in demand on which government spending is more efficient then increasing household revenue.
- Indeed, the increase in *household consumption* through household revenue does not appear very efficient, and it seems better to work through VAT rate on consumption (this looks normal) but also through TCSE, which has only indirect effects, but very important ones, through an increase in employment. The most important explanation for this apparent anomaly is the evolution of the savings ratio: when their revenue increases, households tend to save a larger share of their income, and when prices decrease, they lower their saving level as their notion of savings is in real terms.
- As we have seen, the instrument affecting *prices* (TCSE, TACP and TAI) have a positive effect on exports, and the others a negative one.
- Concerning *prices*, we can see that the demand-side instruments have a negligible influence, while the influence of the others is either direct (for the VAT rates, TACP and TAI) or through the wage cost (TCSE, but also TACP, as wages are indexed on the consumption prices); the effect of XIS and TAI on the profits rate will only come into play in the following year due to the lagged influence of this variable.
- As to *trade balance* (CFX), its negative variation is explained by the increase in internal activity, whether it comes from a direct increase in demand or from the decrease of prices.

Now, reminding that the object of this study is the uncertainty of these *trade-offs*, we first have to set a criterion for the acceptability of their sign: similarly to the *t-statistic* used for the regressions, we shall assume that a *trade-off* is significantly different from zero if its value is more than double its estimated standard error. In that light we can observe that each instrument presents a significant *trade-off* between *government balance* and *demand*, even considering each of its products (industrial or non-industrial) or each of its elements (consumption, investment, imports), except for exports where the instruments increasing exports through price competitivity show a significant probability of having the opposite effect; indeed, the *trade-off* with prices themselves, although it could be considered significant, appeared to be much affected by uncertainty. This comes mostly from the use of *trade-offs* instead of their multipliers: the uncertainty of the influence of *supply-side* instruments on *government deficit* itself is much higher than for demand-side ones as a change in the price level has an important impact on a balance measured in nominal terms.

The main conclusion: demand-side instruments have a much higher precision concerning their *trade-off* between *government balance* and any macroeconomic target; this will serve as guideline for the observation of the way the rank order among instruments evolves when one considers, instead of the *trade-off*, a "*guaranteed value*" obtained by subtracting from the point estimate either one or two standard errors; we then can see that we can separate the eight instruments in four groups: *supply-side* instruments (TCSE, TACP, TAI), *demand-side* ones concerning either households (TCSS, XPSOCT, XTM) or *Government* (AG), with a special comment for XIS which affects mostly the equilibrium in the following period of time.

First, if we consider *activity*, we see that the priority of *supply-side instruments* over *government demand* becomes less and less evident, this instruments becoming, at 2σ level, the most efficient, while the higher precision of TAI, which works through profits ratio rather than through prices (it can then be considered somewhat as a demand-side instrument working through investment) tends to make it the most efficient between the ones affecting firms; in the same way, XIS becomes more efficient than instruments affecting household revenue, which are affected, concerning their influence on demand, by the uncertainty on the savings ratio.

These remarks are confirmed (and completed) if we separate demand into products: although the higher influence of AG on non-industrial demand can make it especially efficient on Q2, and the supply-side instruments stay the most efficient on industrial activity.

Concerning the components of demand, we can see that:

- For *investment* the highest guaranteed efficiency is that of XIS (which affects profits directly, and in a sure manner), followed by the VAT rate on investment itself.

- For *consumption* the superiority of supply-side instruments is still confirmed, but with a much lower margin, and TAI becoming relatively more efficient (we can also remark that TAI affects household investment in lodgings which is not subject to the uncertainty on the savings ratio, as it is intermediate between consumption and savings).
- For *exports*, as we have seen, the significance of the supply-side instruments is not ensured, while the others are comparable (negatively) among themselves; indeed for TCSE and TACP, they could show a negative efficiency higher than the one of the demand-side instruments.
- The higher precision of TAI reflects itself also for *prices*, with a guaranteed efficiency higher than that of TCSE; but although the efficiency of supply-side instruments is much reduced, it stays of course at a level certainly higher than that of the other instruments.
- As to *Trade Balance* (as well as *Imports*) its rank order, whatever the level of uncertainty we consider, remains exactly the same as that of demand in accordance with the observations made above. Indeed the study of the model shows that demand has a quite precise effect on *trade balance* measured in real terms, while a decrease of prices, associating an improvement of the trade balance in real terms with a bigger deflationary effect on export prices than on imports ones, has an uncertain influence on the nominal value.

5. EFFECTIVENESS OF INSTRUMENTS IN THE MULTIPERIOD CASE

We consider in this section the case of a policy action *sustained* over a period of 4 years (1981-1984). The numerator of the *trade-off* criterion is the sustained multiplier (according to its usual definition), which measures the expected change in the target obtained in the last year after a unit change in the instrument sustained over 4 years. However the denominator of the *trade-off* criterion cannot be taken as the sustained multiplier of government balance. Since in fact the policy action is sustained over 4 years, the expected loss for the government balance cumulates over the 4 periods. We use therefore the sustained multiplier of each instrument with respect to an auxiliary endogenous variable which is computed as the sum of CFG (government balance) over 4 consecutive years.

Trade-off between Q and cumulated government balance
Cumulated *trade-off* 1981-1984

	Trade -off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* $+\sigma$	Rank order	*Trade-off* $+2\sigma$	Rank order
TCSS	-.065	8	.009	-7.14	-.056	8	-.047	6
AG	-.099	5	.016	-6.16	-.083	4	-.067	1
TCSE	-.216	2	.097	-2.23	-.119	2	-.022	7
TACP	-.238	1	.112	-2.14	-.127	1	-.015	8
TAI	-.104	4	.025	-4.12	-.079	5	-.053	3
XTM	-.068	6	.009	-7.47	-.059	6	-.049	4
XPSOCT	-.065	7	.009	-7.20	-.056	7	-.047	5
XIS	-.162	3	.049	-3.27	-.112	3	-.063	2

Trade-off between Q1 and cumulated government balance
Cumulated *trade-off* 1981-1984 (multiplied by 10[3])

	Trade -off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* $+\sigma$	Rank order	*Trade-off* $+2\sigma$	Rank order
TCSS	-.087	8	.040	-2.18	-.047	8	-.007	5
AG	-.141	5	.076	-1.86	-.065	5	.010	6
TCSE	-.836	1	.465	-1.80	-.371	2	.094	7
TACP	-.822	2	.486	-1.69	-.336	3	.151	8
TAI	-.370	4	.128	-2.90	-.243	4	-.115	2
XTM	-.095	6	.040	-2.39	-.055	6	-.016	3
XPSOCT	-.090	7	.040	-2.24	-.050	7	-.010	4
XIS	-.667	3	.231	-2.89	-.436	1	-.205	1

Trade-off between Q2 and cumulated government balance
Cumulated *trade-off* 1981-1984

	Trade -off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* $+\sigma$	Rank order	*Trade-off* $+2\sigma$	Rank order
TCSS	-.056	8	.007	-7.68	-.049	8	-.041	4
AG	-.085	4	.009	-9.48	-.076	3	-.067	1
TCSE	-.132	2	.051	-2.57	-.081	2	-.029	7
TACP	-.156	1	.064	-2.44	-.092	1	-.028	8
TAI	-.067	5	.014	-4.93	-.053	5	-.040	6
XTM	-.058	6	.007	-7.89	-.051	6	-.043	2
XPSOCT	-.056	7	.007	-7.71	-.049	7	-.042	3
XIS	-.095	3	.027	-3.51	-.068	4	-.041	5

Trade-off between C and cumulated government balance
Cumulated *trade-off* 1981-1984

	Trade -off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* $+\sigma$	Rank order	*Trade-off* $+2\sigma$	Rank order
TCSS	-.140	5	.007	-20.1	-.133	4	-.126	3
AG	-.065	8	.013	-5.03	-.052	8	-.039	8
TCSE	-.183	2	.051	-3.59	-.132	5	-.081	5
TACP	-.248	1	.068	-3.67	-.180	1	-.113	4
TAI	-.104	7	.020	-5.22	-.084	6	-.064	6
XTM	-.146	3	.007	-19.6	-.139	2	-.131	1
XPSOCT	-.141	4	.007	-20.0	-.134	3	-.127	2
XIS	-.117	6	.034	-3.45	-.083	7	-.049	7

Trade-off between I and cumulated government balance
Cumulated *trade-off* 1981-1984

	Trade -off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* $+\sigma$	Rank order	*Trade-off* $+2\sigma$	Rank order
TCSS	-.012	8	.006	-2.16	-.007	8	-.001	5
AG	-.021	5	.011	-1.93	-.010	5	.001	6
TCSE	-.117	2	.070	-1.68	-.048	2	.022	7
TACP	-.119	1	.074	-1.61	-.045	3	.029	8
TAI	-.055	4	.020	-2.75	-.035	4	-.015	2
XTM	-.013	6	.006	-2.33	-.007	6	-.002	3
XPSOCT	-.012	7	.006	-2.21	-.007	7	-.001	4
XIS	-.110	3	.034	-3.26	-.076	1	-.043	1

Trade-off between M and cumulated government balance
Cumulated *trade-off* 1981-1984

	Trade -off	Rank order	Stand error (σ)	*t-ratio*	*Trade-off* $\pm\sigma$	Rank order	*Trade-off* $\pm2\sigma$	Rank order
TCSS	-.056	8	.004	-13.5	-.052	8	-.048	5
AG	-.071	4	.008	-9.05	-.063	4	-.055	1
TCSE	-.137	2	.053	-2.56	-.083	2	-.030	7
TACP	-.158	1	.064	-2.46	-.094	1	-.030	8
TAI	-.070	5	.014	-5.01	-.056	5	-.042	6
XTM	-.060	6	.004	-14.1	-.056	6	.051	2
XPSOCT	-.057	7	.004	-13.5	-.053	7	-.049	4
XIS	-.107	3	.029	-3.73	-.078	3	-.050	3

Trade-off between XI and cumulated government balance
Cumulated *trade-off* 1981-1984 (multiplied by 10^1)

	Trade -off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* $\pm\sigma$	Rank order	*Trade-off* $\pm2\sigma$	Rank order
TCSS	183	5	.065	2.81	.118	5	.053	7
AG	.219	8	.098	2.23	.121	6	.023	8
TCSE	-.655	1	.541	-1.21	-.114	2	427	2
TACP	-.476	2	.497	-.96	.020	4	.517	1
TAI	-.218	4	.167	-1.30	-.051	3	.117	3
XTM	.193	7	.065	2.97	.128	8	.063	5
XPSOCT	.185	6	.064	2.88	.121	7	.057	6
XIS	-.397	3	.237	-1.68	-.160	1	.077	4

Trade-off between PDRE and cumulated government balance
Cumulated *trade-off* 1981-1984 (multiplied by 10^2)

	Trade -off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* $-\sigma$	Rank order	*Trade-off* -2σ	Rank order
TCSS	.024	8	.013	1.85	.011	8	-.002	4
AG	.038	5	.022	1.75	.016	5	-.006	3
TCSE	.117	2	.070	1.66	.047	1	-.024	2
TACP	122	1	.077	1.57	.044	3	-.033	1
TAI	053	4	.023	2.33	.030	4	.008	8
XTM	.025	6	.013	1.88	.012	6	-.002	6
XPSOCT	.024	7	.013	1.86	.011	7	-.002	5
XIS	.082	3	.037	2.20	.044	2	.007	7

Trade-off between PC and cumulated government balance
Cumulated *trade-off* 1981-1984 (multiplied by 10^5)

	Trade -off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* $\pm\sigma$	Rank order	*Trade-off* $\pm2\sigma$	Rank order
TCSS	-.00006	8	.012	-.01	.012	5	.024	8
AG	.00571	5	.021	.27	-.015	8	-.036	3
TCSE	.18271	2	.132	1.38	.051	2	-.081	1
TACP	.27358	1	.172	1.59	.102	1	-.070	2
TAI	.07621	4	.041	1.87	.036	4	-.005	7
XTM	.00084	6	.012	.07	-.011	6	-.023	5
XPSOCT	.00026	7	.012	.02	-.012	7	-.024	4
XIS	.10446	3	.060	1.75	045	3	-.015	6

Trade-off between CFX and cumulated government balance
Cumulated *trade-off* 1981-1984

	Trade -off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* $-\sigma$	Rank order	*Trade-off* -2σ	Rank order
TCSS	.217	7	.010	21.28	.207	7	.197	4
AG	.274	4	.016	17.01	.258	2	.242	1
TCSE	.348	2	.097	3.56	.250	3	.153	6
TACP	.437	1	.136	3.22	.301	1	.165	5
TAI	.193	8	.031	6.25	.162	8	.131	8
XTM	.231	5	.011	21.00	.220	4	.209	2
XPSOCT	.221	6	.011	20.92	.211	6	.200	3
XIS	.279	3	.067	4.19	.213	5	.146	7

Trade-off between CFXSUM and cumulated government balance
Cumulated *trade-off* 1981-1984

	Trade -off	Rank order	Stand. error (σ)	*t-ratio*	*Trade-off* $-\sigma$	Rank order	*Trade-off* -2σ	Rank order
TCSS	.700	5	.040	17.72	.661	4	.621	2
AG	948	3	.069	13.75	879	2	.810	1
TCSE	1.222	2	.391	3.12	.830	3	.439	8
TACP	1.578	1	.550	2.87	1.028	1	.478	5
TAI	.652	8	.100	6.55	.552	8	.453	6
XTM	.693	7	.040	17.33	.653	6	.613	4
XPSOCT	.695	6	.039	17.60	.655	5	.616	3
XIS	.837	4	.199	4.21	.638	7	.439	7

The tables are accompanied, as in the previous case, by histograms (see figures 4 and 5) built in the same way as before. However these new histograms are not directly comparable with the others, as they link

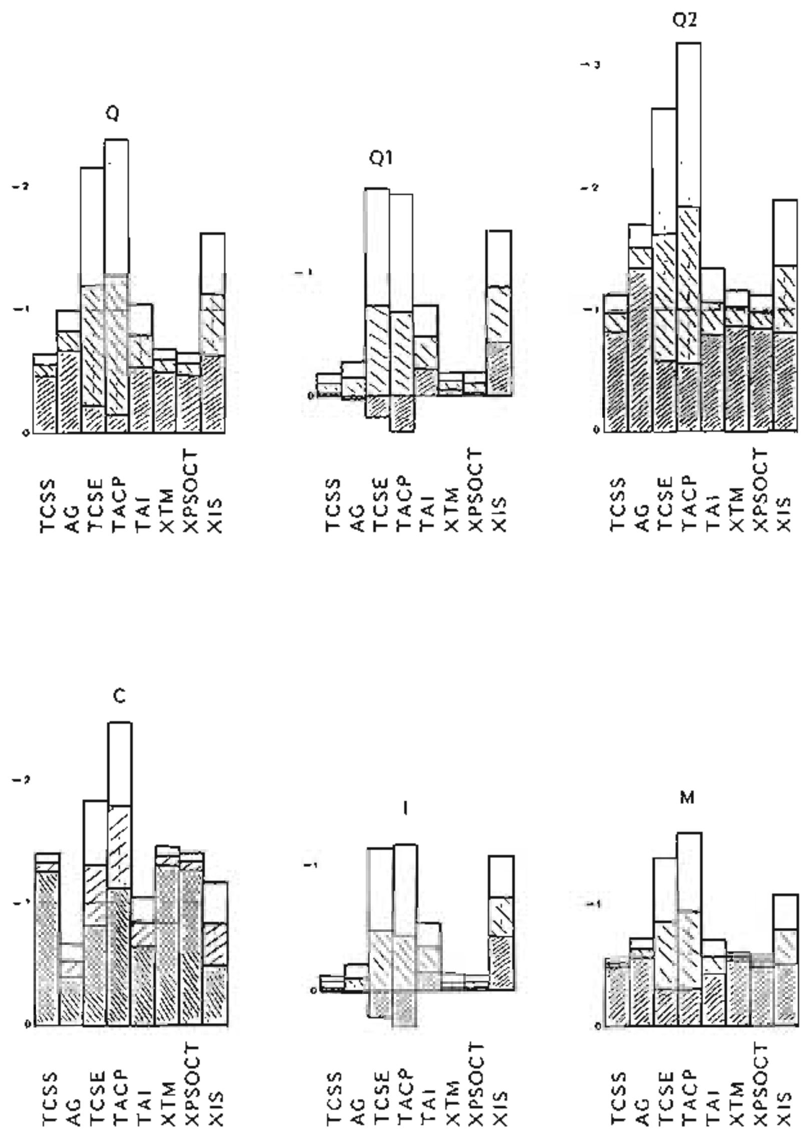

Q
Q1
Q2
C
I
M
TCSS
AG
TCSE
TACP
TAI
XTM
XPSOCT
XIS

Fig. 4

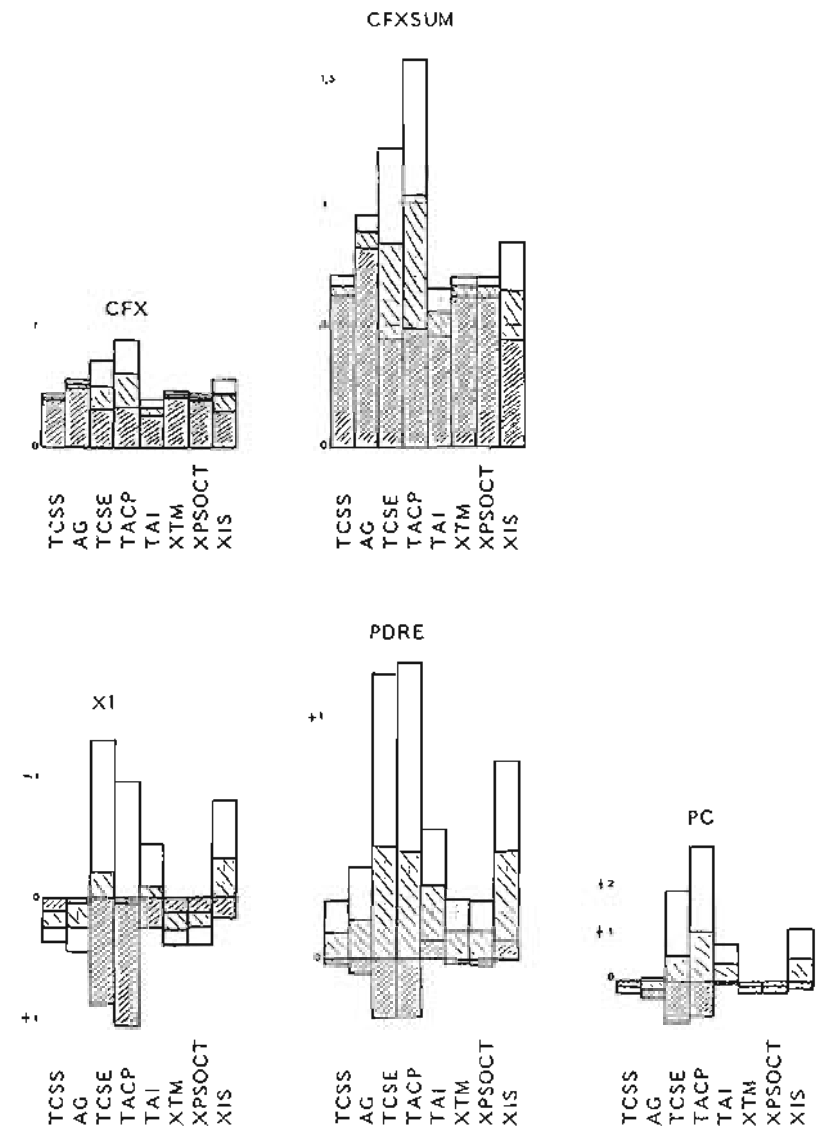

CFXSUM
CFX
X1
PDRE
PC
TCSS
AG
TCSE
TACP
TAI
XTM
XPSOCT
XIS

Fig. 5

the variation of one variable for the last period with the cumulated variation of *government balance* over the whole four-year period: to get a directly comparable statistic we should have cumulated the variations of the numerator itself.

So these *trade-offs* should be interpreted as the cumulated costs, using one particular instrument in the same way over the period, of an unitary change in the cumulated deficit (in other words, multiplying the *trade-off* by four gives the effect, at the last period, of an unitary average change in the *government balance* over the whole period).

Let us first consider the point estimates of the *trade-offs*. Concerning *global activity* we see that the main change in the rank order with respect to the one-period case concerns XIS (tax on firms profits) which becomes highly efficient; regarding the values themselves, they show for each of the instruments a growing efficiency as they are higher than the division by four of the results of the one-period experiments; the same remark applies to each of the products (Q1 and Q2). Concerning the elements of *demand*, average effect on household consumption of an increase in revenue grows, as it is no longer reduced by the evolution of the savings ratio. For *investment*, the influence of XIS grows to the level of the other supply-side instruments; this comes mostly from the fact that its influence on prices through the lagged value of the profits rate, and so on competitivity and demand, is now taken into account; indeed we can see that decreasing XIS now improves exports, and that it decreases prices, while the inflationary influence of demand stays at low level (although it is not as negligible as before). Lastly, the *trade-off* between the cumulated variation of *trade balance* and that of *government balance*, while still showing the same kind of rank order as before between supply-side instruments (plus *government demand*) and demand-side-ones, presents a smaller difference.

Concerning uncertainty, we can see that the significance observed in

the one-period experiment remains in effect in most cases; the most important exception concerns the efficiency of supply-side instruments on prices themselves, as to an initial deflationary effect they now add the contrary influence of the increase in activity: this explains the growth of the uncertainty on exports, as they are very sensitive to price competitivity. TCSE and TACP show also no longer a significant influence on investment, mostly influenced by the increase in industrial demand and by profits. As to unemployment, the loss of significance of the increase in the production of the industrial sector, where job creation draws much more in the unemployed population than the non-industrial (where it attracts on the labor market a large number of previously unemployed) explains its unreliability for all instruments but XIS and TAI.

Indeed the second exception concerns the tax on firms profits and, to a smaller degree, the VAT rate on investment: as explained before, the main influence of the first one (though prices) now comes into play, while the second is less affected by uncertainty as it works only through profits.

If we now consider the evolution of the rank order, we can see indeed that the large increase in the uncertainty on TCSE and TACP, and the progress of the average influence of XIS, makes this last instrument the most certainly efficient on global demand (at the same level as government demand), while TCSE and TACP take now the last place (although they can be considered as significantly efficient); if we separate the products, we see that for the industrial one only XIS and TAI can guarantee a significant non-negligible level, while for the non-industrial AG remains the most efficient, followed by all the others at the same level, except once more for TCSE and TACP.

As to the division into the elements of demand, the following considerations hold.

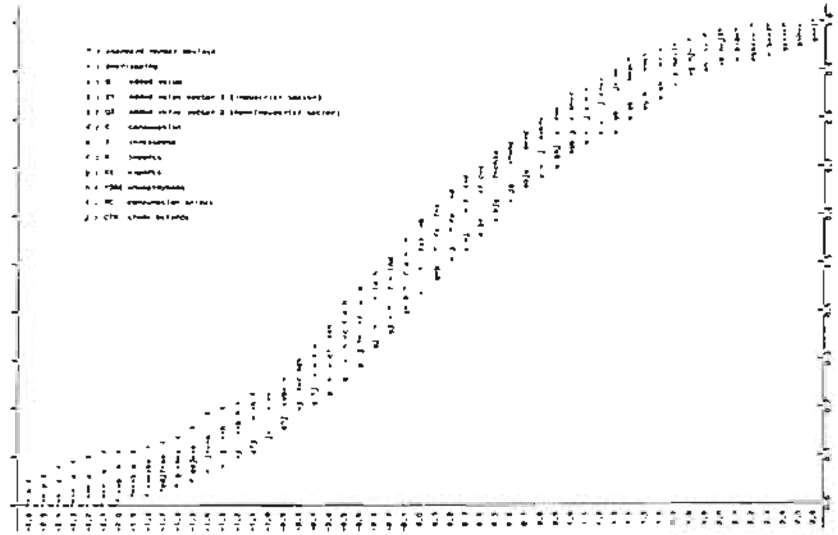
- As we have seen, only TAI and XIS can be used significantly to increase investment.
- Increasing household revenue now seems the most efficient way of increasing consumption, while TACP and TCSE keep a good place, due to their previous influence on employment and, more importantly, on the purchasing power of the wage rate.
- *Imports* follow demand as before.
- For *exports* we can no longer consider a rank order, as no instrument can be used to increase significantly exports, unless we do so by decreasing demand, in which case we get a low significant effect (in this case we can no longer speak of *trade-off*, as we increase government balance and exports at the same time).
- In the same manner the rank order on *unemployment* has a meaning only for TAI and XIS, which have (almost at the same level) a guaranteed efficiency.
- As to *trade balance* (cumulated over the period) the much higher precision of demand-side instruments inverts the rank order with (as we have already noted) a reduction of the intervals.

6. SMALL SAMPLE DISTRIBUTION

A sampling experiment has been performed to evaluate how good are in the small sample case the asymptotic first order approximations derived in the previous sections.

We start from the model with a fixed set of parameters (in practice the coefficients and the error process covariance matrix obtained from estimating the model with historical data). We then generate vectors of pseudo-random error terms with the given covariance matrix (McCarthy, 1972) over the entire sample period and solve the model (stochastic

simulation). The solution gives a matrix of pseudo-historical values of the endogenous variables which are used to re-estimate the structural coefficients of the model. Using this new estimate of the coefficients we compute the multipliers and the *trade-offs* $\tilde{\pi}_{ij}/\tilde{\pi}_{1j}$ for the target variables and for the instruments previously considered.



Sampling distribution of standardized impact *trade-offs* (1981) between government balance CFG and the main targets. Instrument: TCSS.

Fig.6

All the process is repeated a 500 times so that a sample of *trade-offs* $\tilde{\pi}_{ij}/\tilde{\pi}_{1j}$ is obtained for each couple of targets and instruments of interest.

The first order approximation (asymptotically exact) derived in section 2, which led to the results in sections 4 and 5, can be considered acceptable if the experimentally generated values of $\tilde{\pi}_{ij}/\tilde{\pi}_{1j}$ are approximately distributed like a normal with mean equal to $\hat{\pi}_{ij}/\hat{\pi}_{1j}$ (the point estimates of the *trade-offs* appearing in the first column of each table) and standard deviation equal to those displayed in the second column of the tables. In other words, using $\hat{\pi}_{ij}/\hat{\pi}_{1j}$ and its asymptotic standard error to standardize $\tilde{\pi}_{ij}/\tilde{\pi}_{1j}$, we should get a random variable close to a standard normal.

Most of the results appear as in figure 6, provided that we confine ourselves, among the variables of practical interest, to those cases in which the *trade-off* is significantly non-zero (a large *t-ratio* according to the asymptotic approximation).

Of course the situation is not the same if we consider also cases in which the denominator $\hat{\pi}_{1j}$ is affected by such a large degree of uncertainty as to be non-significantly different from zero. In these cases the first order (asymptotic) approximation is very poor, but at the same time the case would be of no practical interest for the risk averting policy maker.

REFERENCES

Amemiya,T. (1983), "Non-Linear Regression Models", in *Handbook of Econometrics*, Vol.I, ed. by Z.Griliches and M.D.Intriligator. Amsterdam: North-Holland, 333-389.

Bianchi,C., J.L.Brillet et G.Calzolari (1984), "Analyse et Mesure de l'Incertitude en Prévision d'un Modèle Econométrique. Application au Modèle Mini-DMS", *Annales de l'INSEE* 54, 31-62.

Bianchi,C., G.Calzolari, and P.Corsi (1981), "Estimating Asymptotic Standard Errors and Inconsistencies of Impact Multipliers in Nonlinear Econometric Models", *Journal of Econometrics* 16, 277-294.

Brillet,J.L. (1981), "Mini-DMS: Modèle Macroéconomique de Simulation". Paris: INSEE, Archives & Documents No.35.

Brundy,J.M., and D.W.Jorgenson (1971), "Efficient Estimation of Simultaneous Equations by Instrumental Variables", *The Review of Economics and Statistics* 53, 207-224.

Evans,M.K., and L.R.Klein (1968), *The Wharton Econometric Forecasting Model*. Philadelphia: Economics Research Unit, University of Pennsylvania.

Fouquet,D., J.M.Charpin, H.Guillaume, P.A.Muet et D.Vallet (1978), "DMS, Modèle Dynamique Multisectoriel". Paris: Collections de l'INSEE, Série C, No.64-65.

McCarthy,M.D. (1972), "Some Notes on the Generation of Pseudo-Structural Errors for Use in Stochastic Simulation Studies", in *Econometric Models of Cyclical Behavior*, ed. by B.G.Hickman. New York: NBER, Studies in Income and Wealth No.36, 185-191.

Rao,C.R. (1973), *Linear Statistical Inference and its Applications*. New York: John Wiley.