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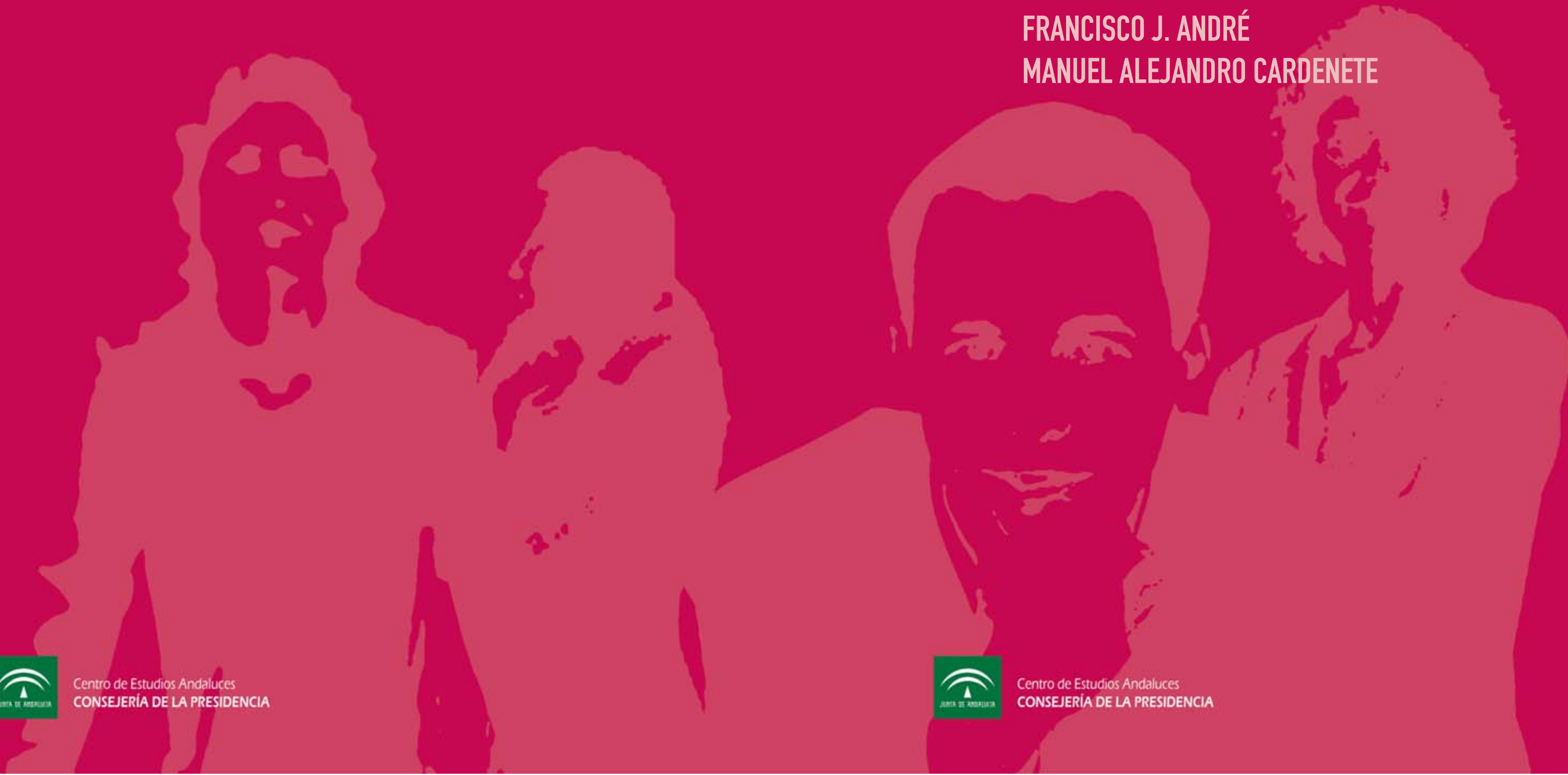

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Multicriteria Policy Making. Defining Efficient Policies in a General Equilibrium Model

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RESUMEN

Proponemos un enfoque metodológico para modelizar el diseño de políticas económicas y obtener recomendaciones prácticas de política basado en la teoría de la decisión multicriterio y un modelo económico estructural. En particular, se aplica la técnica de Programación Multiobjetivo en combinación con un modelo de equilibrio general aplicado, calibrado con datos españoles del año 1995, lo que permite proponer el concepto de *política eficiente* y calcular empíricamente el conjunto de políticas eficientes para la economía española. Este enfoque permite cuantificar el "tradeoff" entre el crecimiento y la inflación, medir la eficiencia de la política fiscal aplicada en la realidad y recomendar algunas modificaciones que pueden aumentar la eficiencia de la política económica en la práctica.

Palabras claves: Política Pública, Decisión Multicriterio, Frontera Eficiente, Equilibrio General Aplicado.

ABSTRACT

We propose to model policy making as a multicriteria problem and solve it using suitable multicriteria techniques in connection with some structural economic model to represent optimal policy making and to get useful policy recommendations. By using a multiobjective approach combined with a Computable General Equilibrium model, we propose the concept of efficient policy and calculate the set of efficient policies for the Spanish economy in an empirical exercise. This approach allows us to quantify the trade-off between growth and inflation, to measure the efficiency of the actually applied fiscal policy and to get some plausible modifications that could foster policy efficiency in practice.

Keywords: Public Policy, Multicriteria Decision Making, Efficient Frontier, Computable General Equilibrium Model.

JEL Classification: C61, C68, D78.

1. INTRODUCTION

The standard approach in economics to model the optimal design of economic policy is to assume that a social planner aims at maximising some social welfare function, typically the utility function of a representative consumer[1]. Although this approach is theoretically robust and elegant, it presents some difficulties concerning its realism and implement ability in practice. First, as Arrow (1963) showed, it is virtually not possible to define a welfare function with reasonable properties to represent the preferences of all the society. Second, the maximisation of a single utility function does not appear to be consistent with the observed practice in policy making, regarding the behaviour of the economic authorities. Rather, it seems to be the case that policy makers are concerned about a bundle of economic indicators that represent the state and evolution of the economy from a macroeconomic point of view (growth rate, inflation rate, unemployment rate, public deficit, public debt, foreign deficit…) and they try to design their policies to improve the performance of the economy as measured by these indicators. In other words, the government typically faces a decision problem with several policy goals and, moreover, these goals usually conflict with each other. For example, an active anti-unemployment policy could foster inflation; increasing economic growth could be harmful for the foreign sector, and so on.

The so-called Multicriteria Decision Making (MCDM henceforth) literature has been developed specifically to deal with situations in which there are multiple conflicting goals. Several particular techniques, such as multiobjective programming, compromise programming, goal programming and others, have been fruitfully applied to many economic problems in which it is not reasonable or operational to assume the existence of a single goal or objective. See Ballestero and Romero (1998) for an introduction to multicriteria techniques and their applications to economic problems.

In this paper we propose to model policy making as a multicriteria problem for a double reason. Firstly, from a conceptual perspective, it seems a sensible way to understand and represent the concerns and the procedures actually followed by policy makers. Secondly, from an empirical perspective, we argue that MCDM techniques, if properly applied, can be of considerable help to get operative policy recommendations and, therefore, to decide how to use policy instruments in practice. To elaborate on the

[1] See Ramsey (1927) for a pioneering work.

second argument, we investigate the potentiality of multiobjective programming, which is a MCDM technique designed to look for so-called *efficient solutions* and it can be applied to policy making problems to define what we call *efficient policies*. After identifying relevant policy objectives, a policy (i.e., a combination of policy instruments) is said to be efficient if there is no other feasible policy that can achieve the same of better performance for all the policy objectives being strictly better for at least one objective.

In the 70's some authors recognized the multicriteria nature of policy making and made some attempts to connect multicriteria techniques with econometric models to give policy recommendations (see Spivey and Tamura 1970, Wallenius, Wallenius and Vartia 1978, Zeleny and Cochrane 1978). This branch of work did not go very far, probably because of the intrinsic limitations of estimated econometric models to predict the effect of alternative policies. This limitation was clearly stated in a well-known article by Robert Lucas (1976). The main idea is that the parameters estimated from a reduced form model reflect a combination of economic agents' behaviour and the prevailing policy framework, so that in order to predict the effects of a different policy, it is not suitable to use a reduced form model, and a structural model, specifying behaviour functions for all the agents, is needed instead.

We propose to use a multicriteria approach connected to a structural economic model to approach the design of economic policies. Specifically, we present an application using a computable general equilibrium model (CGE model hereafter) calibrated for the Spanish economy. Following the CGE tradition, this model performs a structural disaggregate representation of the activity sectors in the economy and the equilibrium of markets, according to basic microeconomic principles.

In Section 2, we identify the main elements required to represent optimal policy making as a multicriteria problem both in a theoretical and an operational setting. Furthermore, we apply the multicriteria concept of efficient solutions in order to define *efficient policies*. In Section 3 we present an application to the Spanish economy using a CGE model. We discuss the main features of the model and the database used for the calibration and we set up the policy problem to be solved. For the sake of simplicity, we focus on a bi-criteria problem (growth vs. inflation) so that we can show a clear illustration of the methodology proposed. In Section 4, the most important results are presented. We construct an efficient frontier for the policy objectives and evaluate the observed policy as compared to this frontier. We detect some degree of inefficiency and we provide some empirical indications about how policy should be modified in practice to become more efficient. It is remarkable that the model recommends some policy changes depending on the policy focus but there are also a number of policy recommendations that appear to be relevant for the sake of efficiency independently of whether the decision makers are primarily concerned about growth or inflation.

2. GENERAL SETTING

Assume the government has a vector x of policy instruments which, depending on the institutional setting, may include different taxes, public expenditure and investment, interest rates, and so on.

Economic agents are assumed to act rationally in the sense that they choose the values for their decision variables to maximise their objective functions. Consumers make consumption and saving decisions to maximise utility and firms decide their factor demand and goods supply to maximise profits. Assume there are m economic agents in the economy and each agent h ($h=1,...,m$) has a vector, denoted as z_h, of decision variables. Agent h decides the value of z_h to

$$\begin{array}{ll} \textit{maximise} & f_h(z_h, z_{-h}, x) \\ \textit{subject to} & z_h \in R_h \end{array}$$

where R_h is the feasible set for the decision variables of agent h. In general, the objective function of agent h, f_h, may depend on his own decisions, the decisions (denoted as z_{-h}) of the rest of agents, and the value of the policy variables. For example, the profit of a firm depends on its own strategy, the competitors' strategy, the consumers' behaviour and the taxes they have to pay.

Let $\mathbf{z}_h(z_{-h},x)$ denote the optimal response of agent h, i.e., the (feasible) value of his decision variables maximising u_h, given the value of z_{-h} and x. Once the value of x is fixed, the interaction among agents provides the *equilibrium* value of all the decision variables for all the agents, denoted as $z^*(x) \equiv (z_1^*(x), \dots z_m^*(x))$. In equilibrium the following conditions must hold:

$$z^*_h(x) \in \mathbf{z}_h(z^*_{-h}, x) \qquad h=1,...,m \tag{1}$$

$$z^*(x) \in R$$

where R is a set determined by feasibility constraints for the whole economy (in a standard economic model, this includes the equality between demand and supply for all markets and overall resource constraints).

After aggregation of z^*, we get the value of the relevant macroeconomic variables which are the typical policy objectives (for example, Domestic Growth Product results from the aggregation of outputs from all the firms, the Consumer Price Index results from the weighted average of the prices of all goods and services, and so on). Assume the government is interested on K macroeconomic aggregates denoted as $Z_1, \ldots, Z_K$, which can be obtained from z* according to some aggregation rules:

$$\begin{aligned} Z_1 &\equiv Z_1(z^*(x)) \\ &\ldots \\ Z_K &\equiv Z_K(z^*(x)) \end{aligned} \qquad (2)$$

If a planner knows the response functions of all the agents, using (1) he can predict the equilibrium of the economy for every value of x and, using the aggregation in (2), he can get the values of the policy objectives as a function of x. If there were a single policy objective ($K=1$), the optimal design of the economic policy would result from solving the following problem[2]:

$$\begin{aligned} &\underset{x}{Opt} \quad Z \\ &s.\ t. \quad (1), (2) \\ &\qquad x \in X \end{aligned}$$

where *Opt* means the search for optimal solutions in a maximising sense when “more is better” (for example, economic growth) or in minimising sense when “less is better” (for example, inflation) and X is the feasible set accounting for any constraint on the policy variables (for example, fiscal pressure should not be too high, public expenditure should not exceed some limit, and so on). Nevertheless there are typically several policy

2 Following standard economic terminology, this policy making process can be interpreted as a game in which the planner acts as a leader by playing his strategy in the first stage and the rest of economic agents play their optimal responses in a subgame starting in the second stage (a single stage if we adopt a static approach or several subsequent stages if we use a dynamic approach).

objectives presenting some trade-off between them so that the government faces a multicriteria problem when making its policy. Depending on the specific context and the aims of the government, this problem could be handled using different techniques from those available in the literature (see, for example, Ballestero and Romero 1998). In this paper, we illustrate a way to handle policy design using multiobjective programming, which is a multicriteria technique aimed at determining efficient solutions. In MCDM, a feasible solution is defined as *efficient* if there is no other feasible solution that can achieve the same or better performance for all the criteria being strictly better for at least one criterion. In our context, the multiobjective design of policies can be represented by the following decision problem:

$$\begin{aligned} &Eff \quad Z \equiv [Z_1, \dots Z_K] \\ &s.\,t. \quad (1), (2) \\ &x \in X \end{aligned} \tag{3}$$

where *Eff* means the search for *efficient policies*. A feasible policy (i.e., a value of $x \in X$) is said to be efficient if it provides some values of the objective variables such that there is no feasible policy that can achieve the same of better performance for all the policy objectives being strictly better for at least one policy objective.

For practical purposes, the implementation of this approach requires the following elements:

1. Identifying the relevant policy goals as measured by economic variables.

2. Determining the policy instruments and the feasible range for them.

3. A structural model including behaviour functions for economic agents from which it is possible to express the equilibrium of the economy and the value of policy objectives as a function of policy instruments.

4. If, apart from a theoretical exercise, the research aims to be empirically useful, then it is also necessary to have a reliable database in order to find the parameter values of the model by some estimation of calibration procedure.

5. Finally, some suitable optimisation tool (typically, implemented in a software) is needed to make the computations required to solve (3).

3. AN APPLICATION FOR THE SPANISH ECONOMY

To implement this approach, firstly we need an economic model to represent the economy where the policy is to be applied. We use a CGE model calibrated for the Spanish economy in order to have a description of the real world as accurate as possible. Secondly, the policy instruments and policy objectives have to be defined. For the sake of simplicity, we stick to a bi-criteria setting assuming that the government only cares about growth and inflation. This allows us to get clear-cut results, which are easy to interpret and to illustrate graphically. A larger number of objectives could be handled in a similar way (of course, at the cost of a higher computational burden).

3.1. The economic model

We use a CGE model following the basic principles of the walrasian equilibrium -as in Scarf and Shoven (1984), Ballard et al. (1985) or Shoven and Whalley (1992)-, enlarged by including public and foreign sectors. The activity level of the foreign sector is assumed to be exogenous, while the relative prices and the activity levels of all the productive sectors are endogenous variables. Taxes and the activity of the public sector are taken as exogenous by consumers and firms and they are seen as decision variables by the government. A price vector for all goods and inputs, a vector of activity levels, and a value for public income give the equilibrium of the economy such that consumers maximise their utility, firms maximise their profits (net of taxes), public income equals the payments of all economic agents, and supply equals demand in all markets. A very similar model has been used for Spain in a regional basis. To save some space, we only present the basic features of the model. A more detailed description can be found in Cardenete and Sancho (2003) or André, Cardenete and Velázquez (2005).

The model comprises 9 productive sectors (in order to match the aggregated version of the Social Accounting Matrix, see below) with one representative firm in each sector, a single representative consumer, one public sector and one foreign sector. The production technology is described by a nested production function. The domestic output of sector j, measured in euros and denoted by Xd_j, is obtained by combining, through a Leontief technology, outputs from the rest of sectors and the value added VA_j. In turn, this value added is generated from primary inputs (labour, L, and capital, K), combined by a Cobb-Douglas technology. Overall output of sector j, Q_j, is obtained from a Cobb-Douglas combination of domestic output and imports $Xrow_j$, according to the Armington (1969) hypothesis, in which domestic and imported products are taken as imperfect substitutes.

There are 9 different goods –corresponding to productive sectors- and a representative consumer who demands present consumption goods and saves the remainder of his disposable income after paying taxes. The government raises taxes to obtain public revenue *R*, as well as it gives transfers to the private sector, *TPS*, and demands goods and services GD_j from each sector *j=1,…,9*. *PD* denotes the final balance (surplus or deficit) of the public budget:

$$PD = R - TPS\ cpi - \sum_{j=1}^{9} GD_j\ p_j$$

cpi being the Consumer Price Index and p_j a production price index before Value Added Tax (*VAT* hereafter) referring to all goods produced by sector *j*. The Consumer Price Index is calculated as a weighted average of the prices of all sectors, according to the participation of each one in the overall production of the economy.

Consumer disposable income (*YD* henceforth) equals labour and capital income, plus transfers, minus direct taxes:

$$YD = w\,L + r\,K + cpi\ TPS + TROW - DT\,(r\,K + cpi\ TPS + TROW)$$

$$- DT\,(w\,L - WC\,w\,L) - WC\,w\,L$$

where *w* and *r* denote input (labour and capital) prices and *L* and *K* input quantities sold by the consumer, *TROW* represents transfers received by the consumer from the rest of the world, *DT* is the tax rate of the Income Tax (*IT* hereafter) and *WC* the tax rate corresponding to the payment of the employees to Social Security (*ESS* hereafter). The consumer's objective is to maximise his welfare, subject to his budget constraint. Welfare is obtained from consumption goods CD_j (*j = 1,…,9*) and savings *SD*, -according to a Cobb-Douglas utility function:

$$\text{maximize} \qquad U\ (CD_1,\ldots,CD_9, SD) = \left(\prod_{j=1}^{9} CD_j^{\alpha_j} \right) SD^{\beta}$$

$$\text{s.t.} \qquad \sum_{j=1}^{9} p_j CD_j + p_{inv}\ SD = YD$$

p_{inv} being an investment price index.

Regarding investment and saving, this is a *saving driven* model. The closure rule is defined in such a way that investment is exogenous, savings are determined from the consumer's decision and both variables are related with the public and foreign sectors by the following identity, where INV_j denotes investment in sector j:

$$\sum_{j=1}^{9} INV_j \, p_{inv} = SD \; p_{inv} + PD + ROWD$$

Labour and capital demands are computed under the assumption that firms minimise the cost of producing value added. In the capital market we consider that supply is perfectly inelastic. For labour supply, we use the following approach, which shows a feedback between the real wage and the unemployment rate, related to the power of unions or other factors inducing frictions in the labour market[3]:

$$\frac{w}{cpi} = \left(\frac{1 - u}{1 - \bar{u}} \right)^{\frac{1}{\beta}}$$

where u and $\bar{u}$ are the unemployment rates in the simulation and in the benchmark equilibrium respectively, w/cpi is the real wage and β is a flexibility parameter. For the empirical exercises, we take an estimated value for Spain from the econometric literature: β=1.25 (Andrés et al. 1990). Gross Domestic Product (GDP hereafter) is calculated from the expenditure point of view, as the aggregation of private consumption, investment, public expenditure and net exports.

3.2. Databases and calibration

The main data used in this paper come from the aggregated 1995[4] social accounting matrix for Spain (SAM hereafter, see Cardenete and Sancho 2004 for the technical details about the construction of this matrix). The SAM comprises 21 accounts, including 9 productive sectors as shown in Table 1[5], two inputs (labour and capital), a saving/investment account, a government account, direct taxes (*IT* and *ESS*)

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[3] This formulation is consistent with an institutional setting where the employers decide the amount of labour demanded and workers decide real wage taking into account the unemployment rate: if labour demand increases (decreases), the unemployment rate *u* decreases (increases) and workers demand higher (lower) real wages. If, after the simulation, employment remains unchanged, the real wage is the same as in the benchmark equilibrium. (see Kehoe et al. (1995)).

[4] The latest symmetric input-output table (from which the SAM is built) officially available at this moment in Spain is the one of 1995.

[5] A more disaggregate version is available but we decided to stick to this simpler version since we do not attempt to capture any distributional impact but to focus on aggregate effects.

and indirect taxes (*VAT*, payroll tax, output tax and tariffs), a foreign sector and a representative consumer.

The numerical values for the parameters in the model are obtained by the usual procedure of calibration (see, for example, Mansur and Whalley, 1984). Specifically, the following parameters are calibrated: all the technical coefficients of the production functions, all the tax rates and the coefficients of the utility function. The calibration criterion is that of reproducing the 1995 SAM as an initial equilibrium for the economy, which is used as a benchmark for all the simulations. In such an equilibrium, all the prices and the activity levels are set equal to one, so that, after the simulation, it is possible to observe directly the change rate of relative prices and activity levels. When finding the economic equilibrium corresponding to the policies combinations obtained from the optimisation exercises, the wage is taken as numeraire ($w = 1$) and the rest of prices are allowed to vary as required to meet equilibrium conditions.

3.3. Policy variables, policy objectives and efficient policies

We focus on fiscal policy and we take as **policy variables** (x) the public expenditure in each activity sector (g_j)[6] and the average tax rates applied to every economic sector, including indirect taxes: Social Security contributions paid by employers (EC_j), Tariffs (T_j), Value Added Tax (VAT_j); and direct taxes: Social Security contributions paid by employees (W_j) and Income Tax (TD). Concerning the feasible set for these policy variables (X) we impose the following constraints to give some realism to the exercise:

- We take as a benchmark the values of public expenditure and tax rates observed in the SAM and obtained in the calibration procedure. We restrict all the policy variables to vary less than twenty percent with respect to their values in the benchmark situation (denoted as x_0):

$$0.8\ x_0 \leq x \leq 1.2\ x_0$$

- Furthermore, to avoid obtaining policies that could affect drastically the public budget, we impose the constraint that both the overall tax revenue and the

[6] In the SAM for Spain, the Government expenditure only appears to be positive in sectors 5, 6 and 9 (Chemicals, Machinery and Transports and Services). See Table 3.

overall public expenditure must be equal to their values in the benchmark situation.

We assume that there are only two relevant **policy objectives** ($K = 2$), namely to maximise economic growth (γ) and to minimise inflation (π). Economic growth is calculated by the annual rate of change of *GDP* and inflation is measured by the annual rate of change of the *cpi*:

$$\gamma = \frac{GDP_{1995} - GDP_{1994}}{GDP_{1994}} \cdot 100 \qquad\qquad \pi = \frac{cpi_{1995} - cpi_{1994}}{cpi_{1994}} \cdot 100$$

were the subscript denotes the year. The values of *GDP* and *cpi* for 1994 are exogenously given[7] and the values for 1995 are equilibrium values endogenously determined in the optimisation exercises.

A specific policy combination x providing the objective values $K=(\gamma,\pi)$ is then an **efficient policy** if there is not any feasible policy x' providing $K'=(\gamma',\pi')$ such that $\gamma' \geq \gamma$ and $\pi' < \pi$, or $\gamma' > \gamma$ and $\pi' \leq \pi$.

4. RESULTS[8]

As it is common in MCDM exercises, the first step is to asses the degree of conflict between the relevant policy objectives by computing the so-called payoff matrix. This is made by optimising each objective separately –in this case, maximising growth and minimising inflation[9]- and then computing the value of each objective at each of the optimal solutions. Table 2 displays the results from these calculations. The first row shows the values of growth and inflation obtained from the growth maximisation exercise and the second row the values of the same variables obtained when minimising inflation.

As common macroeconomic intuition suggest, we conclude that there is a strong conflict between both objectives: by implementing a suitable policy, it would be possible to obtain a growth rate equal to 3.62 at the cost of having an inflation rate of 6.59 %. Similarly, the lowest feasible inflation, -6.76 % would imply a negative growth

[7] Source: INE (Spanish Statistical Institute).
[8] All the calculations are made using GAMS software.
[9] Since GDP_{1994} and cpi_{1994} are given, maximising γ and minimising π is the same as maximising GDP_{1995} and minimising cpi_{1995}.

rate equal to -9.69 %. The set of values in the main diagonal (the maximum growth rate and the minimum inflation rate) is known as *ideal point*. The vector with the worst element of each row (in this case, the minimum growth rate and the maximum inflation rate) is called *anti-ideal* or *nadir point*.

The second step is to construct (an approximation of) the efficient set of policies. The difficulty to obtain this set crucially depends on the size of the problem and, specifically, on the number of objectives. In our case, since we focus on bi-criteria problems, it is relatively easy to construct the efficient set using the so-called *constraint method* (initially proposed by Marglin, 1967) in the following way: we make a grid for the feasible values of π, from π= -6.76 to π=6.59. The resolution needed for the grid depends on the problem at hand. In our case, ten values appeared to be enough to get a good approximation to the efficient set. Let π_n (n = 1, …, 10) denote one specific value of π in the grid. For each one of these values we solve the problem *max* γ subject to the constraint $\pi \leq \pi_n$ and all the equations in the model. This procedure is similar to the one proposed by Markowitz (1952, 1959) to construct mean-variance frontiers in finance. Figure 1 shows the result of this process as well as the ideal point and nadir point for the Spanish economy in the year 1995. It can be seen that, in the set of efficient policies, there is a monotonic relationship between economic growth and inflation but the trade-off between both rates, as measured by the slope of the frontier, is not constant. Since the frontier results to be strictly convex, if the government tries to get higher and higher growth rates (i.e., moving to the right), this will come at an increasing cost in terms of stronger upwards shifts in the inflation rate.

Testing the efficiency of observed policies

Calculating the set of efficient policies for a specific economy in a given period (in our case, Spain, 1995) provides an interesting possibility: the observed rates of growth and inflation, which can be understood as the result of the policy actually implemented by the government, can be compared to the efficient combinations in order to determine to what extent the economic policy followed by the government can be considered as efficient in terms of the objectives. Furthermore, by making a projection of the observed values on the frontier we can get some clues about how the policy instruments could be modified to improve the economic results.

In the case under study, we observe the following values for the growth rate and the inflation rate in Spain during the year 1995[10]: γ = 2.71 %, π = 4.3 %. These values are represented by point O in Figure 2, which is a convenient amplification of the relevant part of Figure 1. Since this point lies strictly to the northwest of the efficient frontier, we conclude that the observed policy displays some degree of inefficiency because there are some feasible policies that would provide combinations of growth and inflation that dominate the observed combinations. Note that point H provides the same inflation rate with a strictly higher growth rate (specifically, γ_H=3.02, π_H=4.3) and point V, in turn**,** provides the same growth rate with a strictly lower inflation rate (γ_V=2.71, π_V=3.15). Finally, if we move to a point like D, we get a strictly higher growth rate with a strictly lower inflation rate (γ_V=2.85, π_V=3.63).

From this exercise we can get some information about promising directions for the *fine-tuning* of economic policy. Table 3 shows the value of the policy instruments in the observed situation (resulting from the calibration), in point H ("horizontal projection") and point V ("vertical projection"). The former is obtained by maximising γ subject to $\pi \leq 4.3$ (the observed value of inflation) and the latter by minimising π subject to $\gamma \geq 2.71$ (the observed value of growth).

Depending on the preferences of the government, the policy strategy could be somehow modified to move towards points H, V or D (or any other on the efficient frontier) but, in any case, if any of these combinations are attainable, it is not rational to choose point O instead.

It is worthwhile to remark the similarities and differences between both projections. Since point H is the result of maximising growth (while restricting inflation) and V is the result of minimising inflation (while restricting growth), one could expect to get dramatically different policy strategies in each case. Nevertheless, as it can be seen in Table 3, although there are some policy variables that move differently in both exercises, there are many of them displaying exactly the same behaviour in both cases. Therefore, we can split the set of policy recommendations in two groups: firstly, one group of policy changes that appear to be beneficial for efficiency regardless of whether the priority of the government is to foster economic growth or to reduce inflation, which we label as *general efficiency recommendations*, and secondly a set of

[10] Source: INE (Spanish Statistical Institute).

policy changes that depend on the preferences of the government concerning policy objectives. We label them as *objective-specific recommendations*.

In the first group (*general efficiency*) we can highlight that the model recommends to increase the public sector expenditure on goods from sectors 5 (Chemicals) and 6 (Machinery and transport) and to reduce that of goods from sector 9 (Services). Concerning VAT, the tax rates should decrease for sectors 1 to 4 and 9 and to increase for sectors 5, 6 and 8. The Social Security contribution paid by employees and that paid by employers in sectors 1 to 4 should unambiguously decrease, whereas that paid by employers should increase in sectors 6, 8 and, to a smaller extent, in sector 7. As a general comment, the model seems to suggest that taxation should be alleviated in less productive sectors (Agriculture, Extractives, Energy or Food) or those generating a lower valued added (Services) and increased in dynamic sectors such as Machinery and transport or Construction.

The shadowed cells show the objective-specific policy recommendations, i.e., the policy variables that should be modified in a different way for a growth-maximising strategy and for an inflation-minimising strategy. The differences between both strategies appear to be rather small as compared with their common features. The clearest differences arise in the Social Security contribution paid by Employers in sectors 5 and 9 that should be higher to increase growth and lower to reduce inflation. Something similar happens with the indirect tax on consumption (VAT) in sector 7.

5. DISCUSSION AND CONCLUDING REMARKS

We have argued that the process of designing optimal policies can be suitably understood as a multicriteria decision problem from the point of view of the government. Consequently, we propose to use multicriteria techniques in connection with some structural modelling strategy for the economy in order to get a realistic picture of this decision process and sensible recommendations to improve the efficient use of policy instruments in practice.

Multiobjective programming allows us to define efficient policies with respect to given policy goals and, combining this tool with a suitable economic model, it is also possible to calculate empirically the set of efficient policies. We claim that a CGE model is an adequate complement for this exercise because it rests on a structural definition of agents' behaviour.

A CGE model properly calibrated for the Spanish economy allows us to quantify the trade-off between growth and inflation when designing fiscal policy. Furthermore, possible inefficiency of the policy currently applied can be detected and we can get some recommendations about lines for improving the policy mix. It is remarkable that a number of policy changes seem to be relevant for the sake of efficiency independently of the weight given to growth and inflation by the policy makers.

Some limitations and plausible ways to extend this analysis should also be remarked. Firstly, the analytical model suggests which policy changes could be beneficial for the economy, including the policy instruments that should change and the directions for these changes. In practice, it could be difficult to follow strictly these recommendations because of financial and institutional rigidities. In any case, we claim that this kind of information could be interesting for the government as an orientation, even if it is not possible to be fully applied. Secondly, note that the definition of efficient policies is essentially determined by the selection of policy objectives. Therefore, what appears to be an inefficient policy relative to a set of objectives could be efficient when evaluated with different criteria. For example, we identify some degree of inefficiency in the Spanish fiscal policy assuming that policy objectives are basically represented by economic growth and inflation. Considering different objectives such as employment, environmental impact or international convergence could give totally different results concerning the efficiency or inefficiency of policy. An immediate extension of this work consists of widening the set of policy objectives and analysing policy decisions under alternative combinations of those objectives.

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REFERENCES

ANDRÉ, F.J., CARDENETE, M.A., VELÁZQUEZ, E. (2005) "Performing an Environmental Tax Reform in a Regional Economy. A Computable General Equilibrium Approach" *Annals of Regional Science*, forthcoming.

ANDRÉS, J., DOLADO, J.J., MOLINAS, C., SEBASTIÁN, M., ZABALZA, A. (1990) "The Influence of Demand and Capital Constraints on Spanish Unemployment" in: Drèze, J., Bean, C. (eds.), *Europe's Unemployment Problem*. MIT Press, Cambridge, USA.

ARMINGTON, P. S. (1969). "A Theory of Demand for Products Distinguished by Place of Production" *International Monetary Fund*, Staff Papers 16: 159-178.

ARROW, K.J. (1963) Social Choice and Individual Values, New Haven, Yale University Press.

BALLARD, C. L. ET AL. (1985). *A General Equilibrium Model for Policy Evaluation.* University of Chicago Press, Chicago.

BALLESTERO, E., ROMERO, C. (1998) Multiple Criteria Decision Making and its Applications to Economic Problems, Kluwer Academic Publishers.

CARDENETE M.A., SANCHO, F. (2003) 'An Applied General Equilibrium Model to Assess the Impact of National Tax Changes on a Regional Economy' *Review of Urban and Regional Development Studies* 15 (1): 55-65.

CARDENETE, M.A., SANCHO, F. (2004) "El marco del SEC95 y las matrices de contabilidad social: España 1995" *WP* E2004/03, Fundación Centro de Estudios Andaluces.

KEHOE T.J., POLO, C., SANCHO, F. (1995) 'An evaluation of the performance of an applied general equilibrium model of the Spanish economy' *Economic Theory* 6:115-141.

LUCAS, R.E. (1976) Econometric Policy Evaluation: A Critique, in Brunner and Meltzer (eds.) *The Phillips Curve and Labour Markets*, Carnegie Rochester Conference Series on Public Policy 1: 19-46.

MANSUR, A.,WHALLEY, J. (1984). "Numerical Specification of Applied General Equilibrium Models: Estimation, Calibration, and Data", en Applied General Equilibrium Analysis, H. Scarf y J. B. Shoven (eds.): 69-117.

MARGLIN, J.A. (1967) Public Investment Criteria. The Massachusetts Institute of Technology, Cambridge.

MARKOWITZ, H.M. (1952) Portfolio Selection. Journal of Finance 7: 77-91.

MARKOWITZ, H.M. (1959) Portfolio Selection, Wiley, New York.

RAMSEY, R.P. (1927) "A Contribution to the Theory of Taxation" *The Economic Journal* 37: 47-61.

SCARF, H., SHOVEN, J.B. (eds.) (1984). Applied General Equilibrium Analysis. Cambridge University Press. Cambridge.

SHOVEN, J.B., WHALLEY, J. (1992). Applying General Equilibrium. Cambridge University Press. New York.

SPIVEY, W.A., TAMURA, H. (1970) "Goal Programming in Econometrics" *Naval Res. Logist. Quart.* 17: 183-192.

WALLENIUS, H., WALLENIUS, J., VARTIA, P. (1978) "An Approach to solving Multiple Criteria Macroeconomic Policy Problems with Applications" *Management Science* 24: 1021-1030.

ZELENY, M., COCHRANE, J.L. (1978) A Priori and a Posteriori Goals in Macroeconomic Policy Making in *Multicriteria Decision Making*, J. Cochrane and M. Zeleny (eds.), Columbia, South Carolina; pp: 373-391.

FIGURES AND TABLES

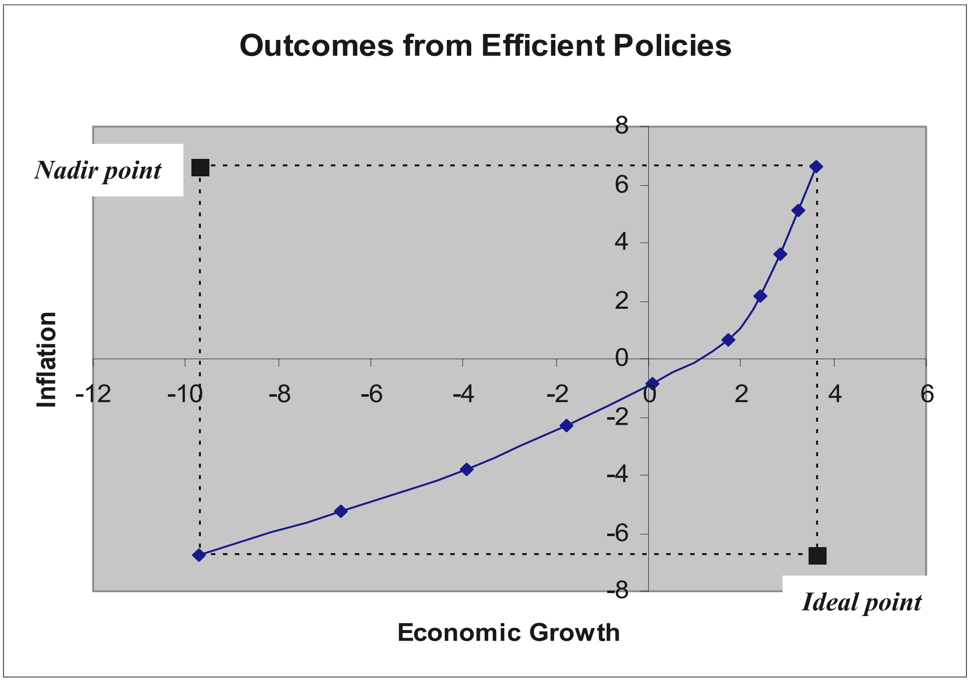

Figure 1. Efficient policies in the Growth-Inflation plane

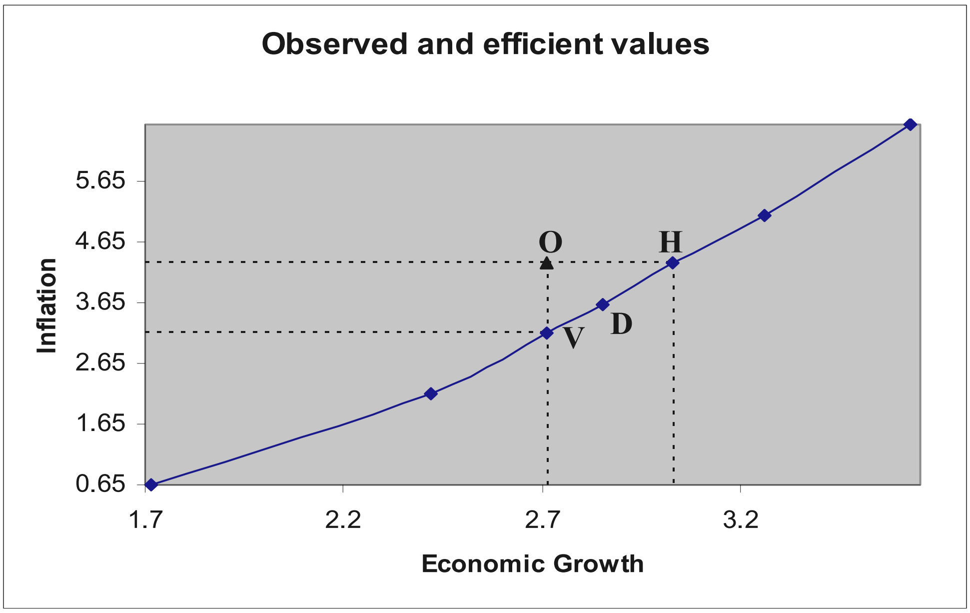

Figure 2. Projecting the observed policy on the efficient frontier

Table 1: Productive sectors in SAM

Nº	Name
1	Agriculture, cattle, forestry and fishing
2	Extractives
3	Energy and Water
4	Food
5	Chemicals
6	Machinery and transport
7	Manufactures
8	Construction
9	Services

Source: Cardenete and Sancho (2004)

Table 2. Pay-off matrix

	γ ***Econ. growth* (%)**	π ***Inflation (%)***
Max γ	**3.62**	6.59
Min π	-9.69	**-6.76**

Source: own elaboration.

Table 3. Policy variables (observed and projected)

	Sector	Observed[(a)]	Point H Value[(a)]	Point H Change rate[(b)]	Point V Value[(a)]	Point V Change rate[(b)]
Public expenditure	**5**	3295	3954	20.00	3954	20.00
	6	119	143	20.00	143	20.00
	9	80362	79679	-0.85	79679	-0.85
VAT	**1**	0.65	0.52	-20.0	0.52	-20.0
	2	1.30	1.04	-20.0	1.04	-20.0
	3	3.29	2.63	-20.0	2.63	-20.0
	4	2.28	1.82	-20.0	1.82	-20.0
	5	1.02	1.22	20.0	1.22	20.0
	6	1.42	1.71	20.0	1.71	20.0
	7	1.89	2.26	19.5	1.86	-1.7
	8	1.70	2.04	20.0	2.04	20.0
	9	3.61	2.89	-20.0	2.89	-20.0
Social Security Employers	**1**	11.17	8.94	-20.0	8.94	-20.0
	2	39.64	31.72	-20.0	31.72	-20.0
	3	36.22	28.98	-20.0	28.98	-20.0
	4	27.28	21.83	-20.0	21.83	-20.0
	5	32.33	32.73	1.2	29.57	-8.5
	6	28.52	34.23	20.0	34.23	20.0
	7	25.58	28.05	9.6	26.70	4.4
	8	23.28	27.94	20.0	27.94	20.0
	9	26.60	27.44	3.2	24.84	-6.6
Tariffs	**1**	0.15	0.15	0.0	0.15	0.0
	2	0.11	0.11	0.0	0.11	0.0
	4	0.57	0.56	-1.75	0.57	0.0
	5	0.56	0.66	17.85	0.56	0.0
	6	1.62	1.62	0.0	1.59	-2.2
	7	0.89	0.89	0.0	0.89	0.0
Income Tax		10.29	10.75	4.5	11.47	11.5
Soc. Sec. Employees		6.50	5.17	-20.5	5.17	-20.5

Source: own elaboration. Units: [(a)] Million euros for Public Expenditure and per cent average rates for taxes; [(b)] per cent rate of change with respect to the observed value.