Operationalising Senian capability approach by modelling human development

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Sommario: Questo modello rappresenta un tentativo di operazionalizzazione del capability approach di Amartya Sen attraverso l'impiego dell'analisi su sistemi dinamici. Il nostro obiettivo è quello di studiare le variazioni nel corso del tempo di alcuni funzionamenti considerati come proxy delle capabilities.
Il modello è composto di due sezioni: la prima, denominata 'Left Side' rappresenta la 'domanda' dei funzionamenti stessi in una situazione ideale; la seconda, denominata 'Right side', indica invece l''offerta' di un certo livello di funzionamenti che il sistema socio-economico è in grado di garantire agli individui.
Il modello è specificato per il caso italiano è può essere simulato su orizzonti temporali prestabiliti: su ogni periodo, si tiene conto della differenza tra situazione ideale e reale che innesta un meccanismo di risposta a livello di policy e determina la dinamica di quello che, in ultima analisi, consideriamo sviluppo umano.

Abstract: In this paper we model sustainable human development as intended in Sen's capability approach in a system dynamic framework. Our purpose is to verify the variations over time of some achieved functionings, due to structural dynamics and to variations of the institutional setting and instrumental freedoms (IF Vortex).
The model is composed of two sections. The 'Left Side' one points out the 'demand' for functionings in an ideal world situation. The real world one, on the 'Right Side' indicates the 'supply' of functionings that the socio-economic system is able to provide individuals with.
The general model, specifically tailored for Italy, can be simulated over desired time horizons: for each time period, we carry out a comparison between ideal world and real world functionings. On the basis of their distances, the model simulates some responses of decision makers. These responses, in turn influenced by institutions and instrumental freedoms, ultimately affect the dynamics of real world functionings, i.e. of sustainable human development.

Keywords: Capabilities, Instrumental Freedoms, Sustainable Human Development.

1. *Introduction*

The notion of welfare highlighted by the utilitarian framework that forms the basis of mainstream economics offers only a limited perspective of human well-being. In fact this notion reflects only the class of differences captured by money metric, under the economic rationality of self-interested utility maximization. Moreover, the income approach to well-being doesn't account for the diversity in human beings and for the heterogeneities of contingent circumstances[1].

It is preferable therefore to enlarge the notion of well-being in order to encompass other important dimensions – social, environmental, institutional, intergenerational – for the flourishing of human beings that utility metric does not account for. This perspective can be intended as a model of development which advances economic and social justice, protects the environment, strengthens institutional capacities and protect the freedoms of future generations. In brief, this is the notion of sustainable human development, as intended in Sen's capability approach.

The ultimate goal of this paper is to point out a possible a way of modelling and simulating the evolution of sustainable human development over time through system dynamic analysis. In doing so, we monitor the variations over time of some achieved functionings, due to structural dynamics and to variations in the institutional setting and in instrumental freedoms (IF Nexus).

Section 2 defines the notion of sustainable human development according to the capability approach. Section 3 deals with the operationalization of the capability approach. Section 4 highlights the generalities of the simulation model, focusing on the relationships between MiSS and the notion of equilibrium in economic theory. Section 5 sets its underpinnings and main strengths and weaknesses. Section 6 depicts specifically the architecture of the proposed framework. Section 7 and section 8 conclude the report by presenting the most relevant findings, analysing and discussing the different scenarios obtained through the running of the model.

[1] A complete critique of the drawbacks of utilitarianism is however beyond the goals of this paper.

2. *Sustainable human development*

Sen's conception of sustainable human development departs from the traditional Bruntland's one[2] insofar its focus is on the broadening of human freedoms on a sustainable basis, rather than on needs. In fact he has continuously underlined the importance of entitlements, opportunities, and freedoms as conceptual foundations of social choice.

In the latest thirty years Sen has been developing an approach based on individuals' possibilities to pursue their own project of life in terms of doing valuable acts and of reaching valuable states of being. This perspective is the core of the capability approach, whose main novelty lies in the definition of a broader theoretical framework of well-being, stressing the importance of enjoying enduring essential freedoms to reach a specific project of life, dependent at the same time «on a number of contingent circumstances, both personal and social» (Sen, 1999:70).

In spite of the fact that Sen's interest seems to be mainly focused on the role played by the capability approach as a framework of thought aiming at highlighting the drawbacks of other social choices approaches, this approach can also be considered a method for making interpersonal comparison of well-being. In fact Sen himself, though acknowledging the empirical difficulties, ascribes significant importance to the practical usability of the theory he has put forward: «the approach must nevertheless be practical in the sense of being usable for actual assessment» (Sen, 1987(b): 20). In this sense we intend to rely on the capability perspective, used for exploring a number of social issues such as well-being and poverty, liberty and freedom, living standards and development, gender bias and sexual division, justice and social ethics (Sen, 1993: 30, note 1), to analyse the evolution of sustainable human development.

In the capability approach human development implies the broadening of individuals' potential, being individuals the very ends of developments, rather than its mere means. Actually, in Sen's vocabulary sustainable human development is closer to the notion of

[2] In the Bruntland Report (1987) sustainable development is intended as a form of development that satisfies the needs of the present generation without compromising the ability of future generations to meet their own needs.

agency than to the narrower one of well-being: the latter in fact refers to a personal situation in term of achieved functionings and includes also sympathy, a concern for others' achieved functionings (or others' well-being); while the former taking into account commitment, is more inclusive insofar it relates also to the willingness to actually support other individuals in pursuing their projects of life regardless of the impacts on one's own well-being[3]. Hence sustainable human development considers in its agency notion a real social commitment, stronger than the sort of proximity to other individuals put forward by the notion of well-being. So, basically, we use the term well-being interchangeably with sustainable human development, instead of the more appropriate agency to keep on with the traditional vocabulary of the literature on the argument.

This Senian approach has profound roots in philosophy and classic economic theory. Both in fact take extensive note of the issue of human development: «The approach [to human development] reclaims an old and established heritage, rather then importing or implanting a new diversion» (Anand and Sen, 1994b: 3). More specifically, Sen's work has evident relations with Aristotle's human flourishing and «strong connections with Adam Smith's analysis of 'necessities' and conditions of living» (Sen, 1999: 24), concerning the ability of people to choose a reasonable life. Furthermore, Sen in the critic of utilitarianism is also close to the Marxian approach. In fact the latter seems to valuate goods themselves as intrinsically good in what is called 'commodity fetishism'. What he tries to establish is a sort of ethic foundationalism not rooted in a metaphysical principle, rather in ethical concepts intrinsically important for human lives: «We must ask which things are so important that we will not count a life as a human life without them? Such an evaluative inquiry into what is deepest and most essential in our lives…can be a way of looking at ourselves, asking what we really think about ourselves and what olds our history together» (Sen, 1992: 210).

In Sen's view of human development individuals are not simply people with needs, but they are «agents of change who can -given the

[3] Furthermore, Sen pointed out a narrower notion, namely the standard of living, which involves only the aspects of well-being regarding «the nature of his own life, rather then [from] 'other-regarding' objectives or impersonal concerns" (Sen, 1993: 37).

opportunity- think, assess, evaluate, resolve, inspire, agitate, and through these means reshape the world» (Sen, 2000: 1). The enlargement of substantive human freedoms is at the core of Sen's perspective. In brief, the capability approach requires «a broader informational base, focusing particularly on people's capability to choose the life they have reason to value» (Sen,1999: 63), to highlight the social and economic factors which give people the opportunity to achieve such a valuable project of life. Thus the capability approach concentrates directly on substantive freedoms of individuals involved. In this sense, Sen suggests that well-being be considered in terms of human functionings and capabilities. Functionings relate to what a person may value doing or being: they are the living conditions achieved by an individual and represent a set of interrelated activities and states ('doings' and 'beings') that form her life. Capabilities concern the ability of an individual to achieve different combinations of functionings, and define the freedom to choose the life that she prefers. These two categories are complementary but however distinct: «A functioning is an achievement, whereas a capability is the ability to achieve. Functionings are, in a sense, more directly related to living conditions, since they are different aspects of living conditions. Capabilities, in contrast, are notions of freedom, in the positive sense: what real opportunities you have regarding the life you may lead» (Sen, 1987: 36). It is not the aim of this paper to reconsider all the theoretical issues concerning this approach, since they have been thoroughly analysed in the literature. Rather, here we intend to define a model for monitoring the evolution of sustainable human development according to Sen's view.

Sustainable human development, as pointed out, can be generally intended as an increases in the quality of life, both equitable and durable. In this sense «[the human development approach] applies …to the freedom to lead lives that people today and in the future value» (Anand and Sen, 1994b: 6). Accordingly Sen himself defines sustainable development «as development that promotes the capabilities of present generation without compromising capabilities of future generations» (Sen, 2000: 5). It is in fact a point of view strictly consistent with the extension from the fulfilment of needs to the enhancement of human freedoms on a sustainability basis.

At the same time sustainable development as intended by Sen owes very much to the Bruntland's notion: the latter too, in fact,

includes consideration on the quality of life of each future generation, combined with concerns of intragenerational equity, and pays attention to the ability of meeting ones' own goals. The very difference between the two approaches lies in the evaluative conception. The Bruntland's approach views human beings only in terms of needs and fulfilment, Sen's one underlines the importance of freedom to enhance human capabilities: «[So. That is,] if you broaden sustainable development as sustaining the freedoms that people have, expanding freedoms and sustaining the freedoms that we have, I think we can get an adequately broad view of it. And that is the direction I would like to push the sustainable development literature to go. And it is an important distinction because quite often on the ground that ends justify the means - a very bewildering sentiment - people do things, recommend policies in the name of sustainable development, that begin by obliterating something very worth sustaining, namely human freedom.» (Massarenti, interview with A.K. Sen, 2000).

To sum up, Sen suggests that human development coincides with the expansion of capabilities («..[a] development that promotes the capabilities of present people…», Sen, 2000: 5). If this enlargement of the space of choices is expected to hold in the future («…without compromising capabilities of future generations», ibid: 5) it is possible to refer to it as sustainable (human) development. Finally, in a practical perspective, Sen recommends that «In detailed application, a general idea of this kind [i.e. sustainable development] can, of course, be combined with more precise articulation (taking contingent note of the availability of data and information», ibid: 3). On this ground, therefore, in the following sections we outline a possible model for measuring through system dynamics analysis sustainable human development as intended in the capability approach.

3. *The operationalization of capability approach*

The process of operationalization relies on the translation of theoretical concepts into empirical ones, which eventually become empirical variables usable in quantitative and non-quantitative analysis.

We consider the capability approach primarily as a method for making interpersonal comparison of well-being. Indeed, in Sen's intention it has far wider implications: it is first of all a framework of thought, which aims to highlight the drawbacks of other approaches in identifying and defining well-being and human development. Since Sen's interest seems to be mainly concerned with this foundational level, he has never provided a formula or path to carry out welfare and development measurements and comparisons[4]. Actually, vagueness is a distinctive character of the capability approach, for it depends on the context, which is as ambiguous and complex as human life and values are.

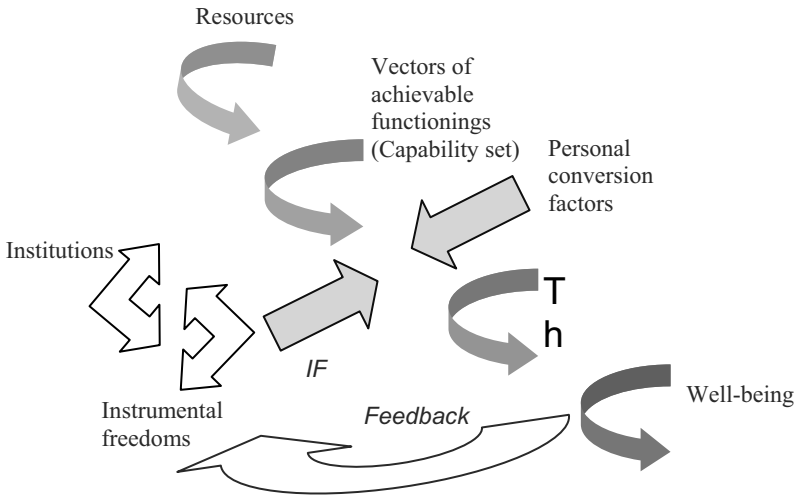
In general, Sen's approach requires the translation of resources into valuable beings and doings (i.e. functionings), from which the various combinations of achievable functionings may be chosen (this possibility of choice forms the space of capabilities). In other words, resources, sifted by personal and social conversion factors, allow the attainment of a number of beings and doings, which may be represented by the vectors of achieved functionings[5] (or the capability set). Moreover, the conversion of resources into functionings is supported by a set of instrumental freedoms, which promote and enhance institutional efficiency and effectiveness and thus uphold the success of the translation process (we call this complex connection 'the Institutions-Freedoms – or IF – vortex'[6]). Finally, the choice of a specific subset (a vector) of functionings generates a given level of well-being, which in turn can eventually 'tune-back' institutions and their responses.

[4] With great disappointment of those who have looked into Sen's writings for these 'recipes'.

[5] Achieved functionings could be alternatively seen as an elementary valuation of the capability set. In this sense – only in this sense – functionings and capabilities coincide.

[6] The expression 'Institutions-Freedoms vortex' is taken from Chopra, Duraiappah (2001).

Figure 1 – *The capability approach: a general view*



We consider this schematic, and intrinsically dynamic representation as the capability approach itself, quite consistent with Sen's view of well-being: «We use incomes and commodities as the material basis of our well-being. But what use we can respectively make of a given bundle of commodities, or more generally of a given level of income, depends crucially on a number of contingent circumstances, both personal and social» (Sen, 1999: 70). These different contingent circumstances «make opulence … a limited guide to welfare and the quality of life» (ibid: 71).

In order to operationalize the capability approach we must introduce a major simplification[7]: we restrict the model to the space of the chosen vector of functionings. In doing so we avoid the issue of the measurement of capabilities, and bypass the problem of their

[7] We are aware of other areas of incompleteness with respect to the foundational theory. For thorough and yet synthetic analysis of the capability approach, see for instance Gasper (2002), Robeyns (2000), Saith (2001).

unobservability[8]. Therefore, we too stick to Basu's suggestion – reported in Brandolini and D'Alessio (1998:15) –: «…to go along with Sen and evaluate well-being on the basis of functionings, but be content with achievements, instead of capabilities». Sen himself suggests that at a practical level the most appropriate focus of attention should not always lie in the measure of capabilities: «Some capabilities are harder to measure than others and attempts to putting them on a 'metric' may sometimes hide more than they reveal» (Sen, 1999: 81). Furthermore, the chosen vector of functionings could be seen as an elementary valuation of the capability set, which depending on the appropriate choice of the elements of the vector (e.g. assuming a maximizing behaviour), can in turn be considered as the maximally valued one[9]: «the focusing on a chosen functioning vector coincides with concentration on the capability set, since the latter is judged, ultimately, by the former.» (Sen, 1999: 76 – emphasis in the original). In fact, although Sen claims the necessity of specifying deprivation or achievements in terms of capability, he provides no definitive argument for this point. So we can say that a universal need for A can be a proxy for a universal capability to A, considering A sufficiently general in order to permit different specifications in different contexts (as we try to do in our model).

From a theoretical point of view the reference unit of the capability approach is the individual, functionings and capabilities being in fact properties of individuals. More specifically, Sen moves in the space of moral individualism and considers the individual as the only unit that counts when evaluating social states, avoiding at the same time to reduce society to the mere sum of individuals and their properties, as set by ontological individualism. In other words, the use of different units of analysis (groups based on age, gender, administrative boundaries or other elements) in the empirical work points out intergroup variations, but according to Sen (1992: 117, n.1) the focal point of the analysis remains the individual, since the interest in group

[8] In fact their potential nature can become actual only after an individual's process of choice.

[9] In this perspective the value of the capability set is that of a single element of the set itself, the maximally valued one. But this view holds if freedom is considered mainly in its instrumental meaning, and not in its substantive one. In this latter case we inevitably should have pushed our analysis to the capability set, with all the problems deriving from unobservabilty and from the increase of information required.

is only derivative (i.e. regarding the differences among individuals placed in different groups) and not intrinsic (i.e. regarding the differences between groups seen as unique bodies). Nonetheless, Sen's moral individualism does not forget that the human being is a zoon politikon, insofar her evaluative process is shaped by a number of social elements, such as the social conversion factors and, mainly, the IF vortex. Indeed in Sen's words, as pointed out by some observers, there is a deep interest for the institutional basis of human life, and his concern for the individual seems rather formal, or at least instrumental, insofar individuals are member of a community (Comim 2001: 9). For these reasons it is possible to use the capability approach to assess social well-being, that is some form of aggregation of individuals' well-being[10]. In other words, focusing the capability approach at a macro level indeed implies the loosing of the keener in-depth perspective of individual analysis. But this is the price we have to pay to obtain a policy tool, which hopefully could be useful for a keener comprehension of sustainability dynamics over time.

Sen himself in applying the capability approach refers to regional, national, sub-national, or group data. For instance, when examining poverty and deprivation in India and Sub-Saharan Africa (Sen, 1999: 99-104), he draws on national and sub-national level data. Or, when dealing with gender inequality, he works both with different territorial level and group data (Sen, ibid: 104-107).

4. *The MiSS as an economic model: generalities*

4.1. Introduction

The purpose of this sub-section is to discuss some general properties of MISS as an economic model. Such a discussion is needed since MISS cannot be considered as a conventional model of the economic system. There are two reasons for this: first, to some extent MISS goes beyond the customarily set boundaries of economic models, in that it attempts at modelling variables and phenomena which are usually attributed to the broader realm of social science;

[10] Sen (1991: 15-16) points out that this is a non-welfarist approach to the assessment of what standard economic theory defines social welfare.

secondly, even its purely economic component is rather eclectic as far as theory is concerned. The latter feature is not unrelated to the first one.

The model of the economic relations among agents and institutions which MISS embeds will be discussed with reference to two main issues: the role of individual preferences and the equilibrium notion in use.

4.2. Tastes, needs and reduced forms

There are three basic ways of approaching the consumption[11] behaviour of groups and individuals in economics: the taste-based view; the need-based view; the reduced-form view.

The taste-based view builds on:

- the notion of preference ordering on some set of alternatives;
- a set of axioms conveniently restricting the set of admissible orderings;
- a definition of the subset of admissible alternatives.

Finally, the agent is assumed to select the preferred alternative out of those included in the admissible subset.

This approach has a much broader scope than it is suggested by its highly abstract setting; on the contrary, its power lies in its abstractness. The greatest intellectual success of this approach is represented by general equilibrium models where alternatives are represented by bundles of contingent commodities, admissible sets are budget sets and the individual choices are coordinated by a proper set of prices[12]. The outcome of the coordination process depends crucially on whether or not markets are available for each commodity, no matter how large the space of commodity is, on market power and on the distribution of information. It is important to remark that the celebrated Welfare Theorems do not represent *per se* to an apologetic of real world 'free' markets; they rather represent a key to understand what happens when the above requirements (completeness of markets, perfect competition, symmetry of

[11] Including consumption of future goods, or even consumption by future generations, which brings under the same heading consumption, saving and bequest behaviour.
[12] See below, paragraph 4.

information) fail and what policy responses may be. For a strict follower of this approach, the procedure should then be the following:

1. Determine for a given set of initial endowments the Pareto-Optimal (paths of) resource allocation.
2. After defining the set of markets, tastes, technology, market power and distribution of information, determine the equilibrium allocation.
3. Define the optimal (least distortionary, second best) policies to bridge the gap (if any) between Pareto optimal and equilibrium allocation.

As a matter of fact, this approach plays a minor role in the MISS model (and given the aspiration to generality and the self-consistency of this approach, this more or less amounts to say that it plays no role). Only in the production-accumulation section of the model (see below) some notion of equilibrium is implicitly used.

What are the reasons for this neglect of such an important theoretical basis in MISS model? The main reason lies in the treatment of equity and ethical issues.

Within the general equilibrium approach we are able to distinguish between efficient and inefficient allocations, not between 'just' or "fair" allocations and allocations which are not. To make an example, a certain degree and spread of drug addiction can be socially optimal (in the sense that at least one agent would be strictly worse off at an alternative allocation) but this is different from judging that degree and spread socially desirable from an ethical or philosophical point of view.

What I called the need-based approach addresses directly this issue. In this approach, an individual agent is not represented in the first instance by a preference ordering but by a set of needs, which reflect both his/her status of human being, but also his/her living in a specified place at a specified time. This set of needs may include a more or less broad range of material/immaterial act of consumption, but in the most developed versions, the fulfilment of all these needs is seen as instrumental to the really fundamental need, namely, the full development of human beings as such. Needs do not coincide with demand: the latter depends on individual preferences and on budget constraints; the former may depend on simple biological facts (the need for sufficiently clean air and pure water) as well as on complex judgmental issues (for instance, the need for a rieducation-oriented

jail system). Te be sure, the need-based approach requires a statement of 'preferences' on the part of the researcher, who can no longer simply take given individual 'demand' as the only guiding line.

In the MISS model the need-based approach represents the essential ingredient. The reasons have been exposed in Section 2 (see Di Giulio-Grasso, 2003 on Sen). The very basis of the MISS model is population, and population is seen (in principle) as a collection of individuals, each carrying a set of age-, gender-, and nationality-specific needs (although in the present version MISS features one 'average' population. Then as population grows and changes in structure, a whole set of needs increases and is modified as regards both the range and the amount of goods required.

The structure of needs represents what we call the 'left-hand side' of the model. It is important to notice that needs are not derived by individual preferences. Different principles apply to different types of needs (tentative list)

1. Politically set targets (example: Kyoto Target);
2. International comparisons (example: the European average for the R&D expenditure/GDP rate);
3. Maintenance or 'reasonable' improvement of achieved levels (example: one-third reduction in crime rate).

Leaving aside for the moment the theoretical reasons for not resorting to a general equilibrium approach, there are also some practical issues coming to the fore. General equilibrium models specify and analyse full set of market interactions between individual agents. Since however the focus of the MISS project is on the relationships among subsystems (economic-institutional-social) rather than on the interactions among agents within the economic subsystem, a full general equilibrium modelling would add too much complexity to an already complex setting. Even a static, certain, standard-preference and complete-market general equilibrium model would do so, let alone a slightly extended one.

This is why, in modelling the so-called 'right-hand side' of the model (the extent to which the economic and social system meets the needs defined on the left-hand side), we resorted to a set of reduced forms. By a "reduced form" we mean some empirically estimated relationship between a set of exogenous and one endogenous variable. Estimates are taken from the literature One should not indulge to the idea that resort to reduced forms is an easy way-out of theoretical

work: observation is never neutral, since it is theory (not necessarily a full-fledged theory, some broad *a priori* view is sufficient) which tells us what to observe and how to observe it. Nevertheless, it is sometimes reasonable to incorporate in a model some empirical 'law' without enquiring whether available theoretical explanations of that regularity are consistent with the general theoretical 'mood' of the model itself. In MISS we make a large use of these reduced forms especially in the so-called right-hand side of the model. One example for all is the mechanism determining schooling levels. Reinterpreting Checchi-Brunello (2003) we assume there that difference between the schooling levels of two individuals corresponds to one half of the difference between the schooling levels of their parents. Obviously, a complex theoretical story lies behind this empirical relationship (and indeed, more than one sensible story could be told about it): however we do not discuss the theoretical explanation and simply 'use' the relationship. Similarly, the introduction of a constant marginal propensity to save skips all theoretical modelling of intertemporal choices.

4.3. Equilibrium notions in MiSS

When in Section 2 we described the taste-based approach to consumption decisions, we also briefly mentioned the role of prices in the coordination of decisions in a general equilibrium setting. As a matter of fact, equilibrium within that approach means market equilibrium, and the assumption is that prices adjust to clear all markets. In MISS, the notion of market equilibrium and of price adjustment play a minor role, consistently with the almost nil weight that the taste-based approach has in our work.

In MISS, two sets of markets are implicitly dealt with. The first is the set of factor markets, where we assume that the existing, previously accumulated stocks of physical and human capital are supplied inelastically, as well as raw labor. The flow of the latter and the accumulation rules of the former depend in turn on price-unresponsive variables: we assume that individuals consume a given, constant share of their after-tax income; human capital is accumulated at no private cost, following the pattern mentioned at the end of the previous paragraph; the flow of raw labour depends on population and on other price-insensitive variable (see below 'The income box' for

details). Then implicitly we assume that the wage and the rental rates of physical/human capital adjust so as to equate demand and supply for labour and productive stocks. On the other hand, these prices have no influence on current and even future supply of factors, so that we can disregard them in our analysis.

The other is the market for private consumption/savings. However, consumption is the residual left after deducting taxes and capital accumulation from income, so that equilibrium in this market is warranted.

There is however in MISS another important non-market equilibrium mechanism. By equilibrium here we mean a situation where the left-hand side of the model coincides with the right-hand side, i.e. where the needs of the individuals are satisfied on a permanent basis.

Three important features distinguish the role which this equilibrium plays in our model.

First, the adjustment mechanism does not rely on prices. It is instead a political adjustment: the government is assumed to react to *disequilibria* by changing both the level of the taxation and the composition of public expenditure, according to a fiscal rule which can be summarized as follows (for a more precise description, see Paragraph 4.2 below). Public Funds are raised by means of income taxation. They are allocated to different type of expenditures according to the weight that different functionings have in the political agenda. Such weights depend in turn on a (fixed) basic budget share, which expresses the general policy attitude of the government, and on an index of the distance between the actual and the target level for the functioning. The latter element may be seen as an indicator of the 'pressure' from public opinion, opposition, citizen's mobilisation, etc., to meet that specific need.

Secondly, private consumption and investment in physical and human capital do not react to this kind of *disequilibria*, that is to implicitly say that markets do not provide the goods required to satisfy these needs.

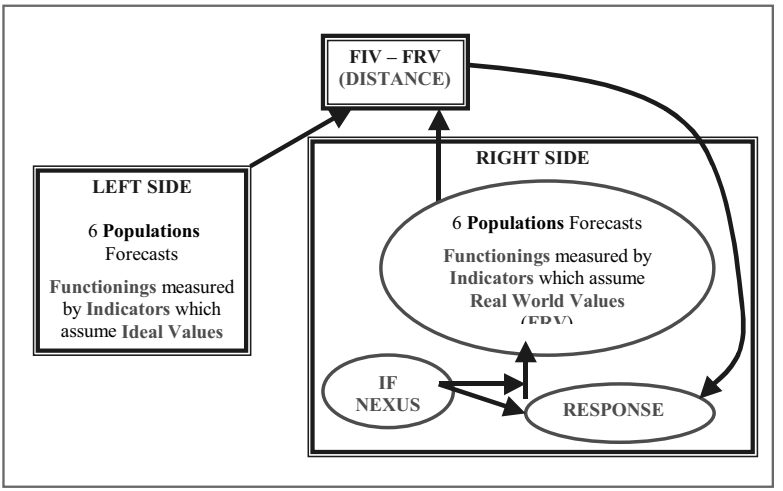
Third, there is no *ex ante* reason to expect the adjustment mechanism to achieve the equilibrium in the given time period, and in principle not even over a very long time horizon. Three examples can be useful in understanding.

First, in spite of a great 'pressure' for solving, say, environmental needs (i.e. in the presence of a large difference between actual and target level of GHG emissions), government may place a very low basic budget share on such a target, thereby allocating a small share of the budget to environmental policies;

Second, if all 'pressures' (differences between actual and target levels) simultaneously grow on all functionings, the budget weight of , say, environmental policies may remain small.

Third, policies may be poorly effective. Then, if a large effort is spent on a specific functioning (say, again environment) where policies have little impact, this may lead in the long run to increases in the differences between actual and target levels for other functionings. This increased pressure for spending on these functionings may lead in the long run to a squeeze on resources for environmental policies.

Figure 2 – *An overview of the MiSS Model*



5. *The MiSS model: from theory to practice*

5.1. The MiSS model consistence with the Senian approach

Economic literature has often focused its attention on the difficulties of operationalising Senian approach. Sen too says: «I am

not under any illusion that the capability approach to the standard of living would be very easy to use. It is particularly difficult to get an idea of a person's positive freedom of choice – what he or she could not have done or been. What we observe are the actual choices and realizations. But the case for using the capability approach is not, of course, logistic convenience but relevance» (Sen, 1984: 87).

The MISS project structure, briefly outlined in the previous section, is based on the definition of a set of functionings used as proxies for capabilities.

On the left side ('should be') achievable functionings are measured by an ideal value that people could try to achieve. This choice could seem problematic: is not the case of a Basic Need Approach operationalization? This section tries to answer this all important question, focusing primarily on the MiSS strength points and on their consistence with the Senian theory.

First of all, the measurement of distances between ideal and real values of considered functionings that determine the institutional response, reproduces the mechanism through which instrumental freedoms turn into achieved functionings.

The dynamic interaction between each single part of the model is another peculiarity of the MiSS model. According to a systemic approach, each functioning is not an island, rather it is a constellation of interdependent elements continually interacting over time through feedback loops. This feature reminds to the Senian 'social interdependence' and justifies the choice of considering income as a functioning, while generally in the capability approach it is used only as an instrumental variable, a mean to reach a certain level of well-being.

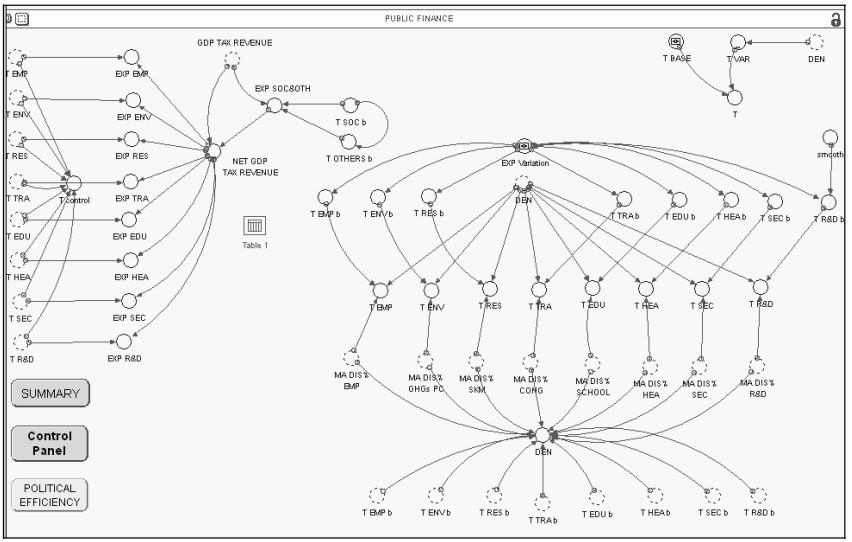
As a matter of fact, GDP is here derived according to the Solow's model. It is a long run model with only structural unemployment, i.e. not related to economic cycles. It is dependent on: physical capital, human capital, technical progress, and labour. The three first factors are aggregated on the basis of the Cobb-Douglas production function, while labour is modelled in a different box and it is determined by physical capital growth rate and technical progress (exogenous variables). The choice of the Solow's approach reflects the ambition of drawing system connections (for example, human capital is directly linked to the educational box) and of highlighting the all important role of the IF vortex.

The use of a systemic, aggregate, perspective could be somehow considered conflicting with the capability framework, which is basically individualistic. Nonetheless, as mentioned before, the MiSS model is run for six different populations. It considers gender differences and three age cohorts (0-18, 18-64, over 64 years), allowing the choice of the population for which the simulations are run. In doing this, we can grasp how the IF vortex actually works and include in a scenario analysis those variations that, to stay with Sen, «give us unequal powers to build freedom in our lives even when we have the same bundle of goods» (Sen, 1990: 121).

5.2. Public Finance Modelling

In the MiSS Model the Public Finance box (see Fig. 3) plays a crucial role, insofar it describes the mechanism through which institutional response tries to reduce the distances between ideal and real values for each functioning.

Figure 3 – *The Public Finance box*



The logic of the box is straightforward: GDP Tax revenue (not including social security expenditures) is divided between all

achievable functionings so that, for each of them, it is possible to calculate a specific tax rate. This tax rate is made of two components: a base value (controlled by a slider in order to make it possible to conduct a sensitivity analysis) and a variable component linked to 'DEN' (a synthetic index of distances). As distances grow, the tax rate increases in order to provide more revenue for political actions.

The variable labelled DEN is the strategic key of the model: it is the synthetic index of all the distances between left and right side functionings.

An example can prove useful to explain how it works.

In the Environment functioning the variable named 'DIS% GHG PC' represents the distance between the target level (should be side) of *per capita* greenhouse gases emissions (GHG) and the real level (will be side), of *per capita* GHG expressed in percentage (a number between 0 and 1). The variable 'T ENV b' calculates, instead, the weight of public expenditures on environment in the base year with respect to total public expenditures.

'DIS %' and 'T base' values are derived in the same way for each functioning of the system, so that the final DEN index is the weighted average of the distances expressed in relative terms (e.g. DIS% GHG's PC) and the weight of each public expenditure component in the base year (e.g. T ENV b).

If we still consider environment functioning (but the mechanism is the same for the other ones) the real expenditures in different subsequent years are derived as follows:

$$(\text{DIS\% GHG's PC} * \text{T ENV b}) / \text{DEN index} \quad (1)$$

The variable expressed in (1) is labelled T ENV. In other words, given the weight in terms of expenditures, the more the distance of the environmental real functioning from the ideal one, the larger T ENV.

DEN index construction catches a particular aspect of the policy making process. Matter-of-factly institutional response does not automatically take place when a particular need emerges in one or more elements of the system, rather it is a process in which past trends and traditions in the political regulation of a particular issue have to be taken in consideration.

For instance, if in the environmental box there is a great distance between the ideal CO_2 emissions value and the measured one, it is not

reasonable to foresee an adequate level of public expenditure to reduce the gap. In Italy, in fact, environmental issues have traditionally been neglected in favour of other aspects of the socioeconomic system, more politically rewarding. Moreover, given the absence of a deep-rooted ecologist consciousness, we can understand the reasons why public expenditure on environmental issues has never been larger than 3% of total public expenditure. So our expectations on tax revenue distribution must pay attention to this features, and the use of DEN index in the MISS model accomplishes this task.

In other words, DEN index can point out the cultural dimension of political systems and its capacity of implementing specific reforms, according to the relative weight attributed to each issue in the control room, that is surely an element of consistence with the Senian approach in its effort of considering conversion factors and their impact on substantive freedoms.

5.3. Governance Box

The MiSS framework intends also to model the policy level, reproducing the context in which policy making takes place and describing the impact of institutional activity on the socio-economic system. This feature certainly represents one of the most important and challenging elements of consistence with the Senian approach. In fact it aimed to include in the resulting simulations the role played by the IF Vortex, specifically the transformation of instrumental freedoms in achieved functioning, and in the end the possibility for individuals to effectively define their project of life.

The governance box is based on the distinction between formal and informal institutional efficiency: the latter includes public opinion impact on the social environment, while the former depicts governmental action. Actually, both dimensions have a considerable impact on policy efficiency.

Formal institutions efficiency is proxied in the MiSS model by the variable POLICY CHANGE, a sort of legislative productivity index, based on the results of George Tsebelis' 'veto players' theory (Tsebelis, 1999), according to which policy change (the political opportunity of abandoning the status quo) is a function of the number

of veto players acting in the political system and can be represented by the number of significant laws passed in a political system.

A problem could rise in the definition of the significance of a law: Tsebelis considers significant only laws that lie at the intersection of two international sources[13]. Taking Tsebelis' dataset as a reference, we have built an index, labelled POLICY CHANGE.

For instance, if we want to calculate the value of this index for country A, the formula to be used is:

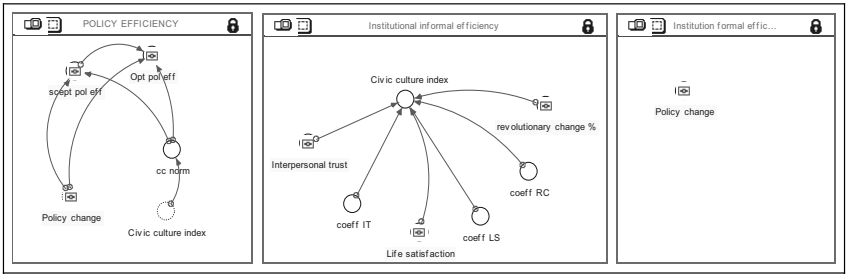
POLICY CHANGE A = (Country A's number of laws x years – min value of the sample/max value of the sample – min of the sample)

Where country A's number of laws per years, min and max values of the sample are taken from Tsebelis' dataset.

The numerator highlights the distance, in terms of number of laws per year, between country A and the minimum value of the sample, while denominator expresses the maximum possible measurable distance.

POLICY CHANGE A represents the relative position of country A in the entire sample: it ranges from 0 to 1. The closer to 1, the more it is probable to foresee a policy change in country A. In the end, we can consider POLICY CHANGE as the probability of a policy change to take place in a specific context[14].

Figure 4 – *The Governance box*



[13] Specifically, NATLEX, an ILO database of legislative systems, and Encyclopedia of Labour Law, edited by Blanpain and written for those lawyers from a country who want to practice law in another.

[14] This value is modifiable by the final user through a slider that takes the base value as a reference in order to conduct a scenario analysis.

Informal institutional efficiency refers, on the other hand, to a Ronald Inglehart's work (Inglehart, 1988: 1203-1230) which is in turn based on Almond and Verba classical study (Almond and Verba, 1963) and on Putnam survey on the impact of Italian regional reform (Putnam, 1983: 55-74).

'Civic Culture' (CC) index is a variable whose value is always positive and determined by three elements: interpersonal trust, life satisfaction and will of revolutionary change expressed in percentage values.

Interpersonal trust is measured by three Eurobarometers surveys (Eurobarometers Surveys, 1976-86) and refers to the specific question: "Now I would like to ask about how much you would trust people from various countries. For each country please say whether, in your opinion they are generally trustworthy, fairly trustworthy or not at all trustworthy".

'Life satisfaction' (LS) refers again to Eurobarometers Surveys (Eurobarometers Surveys, 1973-1987) and to the specific question: "Generally speaking, how satisfied are you with your life as a whole? Would you say you are very satisfied, fairly satisfied, not very satisfied, or not at all satisfied?".

Finally, 'will of revolutionary change' (RC) value is taken from World Values Surveys (World Values Surveys, 1981) and refers to the following question: "Please choose, between the following attitudes, the one which best describes your own opinion: a) the entire way our society is organized must be radically changed by revolutionary action; b) our society must be gradually improved by reforms; c) our present society must be valiantly defended against all subversive forces".

The values of these three dimensions are all modifiable in a sensitivity analysis through the use of specific slider instruments.

In order to build an average weight between formal institutions efficiency and informal one, CC INDEX has to be normalised and divided by its maximum achievable value, so that the final variable, labelled as 'CC NORM', spans from 0 to 1.

CC NORM can be interpreted as the probability of a positive social environment, defined as an ideal context to implement specific political reforms.

To sum up, the governance box is based on two indexes that measure formal and informal institutional efficiency. We have already

noticed that both POLICY CHANGE and CIVIC CULTURE NORM values can be thought as probability values, so that final 'POLICY EFFICIENCY' gives the joint probability of the two factors. More specifically, POLICY EFFICIENCY value is a number between 0 and 1 and is the product of POLICY CHANGE and CIVIC CULTURE NORM: the final value is then linked to each functioning of the system as a multiplier coefficient having an impact on the effective response stimulated by the distance between ideal and real measured values.

We have also introduced another element of complexity in order to give the final user a great degree of autonomy in the simulations. As a matter of fact, it is possible to choose between two options: an optimistic and a sceptical one. In the former situation, political efficiency is assumed to occur when at least one of the two dimensions (formal or informal) exists in the socio-economic environment. In the latter, instead, political efficiency requires the simultaneous action of both formal and informal efficiency. In the control panel, through the use of apposite switches, the final user can choose whether to conduce the simulations in the optimistic or in the sceptical scenario.

The inclusion of governance dimension has a remarkable important role because, like in the public finance domain, political response to a specific problem does not arise automatically as a certain distance between target value and real functioning is experimented. Rather, factors such as Senian 'social interdependence' and governments failures may cause time lags between political decisions and their implementations. In order to be consistent with Senian approach, we have necessarily to catch these dimensions and this is the very scope of the governance box.

6. *The architecture of MiSS model*

6.1. The income box

As it is remarked in the General Introduction, the economic system as it is commonly meant is just one of the subsystems which compose the society as a whole. Moreover, one of our theoretical premises is that per capita GDP is not an entirely significant index of

development. These statements do not imply that the economic system (and its representation) are unimportant. On the contrary, within the MiSS model, the economic system represents one of the most important 'blocks' of what we called the right-hand side or the 'will be' side, the other being the political-institutional block. The (bad or smooth) operation of the economic system results, at the end of the day, in the size and structure of the flow of goods (consumption/investment, durable/non-durable, material/immaterial, public/ private goods) which are , to say the least, complements to the functionings (and the ill-functionings) on which the MISS model focuses.

As a consequence, the issue of how to represent the economic system in the model can be hardly regarded as a trivial one. Let us begin by stating two desirable properties which this representation should have:

1. Long–run: the general setting of the MISS model is a long-run one, so that the economic 'side' also should allow for growth and accumulation;
2. Policy-sensitiveness: a policy-insensitive economic system would imply that public policies just redistribute resources to different uses, rather than also affecting the production of resources.

A very simple, but flexible and manageable tool which satisfies both previous requirement is Solow's model.

6.1.1. Technology

Solow's one-sector model (1956) rests on the representation of the technology by means of a constant-returns-to-scale, decreasing-marginal-returns production function and on a the simple behavioural assumption that individuals devote a fixed share of their income to savings, which are entirely transformed into new physical capital.

The production function then is:

$$Y_t = A_t F(K_t, L_t A_t, H_t)$$

where K is physical capital, L is raw labour, H is human capital and A is the level of technology. K, H, and A are stocks and the suffix t means their levels at the beginning of the period from t to

$t+\Delta$, where Δ is the unit of measurement of time (1 year in our model). L_t is a the average flow of raw labour during the period between t and $t+\Delta$. More precisely, we adopt a Cobb-Douglas form for the production function:

$$Y_t = A_t K_t^{1-\alpha} L_t^{1-\alpha-\beta} H_t^{\beta}$$

Capital changes over time according to the equation:

$$K_{t+1} - K_t = s(1-\tau)Y_t - \delta K_t$$

where: s is the marginal propensity to save out of net-of-tax income, τ is the average tax rate on income, δ is the rate of depreciation of physical capital. The expression for the rate of growth of GDP becomes:

$$\frac{Y_{t+1}-Y_t}{Y_t} = \frac{A_{t+1}}{A_t}\left[(1-\delta)(1+n)^{1-\alpha-\beta} + s(1-\tau)\left(\frac{K_t}{L_t(1+n)}\right)^{\alpha-1}\left(\frac{H_t}{L_t(1+n)}\right)^{\beta}\right](1+g_H)^{\beta} - 1$$

where $n \equiv \frac{L_{t+1}-L_t}{L_t}$ and $g_H \equiv \frac{H_{t+1}-H_t}{H_t}$. These two growth rates, together with $\frac{A_{t+1}}{A_t}$, are determined endogenously to the model. In the next paragraph we discuss human capital accumulation, while the growth of raw labour force is discussed in the employment box and $\frac{A_{t+1}}{A_t}$ is discussed in the Research Box.

6.1.2. The accumulation of human capital

Let us for the moment leave aside the rate of growth of labour and concentrate on the growth rate of human capital. The model embeds the idea that the accumulation of human capital by an individual depends on his/her family background. Checchi and Brunello (2001) find, in large cross section of individuals, that one additional year of schooling of parents translates into one-half additional year of education for the sons. More precisely, if we take two individuals, the difference between their numbers of years in school is estimated to be half the difference between the numbers of school-years of their parents. If we take son s and son s', with parents p and p', we have:

$$H^{S} - H^{s'} = 0{,}5\left(H^{p} - H^{p'}\right)$$

Since we work in time and not with a cross-section, we translated the above result as follows. The stock of individuals living at time t are supposed to have parents who, on the average, had the same age of theirs 25 years before. Then the difference in schooling between individuals living at time $t+1$ and individuals living at time t is deemed to be half the difference between the school-years of the individuals living at time $t-24$ and individuals living at time $t-25$:

$$H_{t+1} - H_{t} = 0{,}5\left(H_{t-24} - H_{t-25}\right)$$

and

$$g_{H} = \frac{H_{t+1} - H_{t}}{H_{t}} = 0{,}5\left(\frac{H_{t-24} - H_{t-25}}{H_{t-25}}\right)\frac{H_{t-25}}{H_{t}}$$

6.2. The employment box

MiSS is a long-run model, so that short-run phenomena such as unemployment due to lack of effective demand is absent. It is the employed labour force which contributes to determining the level of GDP, and not the other way around. The employed labour force depends on population through the employment rate. The target rate of employment is set to 0.47. There are three possible sources of structural unemployment, which may prevent the actual employment rate to equal the target employment rate.

1) Unemployment due to malfunction of the labour market;
2) Technological unemployment;
3) "Complementarity" unemployment, due to lack of fixed capital.

Then the equation from employment is the following one:

$$L_{t+1} - L_t = r_t\left(N_{t+1} - N_t\right) + c_k\left(\frac{K_{t+1}}{K_t} - 1\right)L_t - c_A\left(\frac{A_{t+1}}{A_t} - 1\right)L_t$$

where r_t is the rate of employment of the last period and N_t is population at time t. The term $c_k\left(\frac{K_{t+1}}{K_t} - 1\right)L_t$ means that employment grows to keep the capital/labour ratio constant, to an extent which depends on the c_k coefficient. The c_k coefficient is set to equal 0.1 which means that an increase of ten percentage points in the growth rate of capital causes an increase in the labour force of one percentage point.

Finally c_A is the technical progress coefficient, which is set equal to 0,2, meaning that an increase of total factor productivity by ten percentage points implies a decrease of two percentage points in employment.

Unemployment is then given by the difference between actual employed and the target level of employment, i.e. 47% of population.

Market labour policies focus on training. Government expenditure, divided by the cost of training one unemployed (estimated in 8000 Euro) gives the number of trained unemployed, of which we assume 4.5% re-enter the employed labour force.

6.3. The environment box

In the context of sustainable human development, environment plays a great role, in so far it affects both intra-generational and inter-generational equity. There are several indicators that could be used for exploring this dimension and each of them could be referred to a specific context: for instance, water, soil air, green areas, waste, pressure on territory and so on. The need for a synthesis induced us to refer to a single 'dys-functioning' and use per capita Greenhouse Gases (GHGs) as an indicator of the pressure on environment. Even if a partial representation of the environmental dimension, the indicator per capita GHGs is characterized by some advantages: firstly, it captures the connection between energy, economy and environment and, thus, allows to take into account one of the main stresses for environment: energy consumptions. In fact, GHGs are related to the combustion of fossil fuels (coal, oil, gas) which still represent more than 80% of the world total primary energy supply. In Italy, the economy heavily depends on fossil fuels, their weigh being about 93% of the total primary energy supply. Another reason which underscores the importance of GHGs is their increased relevance since the Kyoto Protocol signature in December 1997 and the recent Russian ratification. This international agreement obliges Italy to reduce its GHGs emissions by 6.5% under the 1990 level. This target is very ambitious since, mainly due to the electricity and transportation sectors, emissions are growing and in 2010 they are forecasted to be about 20% over the Kyoto target level. This means that if Italy will choose to meet its Kyoto target by means of domestic policies, a wide impact on the energy system and environment will emerge. On the contrary, the higher the dependence either on the purchase of carbon credits in the international emissions trading market or the generation of carbon credits thorough projects abroad, the weaker the reshaping of the Italian energy-environmental system. Due to such an uncertainty, and taking into consideration the national energy and environmental policy guidelines, we decided that the value 8.4 ton. is the target of the GHGs per capita emissions (left side of the model). This value depends on the hypothesis that emissions are reduced by 50% through domestic policies and measures and by 50% through foreign action. Naturally, this value is just an indication and any model's user can change it or make sensitivity analysis by assuming

other values. Having said this, the dynamics of environment is quite simple: we start from GHGs intensity, that is the ratio between national GHGs emissions and GDP. On the basis of statistical analyses of past data, which are characterized by a decreasing trend, we derive a 'de-growth' rate for GHGs intensity. Basically, this rate reflects the decoupling between GDP and GHGs emissions emerged in Italy in the last thirty years, that is the fact that GDP increased more than GHGs emissions. In particular, since 1990 to 2001, GDP increased by about 1.6% a year while emissions increased by about 0.6% a year. This means that the ratio GHGS/GDP decreased by about 0.9% a year. Since this rate reflects also the energy and environmental policies of the past years, and we are looking for a business as usual scenario, we adopted a higher rate (0.065%). We pass to GHGs emissions by multiplying GHGs intensity by GDP. In this way we derive a business as usual trend. The difference between such a trend and the effect of climate change policies gives rise to a new variable. We subtract from it the transportation emissions reduced through policies which shift vehicles and trucks form road to railways (see the transportation box). By dividing this new variable by population, we pass to per capita GHGs emissions: this latter variable represents our right side indicator. It is worth stressing that, since the business as usual trend is driven by GDP, this indicator captures the relationship between environment and economy. Moreover, as already mentioned, the specific relationship between environment and transportation is considered. As far as climate change policies are concerned, they are originated by the distance between the right and the left side values. Two kinds of policies are implemented: expenditure and administrative policies. Subject to the mechanisms and constraints described in the public finance and governance paragraphs, the former are climate change policies which need funds, e.g. incentives to renewable energy and energy efficiencies interventions. The basic idea is that technically it is possible to transform 8 Euro spent on GHGs in a reduction of 1 ton. GHGs. Such an abatement cost is coherent with the current price of 1 ton CO2 as it is emerging in the new European emissions trading market. We assume that 0.04 of the total Governmental expenditure goes to Climate Change policies. On the other hand, administrative policies do not require funds but simply good laws which could improve the share of renewables in the energy system, energy efficiency and the capture of carbon emissions by

forests. On the basis of the government climate change policies, we assume that they can give rise to a global reduction of emissions equal to a 25 Mton GHGs/year. As the distance between the right and the left side approaches zero, policies slow down.

6.4. The transportation box

The relevance of the 'mobility' functioning induced us to dedicate a model box also to the transportation sector. As already said, due to its growth, transports are one of the main contributors to GHGs emissions. While in 1990 the total traffic (road, railway, shipping, aviation) was equal to 235.702 millions of passenger kilometres, in 2000 it reached 281.951 millions of passenger kilometres, that is there was an increase of about 20% in 10 years. In the same period, the increase in energy consumption associated to the transportation sector was equal to about 52%: this confirms the relevant role played by this sector within the energy and environmental systems. For this reason, we also calculated its impact on GHGs emissions. Being Italy an industrialised country in which people travel a lot on a wide net of roads, highways and railways, we decided not to explore the degree of mobility, but the quality of mobility. In fact, like many other developed countries, Italy's transports are affected by a typical problem: congestion. We modelled it in the following way: as an indicator of road traffic and congestion (a 'dys-functioning'), both for passengers and for freight, we chose the ratio between vehicle kilometres and road kilometres. Among developed country, Italy is characterised by one of the highest value, about three times above the average. Relying on historical data, we derived a growth rate for such vehicle-km and truck-km. It is worth noting that it is not fixed, it being related to GDP growth: the higher GDP, the higher the growth rate. The annual growth rates associated to an annual 2% increase of GDP are: 2.7% (vh-km) and 2.6% (tr-km). In the left side of the model, as a target, we chose values that are close to the average of OECD countries: 0.00247 MilVh-km/Road Network and 0.00028 Mil, vs. real values (right side) 0.00208 and 0.00019. Again, we have to stress that these values are entirely in the user's hands and, thus, can be easily changed. The wider the distance between the right and the left side, the stronger the policies to improve the situation. Since in Italy the road network is quite developed and its extension does not

solve the problem of congestion, in so far the kilometres travelled by vehicles tend to increase and adapt to the road network, it is not possible to propose policies that lower our indicator acting on its denominator by increasing it. For this reason, we thought of policies which affect the numerator (kilometres travelled by vehicles) and reduce it through a shift of mobility from road to railways. This shift is encouraged by public expenditure: money should be invested in increasing railway network to easy the shift from road to rail, both for passengers and freight. In particular, we assumed the following cost for shifting a passenger-km and a ton-KM: 0.7 Euro and 0.2 Euro. Due to the fact that shifting freight from road to railway is cheaper than shifting passengers, we combined the two indicator by giving them weight 0.2 (vh-km/road net) and 0.8 (tr-km/road net). Both these values can be changed by any user. As the distance between the right and the left side approaches zero, policies slow down. We also considered road accidents per traffic as a 'dys-functioning' related to safety, even if this distance is not relevant in our model.

6.5. The shelter box

We thought that a dimension that must be considered within the context of sustainable human development is shelter. As an indicator we chose the residential square meters (SQKM) per capita. Even if such an indicator cannot encompass the quality of living, we think that it gives a quite good representation of the residential standard. In Italy, data show that progresses occurred in the last thirty years: per capita squared meters increased as per capita GDP grew. On the basis of statistical analyses of past data, we start from 'squared kilometres intensity', i.e. SQKM/GDP, and multiply it by GDP. On the basis of the past trends we assume that such an intensity is constant. This part of the shelter functioning is what we call the private driver for per capita squared kilometres. Then we add what we call public driver, which depends on public expenditure, a price index and parameters for political efficiency. The basic idea is that, given a certain public expenditure for shelter, institutional efficiency and a certain price for SQKM, a certain number of SQKM can be built. In particular, we assume a price of 1200 Milion Euro for 1 SQKM and, on the basis of the past trend, we assume an annual increasing rate for this price equal

to 3.5%. The right side value in year 2000 is 36 square meter per capita, while the target is 50 square meter per capita.

6.6. The education box

In a Senian perspective, educational issues perform a key role in the empowerment of human instrumental freedoms and in the transformation of capabilities in achieved functionings: for this reason the importance of such a box in the MiSS model is straightforward.

As already mentioned in paragraph 5.1.2, in the left side, we use an indicator taken from a study of Brunello and Checchi (2001): the average years of school attended by population.

The relevant literature on the matter often uses other indicators for human capital, such as enrolment rates or ISCED (level of education and training), specific for different educational programmes: the use of 'average years' of school in this model, instead, has the advantage of catching distributional effects of educational attainment among population.

In the regression cited above (Brunello and Checchi, 2001), the dependent variable (average years of school) is explained by two different factors: school quality, proxied by the pupil/teacher ratio (the lower is the indicator, the higher is school quality) and family background, that measures the impact of parents' level of education on their children one.

To estimate the impact of family background and school quality on returns to education, we use a two-steps model. In the first step we use the following equation:

$$Y = \alpha + \beta X + \gamma E + \varepsilon$$

where Y is log annual earnings, α represents region of birth, X is a vector of individual controls, E the years of education and γ the returns to education.

In the second step, we retrieve the estimated values of γ and estimate the relation:

$$\gamma = \lambda + \phi Q + \psi W + \sigma QW + \varepsilon$$

where λ catches the control variables, Q represents school quality calculated through the pupil-teacher ratio W represents family background.

The data used in the MiSS model are taken from the 'Survey on the Income and Wealth of Italian Households' (SHIW – Banca d'Italia) and from OECD online database.

Pupil-teacher ratio is then computed endogenously as follows: the number of pupils attending different educational programmes is considered as a decreasing function of Italian Population (with a decrease rate calculated on the basis of historical series) while teachers number is obtained dividing the total amount of public expenditures on education for the average wage level taken from OECD (on which the policy efficiency switches have their impacts).

The empirical study (Brunello and Checchi, 2001), gives also the values of regressions coefficient used in the MiSS simulations. Here are the values:

Table 1 – *Education coefficients*

β1 (family background coefficient)	0,5
β2 (pupil teacher ratio coefficient)	0,06

Another important feature of the education box is represented by the existence of a connection with the security box, that we will describe in the specific subsection: we assume that part of the disposable public budget on security issue is addressed to finance educational programmes, because educational attainment is assumed to be the most important element capable of reducing crime ratio.

6.7. The health box

Again as in the previous subsection we have to stress the importance of those elements, in the capability approach, capable of enhancing human freedoms: health level is certainly one of the most important, so that, within the MiSS model, the health box is crucial.

We have already stressed in the previous sections the strong interdependence connecting the functionings described in the model:

the level of health plays an important role in the income box (healthy people are supposed to earn more than unhealthy ones) but it is strictly linked also with educational attainment.

Literature on health policy is really extensive but we focused our attention on the analysis of health policy efficiency.

In particular, we refer to WHO World Report, because WHO is the organization with the most precise studies about health issues, with datasets covering 191 countries.

It is not simple to define in what sense an health system can be considered efficient: the WHO Report of 2000 introduced an indicator, the overall goal attainment, trying to capture five dimensions: health level and its distribution among population; responsiveness of health system (the non-health components of a health system, such as waiting lists and other elements) and its distribution among population; the way of financing a health system.

The overall goal attainment is then measured by an index ranging from 0 to 1 (Italy is one of the most efficient countries with 0,991) and comprehending all the above variables. WHO the same underlines the risk of overestimating efficiency. The fact that the countries ranked in the first positions have efficiency index above 0.97 does not mean that they could only improve their systems by 3%. It means that, compared to the most efficient country in the sample, they could improve by 3%.

According to these reasons, in the MiSS model we use the results of an empirical study (Evans, 1999) in which the efficiency of health system is compared throughout 191 countries for the period 1993-1997.

In terms of output, it is generally agreed that one important goal of the health system is to improve population health. We measure health taking into account both mortality and ill health rather than using an indicator such as life expectancy at birth which relates solely to mortality. Our approach is based on an indicator of healthy life expectancy (DALE), whose measured are constantly updated by WHO.

The choice of independent variables, instead, is based on operative reasons. The first one is represented by total health expenditure per capita (public and private) in 1997 international dollars (using purchasing power parities to convert from local currency units), as a summary measure of physical inputs to the health system.

It is well recognised that health is not solely a function of services provided by the health system, however broadly the system is defined. Identifying relevant variables that are available for all countries, but which are not highly correlated with health expenditure per capita, is difficult. For example, income per capita – one of the most obvious indicators of general development – is highly collinear with health expenditure per capita. While it would be possible to add income per capita directly into the estimated equations, income is not a direct determinant of the production of health. It works through other inputs such as education and housing, and it is better to capture these inputs directly. The most widely available information on non-health-system inputs to production is for education, and the most sensitive indicator of the relevant kind of educational attainment is average years of schooling in the adult population, the same variable used in the education box, making it possible to exploiting a feedback loop.

Thus, three data series are used in our model: DALE, health expenditure and average educational attainment in the adult population. Our panel covers the years from 1993 to 1997 and variables are expressed in logarithm.

With regards to the target level, we consider as an optimum for DALE 90 years of healthy life expectancy, as a desirable but feasible goal for the future.

Here is the estimated equation:

$$Y = X\beta + \varepsilon$$

where Y is DALE, X is the matrix of regression variables, and ε is the coefficient vector.

The table of coefficients is the following:

Table 2 – *Health coefficient*

β1 (health expenditures coefficient	0,008
β2 (educational attainment coefficient)	0,063

The cited study concludes saying that «efficiency is positively related to the level of health expenditure per capita. Indeed, the

results suggests that it is very difficult for countries to be good performers below an expenditure per capita of approximately $60 in 1997 international dollars. This implies that there is an apparent minimum level of health expenditure below which the system simply cannot work well…There is still enough variation in efficiency at all levels of expenditure to suggest there are two critical ways of improving health outcomes. The first is to increase the efficiency of the health sector; the second is to increase health expenditures» (GPE Paper n.6).

This feature stresses the importance of public intervention in a delicate issue such as health and focuses on one of the strength point of MISS: public finance box and the public response determined by distance between target value and real one represents for sure an element of consistence with Senian approach in describing the way of transforming capabilities in achieved functionings.

6.8. The security box

Another important block in the MiSS model is represented by the security box, in which, as in the environment section, a 'dis-functioning' is measured.

The choice of an indicator is particularly difficult here, because the security functioning is characterised by a lot of dimensions: the prevalent typologies of crime, the efficiency of judiciary system, the nature of security public policies.

Within the MiSS model, we have chosen as a proxy for security level the property crimes ratio (number of property crimes pro-capite), due to the following reasons:

1. conceptual reason: being Italy an industrialized country, it is probably more effective in representing the incidence of crime the reference to property crimes, which are the most widespread in a rich developed nation;
2. operative reason: we can refer to a very precise dataset taken from International Crime Victims Survey (1996), containing crimes statistics of 19 industrialized countries.

The particular nature of security box makes it possible to enlighten the strict connection existent between this issue, education and employment: thanks to system dynamics approach, then, a feedback mechanism can be exploited. The basic idea is that public

expenditures on security are made essentially of two components: a first one referring to the functions of criminality control and repression (not considered in our model) and a second one that contributes to support education programmes, since education is thought to be an important deterrence variable against criminality. So the model tries to calculate the additional number of pupils attending high schools and universities thanks to educational programmes financed by public security budget.

Another point to be discussed, before describing the equations of the box, is the choice of a target value: who can point out objectively which is the optimum for the number of property crimes?

We assume that the target is equal to 0,18 which is 2/3 of the current value in Italy (0.27). Just to give an idea of the meaning of these numbers, the International Crime Victim Survey (1996) tells us that the best score, i.e. the country with the lowest crime rate in the sample is Finland (0,11).

On the right side, instead, the theoretical model is an individual's choice model between education, work and crime and is inspired by different econometric studies (Buonanno, 2003 – Marselli Vannini, 1997).

As we said before we want to represent the relationship between the number of property crimes and two variables: the level of education (defined as the number of high school and university students), and the level of employment. In particular, we assume that an increase in higher education and employment reduces the criminality index. We defined a simple equation

$$Crimes\_edu\_emp=(EMP^{(\beta_1)})*(High\_Pupils^{(\beta_2)})$$

Where β_1 β_2 are negative and represent the employment elasticity of crimes ratio and the education elasticity of crimes ratio. Different articles on this issue provide a wide range of coefficients and elasticities, and it is quite difficult to point out a univocal value. For this reason we assign two sliders to elasticity values: therefore the user can simulate different hypothesis on the security functioning. However, in the base scenario we assume the following values:

Table 3 – *Security coefficients*

β_1 ("EMP" exponent)	-0,2
β_2 ("High Pupils" exponent)	-0,05

That is to say that if the number of employed increases by 10%, criminality decreases by 2%, and similarly if the public educational programme increases by 10% the number of students in high schools and universities, criminality decreases by 0.5%.

This equation gives us the effect of education and labour policies on security. Actually since we want to match the crimes ratio with its real value, we calculate the growth rate of 'Crimes_edu_emp' and apply it to a stock variable 'crimes number'. The initial value of this stock is exactly the total number of property crimes registered in 2000. Then dividing it by 'population' we get 'crimes ratio R' and we can calculate the distance from the target.

In the Public Finance box, exactly as for the other functionings, the level of security public expenditures is calculated as a response to the distance between target value and real one. We only consider the percentage of public expenditure that is invested in high education (around 5‰ of the total, excluding the expenditure in police forces, crime control, repression and so on) and this percentage is multiplied for the institutional coefficients that measure the efficiency of formal and informal institutions. This money is used to increase the number of students attending high school and university (in the base scenario, in 2050 educational programmes financed by public security budget should involve around 420000 students).

But also the public expenditure in labour policies (see Employment Box) could have a positive feedback on security, increasing the number of employed people. At the same time, a bad situation on the labour market generates an increase in property crimes ratio. Those interconnections are a point of strength of the MiSS Model.

Some observations could be added in this section. First, in security box public expenditures and political interventions considered do not have an immediate strong effect on the measured indicator. The main explanation is that we do not consider the public expenditure in police

forces and repression, which maybe is more effective in reducing the crimes ratio.

Another important aspect to notice is, finally, the ambiguous relationship existent between crime and unemployment: although we assume a negative elasticity, some econometric studies point out opposite effects of unemployment on crime: on one hand, it is reasonable to expect that an increase in activity rate will lead to a lower level of increased crime opportunity cost; on the other hand, it is likely that the number of crimes will be higher where people are richer. In conclusion, as literature seems to confirm (see Marselli and Vannini, 1997), there is not a clear relationship between unemployment and crime: this relationship appears to be very sensitive to econometric specification.

Most relevant results on security issue in the base scenario are summed up in table 5. The distance from the target grows, and even if the public expenditure in this sector is fast growing (on average the tax rate increases by 2% per year) and the employed number increases this trend do not reverse.

Table 4 – *The security box result in the base scenario*

	target	real crimes ratio	distance in %	crimes number
2000	0.18	0.27	48%	15444347
2012	0.18	0.27	51%	15941385
2025	0.18	0.29	59%	16610190
2040	0.18	0.32	75%	17503036
2050	0.18	0.35	90%	18137239
Average annual increase		0.54%	1.3%	0.33%

6.9. The R&D box

Financing R&D is one of the tools that enable governments to support the economy to cope with the changing market conditions and to strengthen its capacity for regeneration.

Government plays an important role in stimulating R&D and supporting knowledge creation in all sectors of the economy. Indeed the economic rationale for government involvement in this area is the

existence of market failures associated with R&D. These market failures are twofold. First, the private rate of return to R&D is lower than its social return. In addition, high risk for research implies extremely high hurdles, discouraging firms from engaging in such activities. In particular this is true for small firms for which access to funding is more difficult. For both reasons, the amount invested by firms in research activities in a competitive framework is likely to be below the socially optimal level

In Italy in year 2000 the total expenditure in R&D was around 12.000 millions Euro, and almost a half is from public funds.

The effect of public spending may differ according to the policy instrument. Three main policy instruments are typically used: public performed research (through public laboratories and universities), government funding of R&D performed by private sector and fiscal incentives.

This box is quite simplified and the structure is very essential but its role is crucial: the technological level is one of our GDP building blocks and it is fed by R&D expenditure. In other words, R&D public expenditure is one of the main drivers of technological progress. We assume that this is a lagging effect: R&D expenditure takes 6 years on average to be effective (as usual this value can be adjusted by the user, performing different hypothesis)

On the left side of the model we set a target for R&D public involvement: the ideal value is expressed in term of percentage of GDP (3%).

In the base scenario the distance between the ideal value and the real one decreases by 0,4% per year between 2000 and 2050. In fact the public expenditure in R&D increases on average by 3% per year.

Table 5 – *R&D results in the base scenario*

		target	R&D as % of GDP	distance in %	EXP R&D	Tech level
	2000	0.03	0.0059	0.60	5569.1	203.68
	2012	0.03	0.0142	0.53	16354.7	215.76
	2025	0.03	0.0158	0.49	23052.8	228.87
	2040	0.03	0.0153	0.48	27138.1	244.03
	2050	0.03	0.0145	0.5	28525.8	253.16
	2001-2012		-1.48%	-1.12%	0.26%	0.48%
Average annual increase	*2012-2025*		0.86%	-0.69%	2.70%	0.46%
	2025-2040		-0.23%	-0.14%	1.09%	0.43%
	2040-2050		-0.56%	0.45%	0.56%	0.41%
	2001-2050		**-0.29%**	**-0.38%**	**1.23%**	**0.44%**

7. *Results*

In what follows we shall analyse the effect on the model as a whole of two basic types of policy changes.

The first type of policy change affects the basic budget shares, i.e. the fundamental attitude of the government towards the different issues. In cases where the basic share is already low (for instance in the case of employment policies the basic budget shares is around 1%) we only considered increases with respect to the reference value, while in cases (like for instance education) where the basic budget share is huge, we also considered reductions in the basic share.

The second type of policy changes affects instead efficiency/effectiveness of government, i.e. the ratio between expenditure actually affecting the policy objective and expenditure as formally determined by the current fiscal rule: discrepancies between the two may depend on government inefficiency, corruption, etc… The default value of this indicator is 1, i.e. we assumed that, in the reference case, government is fully efficient.

The size of changes vary accordingly to the policy considered, although in almost all cases we discussed an increase by 15 percentage point in the basic budget share and a reduction by 50% in government efficiency.

7.1. Employment

In this case we have considered the following policy changes:

1. An increase by 15 percentage points in the basic budget share of employment policies (then value in the reference case is around 1%, so this ,and the following one, are rather sharp policy changes),
2. An increase by 30 percentage points in the basic budget share of employment policies,
3. A decrease by 50% in governmental efficiency in employment policies,
4. A decrease by 75% in governmental efficiency in employment policies.

Considering cases 1. and 2. one finds that there are negligible effects on the growth of per-capita GDP (less than one tenth of a percentage point in the average growth rate over the 2001-2050

period), with no relevant changes in the sub-periods as well. The main effects are found on employment itself, where the convergence to desired levels is faster (distance decreases by 6.2 per year rather than by 1% in the basic case). With the 15 percentage point increase, distance drops in the final year at 0.01, while the stronger increase causes the distance to disappear by 2047. In the basic case, this final value is 0.13.

There are negligible effect on the trends of other distances.

If one considers instead cases 3. 4., the only relevant impact is again on employment, which converges towards the target level at a slower rate than in the reference case. In these last two exercises, the distance for employment reaches respectively the final values 0.15 and 0.14.

Table 6 – *Yearly composed growth rates of distances and real per capita GDP 2001 – 2050*

Yearly composed growth rates of distances (for all functionings) and real per capita GDP 2001-2050

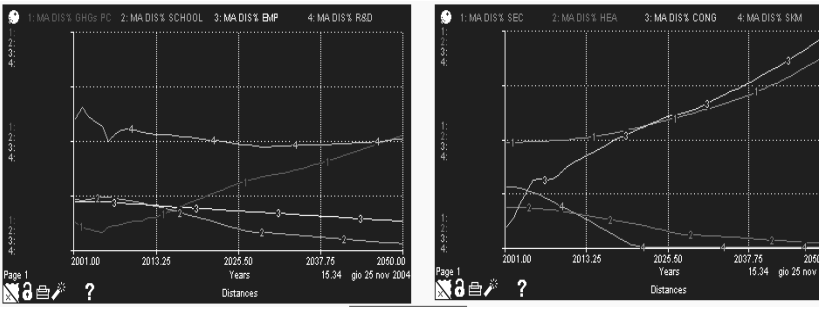
	Mobility	*Employment*	*Environment*	*Health*	*R&D*	*Education*	*Security*	*Residence*	*GDP per capita*
Change in basic budget share = 15%	**5,10%**	**-6,24%**	**3,65%**	**-5,84%**	**-0,38%**	**-4,87%**	**1,20%**	**(*)**	**1,81%**
Change in basic budget share = 30%	**5,10%**	**(*)**	**3,69%**	**-5,84%**	**-0,38%**	**-4,87%**	**1,20%**	**(*)**	**1,82%**
Government efficiency = 0,5	**5,08%**	**-0,94%**	**3,49%**	**-4,47%**	**-0,38%**	**-4,87%**	**1,32%**	**(*)**	**1,72%**
Government efficiency = 0,25	**5,08%**	**-0,94%**	**3,49%**	**-4,47%**	**-0,34%**	**-4,87%**	**1,32%**	**(*)**	**1,71%**
Reference scenario	**5,08%**	**-1,09%**	**3,49%**	**-5,84%**	**-0,38%**	**-4,87%**	**1,32%**	**(*)**	**1,72%**

(*) The distance reached 0

7.2. Environment

The environment functioning does not perform well. In general, we face an increase in GHG emissions and a widening of the distance between the right and the left side. While in the base year the right side value for GHGs per capita emissions is 9.42 ton, in 2050 it becomes 12.91 ton. In the base case, the distance grows from 0.12 to 0.52 (Fig. 5, left figure, red line).

Figure 5 – *Base Case*



The average annual growth rates of the distance in different periods of time are the following: 2000-2050: 0.03; 2000-2012: 0.04; 2012-2025: 0.06; 2025-2040: 0.02; 2040-2050: 0.02. Due to such an increase in the distance, the share of environmental expenditure passes from about 2.6% to 6%. However, this bad picture can be substantially improved through an increase in the expenditure for climate change. If we introduce an increase of the environmental expenditure up to 15%, to be realised in 10 years (i.e. the share of environmental expenditure reaches 15% of the total Government expenditure in 2010), the increase in GHGs emissions is strongly mitigated (Fig.6, left figure, red line). The distance in year 2050 is now 0.20, vs. 0.52 in the base case. This means that GHGs emissions can be reduced, if appropriate policies are specifically addressed to control them[15]. However, if we furtherly increase the share of environmental expenditure, e.g. bringing it to 30% in the first 10 years, the GHG distance between right and left side begins to oscillate: this occurs due to the fact that as the target is reached, the Government expenditure share that goes to environment is reduced, it being an increasing function of the distance (Fig 7, left figure red line).

[15] It is worth stressing that theoretically it would be possible, at the same time, to reduce emissions and improve Government budget simply by using a carbon tax. We excluded this case due to people opposition to environmental tax and the negative impact on social cohesion.

Figure 6 – *Environmental expenditure 15% of the Government budget*

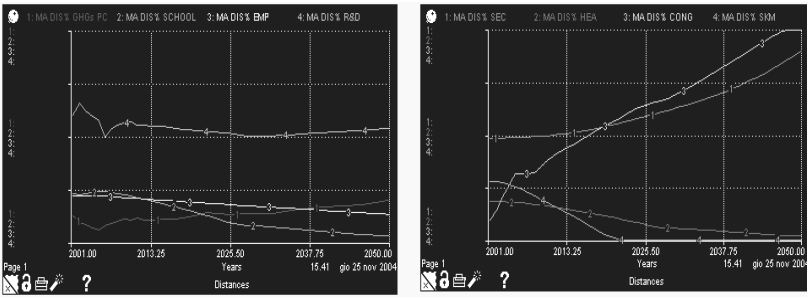
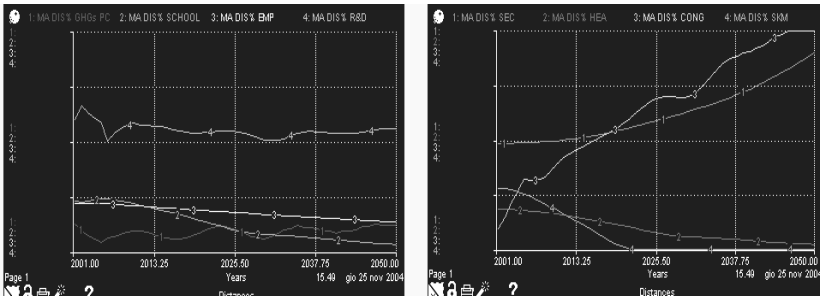


Figure 7 – *Environmental expenditure 30% of the Government budget*



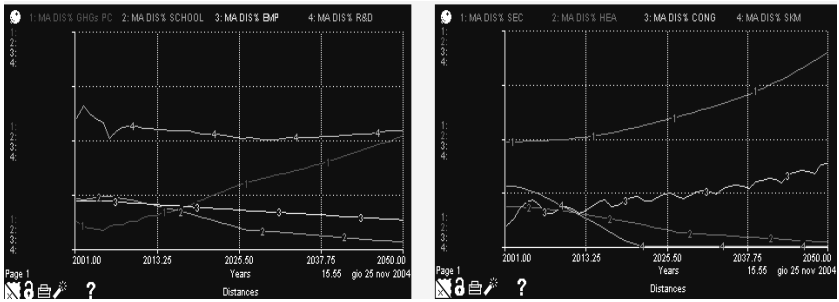
Similar results can be obtained by simply increasing the share of environmental expenditure that goes to climate change policy. For instance, if it passes from 0.04 (base case) to 0.15, the distance in 2050 becomes 0.29. In other words, a wise and efficient use of public funds can be successful in reducing GHGs emissions. This requirement is very important since, if there is a low degree of governmental efficiency, our result does not hold. For instance, an institutional efficiency equal to 50% (vs 1 of the base case) brings the distance in the year 2050 to 0.35, even if a 15% increase in environmental public expenditure is active. Unfortunately, the increasing trend of Italian GHGs and the history of the national climate change

policy tell us that the public programs for reducing emissions are characterised by a very low degree of institutional efficiency. This brings us to conclude that a strong reduction in emissions, even if feasible, is very unprobable.

7.3. Transportation

The Transportation functioning is characterised by a behaviour similar to Environment: an increasing distance (Fig. 5, right figure, sky-blue line). While in the base year the distance is equal to 0.09, in 2050 it is 0.97, i.e. we are about 100%. The average annual growth rates of the distance in different periods of time are the following: 2000-2050: 0.05; 2000-2012: 0.15; 2012-2025: 0.03; 2025-2040: 0.02; 2040-2050: 0.02. As the distance increases the transportation expenditure share grows from 6% (2000) to 26%. This results confirm the relevance of the congestion problem for Italy. An increase of the transportation expenditure up to 15% in 2010 improves substantially the situation but does not solve the problem (Fig. 8, right figure, sky-blue line).

Figure 8 – *Transportation expenditure 30% of the Government budget*



Now the distance in 2050 is 0.38, vs. 0.97 (base case), and the expenditure share associated to it is 36%. An increase up to about 22% allows to reach the target in year 2027, but due to the model's dynamic of Government expenditure (low expenditure associated to low distance), this result is not stable and, again, the distance increase in year 2036. Higher increases of the transportation expenditure are

able to stabilise the functioning on the target until year 2050. The decrease in road mobility has a negligible impact on GHGs emissions, they depending on many other variables (e.g. industry, residences, energy sector) and their total magnitude being huge. As a conclusion, we can say that strong increases in transportation expenditure can bring the functioning close to its target, but we have to admit that the conjectured expenditure increases are huge and not realistic. Moreover, the showed simulations are carried out in a perfect governance context. For instance, if the institutional efficiency passes from the unrealistic value of 100% to the more realistic value of 70%, the distance associated to a 15% increase in transportation expenditure grows from 0.38 to 0.57. This confirms the gravity of the Italian mobility problem, even in presence of a realistic target.

7.4. Shelter

The shelter functioning shows very a good trend. The distance between right and left side is equal to 0.28 and, in the base case, becomes zero in year 2020 (Fig 1, right figure, green line).

The expenditure share decreases from 0.03 to zero in year 2018. An increase in expenditure up to 15% in 2010 implies a moderate acceleration in getting the target (2018 instead of 2020). This implies that the target is reached mainly due to the intrinsic dynamic of the "private" side of the model or, in other words, the public sector does not need to build a lot of new houses. In fact, due to GDP growth and the population decrease, given the constant ratio SQKM/GDP, per capita square meters increase. This is confirmed by the fact that also very low level of institutional efficiency (e.g. 10% instead of 100%) has a very week effect on simulations: the target is reached just 3 years later. This means that the result is robust and, unless strong migration flows, shelter is not a problem for Italy. Nevertheless, it must be firmly stressed that in our model we deal with an average value, which reflects also the fact that some families own more than one house. In other words, we entirely leave out of consideration distributional aspects that can be very important. Especially in the big cities, where many people meet due to the high demand for labour, shelter is characterised by scarsity which make the houses' prices rise. Such very high price strongly affect people life, having a negative

effect on their welfare. The current structure of the MiSS model does not take into account such effects.

7.5. Education

In this case we have considered the following policy changes:

1. Increases by 15 and then by 20 percentage points in the basic budget share of education policies (the value in the reference case is around 31%),
2. Decreases by 15 and then by 20 percentage points in the basic budget share of education policies,
3. Decreases by 50%, 75% and 87,5% in governmental efficiency in education policies.

The effects of type 1 policies are rather limited as far as the growth of per capita GDP and the achievement of schooling objectives are concerned. The main impact is felt, for the sharpest increase in the basic budget share, on the evolution of the health variable, which reaches the target value by 2049.

Decreases in the basic budget share such as those at point 2. have more interesting effects. The growth rate of per capita GDP decreases by one half percentage point with the mildest cut, and by more than one percentage point with the sharpest decrease. With the 15-points decrease, achievement of the targets level is relented, while with the 20-point decrease, in final year distance is even larger than in the initial year. The rate of convergence of health.

Considering cases 1. and 2. one finds that there are negligible effects on the growth of per-capita GDP (less than one tenth of a percentage point in the average growth rate over the 2001-2050 period), with no relevant changes in the sub-periods as well. The main effects are found on employment itself, where the convergence to desired levels is faster (distance decreases by 6.2 per year rather than by 1% in the basic case). With the 15 percentage point increase, distance drops in the final year at 0.01, while the stronger increase causes the distance to disappear by 2047. In tha basic case, this final value is 0.13.

There are negligible effect on the trends of other distances.

If one considers instead cases 3. 4., the only relevant impact is again on employment, which converges towards the target level at a slower rate than in the reference case. In these last two exercises, the

distance for employment reaches respectively the final values 0.15 and 0.14.

Table 7 – *Yearly composed growth rates of distances and real per capita GDP 2001-2050*

Yearly composed growth rates of distances (for all functionings) and real per capita GDP 2001-2050									
	Mobility	Employment	Environment	Health	R&D	Education	Security	Residence	GDP per capita
Change in basic budget share = +20%	0,05123	-0,01090	0,03535	(*)	-0,00298	-0,04873	0,01342	(*)	0,01727
Change in basic budget share = +15%	0,05123	-0,01090	0,03535	-0,05844	-0,00338	-0,04873	0,01318	(*)	0,01727
Change in basic budget share = -15%	0,05100	-0,01090	0,03680	-0,03085	-0,00338	-0,03040	0,01295	(*)	0,01116
Change in basic budget share = -20%	0,051225	-0,0109	0,036371	-0,022628	-0,002977	-0,020854	0,013182	(*)	(*)
Government efficiency = 0,5	0,05123	-0,01090	0,03535	-0,03085	-0,00298	-0,04066	0,01318	(*)	0,01723
Government efficiency = 0,25	0,05145	-0,01090	0,03453	-0,03085	-0,00258	-0,02357	0,01342	(*)	0,01674
Government efficiency = 0125	0,05145	-0,00937	0,02876	-0,01675	0,00000	0,00504	0,01365	(*)	0,01380
Reference scenario	0,05078	-0,01090	0,03494	-0,05844	-0,00379	-0,04873	0,01318	(*)	0,01723

(*) The distance reaches 0

7.6. Health

The Health Box performs really well and it's not a surprising result, because Italian National Health System is always ranked in the first positions in the WHO Reports thanks to the performances of the National Health System created in 1978.

It is also important to stress that initial value of DALE (73. 7 years) is particularly high; this element, in addition with the impossibility of fixing an irrealistic target (life expectancy cannot reasonably exceed a natural bond) has to be considered when conducing sensitivity analysis.

All these factors considered, we have to notice how the functioning performs really well with a constant decrease of distance in the analysed period and a gradual but continuous increase in DALE value, both in the base case and in the hypothesis of greater public expenditures.

While in the base year the DALE value is, as above mentioned, 73.7 years, in 2050 it becomes 86.85.

The annual de-growth rates of the distance are the following: 2000-2050 0.06; 2000-2012 0.02; 2012 – 2025 0.05; 2025 – 2040 0.06 and 2040 – 2050 0.11.

So, if we pass to consider the case of a greater share of net GDP tax revenue addressed to health policies (i.e. + 15% in health public expenditures), it is not surprising to find that the results are not so different from the base case.

DALE value becomes 87,05 in 2050 and distance value in the final year decreases to 0.03 instead of 0.04 obtained in the normal budget hypothesis.

How can we interpret these findings?

Health represents for sure one of the most important functioning in human life and plays a really important role in the senian capability approach (the DALE parameter is used also in the HDI measurements). Because of the strict relationships and interdependencies between health performance and the other functionings taken in consideration in MISS model, its dynamics through time can be analysed in a more senian way, that is to say that performance of health system cannot only be measured by single factors (such as public expenditures or GDP per capita), but has to be considered in its multidimensional nature.

The instrumental freedom of being healthy is not only associated with a certain share of public budget addressed to health policy, but involves literacy quality, environmental conditions and so on.

The interesting conclusion we can prudentially infer considering the good quality of Italian health system is that policy maker can mix their interventions trying to reach multidimensional targets: to make an example, it is reasonable to think that public expenditure on education will have an impact also in the increase of health performances.

Social interdipendence can become an instrument of policy efficiency.

7.7. Security

Thanks to the model's Control Panel we can easily simulate the effect of a fiscal policy addressed to security issues. What happens if we increase security tax rate progressively from 13,17% to 28.17% (+15% in ten years)? As we said before, in the security box we only considered public expenditures in educational programmes (together with an indirect effect of labour policies) and this action do not have an immediate strong effect on the measured indicator. Indeed changing the security tax rate substantially do not change the crimes situation.

Table 8 – *The effect of an increase (+15%) in security tax rate*

	target	real crimes ratio	distance in %	crimes number
2000	0.18	0.27	48%	15444347
2012	0.18	0.27	50%	15927848
2025	0.18	0.29	59%	16586778
2040	0.18	0.32	74%	17461494
2050	0.18	0.35	89%	18073352
Average annual increase		0.54%	1.28%	0.32%

In fact, the tax rate system is strongly interconnected and a sharp increase in the security tax rate generates a strong decrease in the others. As a consequence, other functionings (especially environment and mobility) tend to worse because their funds decreased. Also GDP growth suffers a very slight slowdown. To sum up in the security box the little positive influence of higher expenditure is compensated by the worsening of labour market and the final result is null.

We can also simulate what happens with a less ambitious target: if we halve the initial distance, setting the left value at 0.225, the crimes ratio do not change.

Due to the moderate education elasticity of criminality, also a decrease in institutional efficiency does not affect the result. If the governance index is halved, also the number of students involved in educational programmes falls by half but the effect on crimes ratio is negligible.

7.8. R&D

This sector is quite reactive to any variation in public expenditure, since it influences directly the indicator. For example a gradual increase of R&D tax rate from 0,04 to 0,12 in 10 years leads to a stronger reduction of the distance, especially in the first decade.

Table 9 – *The effect of an increase (+8%) in R&D tax rate*

		target	R&D as % of GDP	distance in %	EXP R&D	Tech level
	2000	0.03	0.007	0.77	6744.6	203.68
	2012	0.03	0.023	0.23	26235.0	215.79
	2025	0.03	0.024	0.24	34321.8	228.96
	2040	0.03	0.023	0.24	41511.6	244.21
	2050	0.03	0.023	0.24	44391.3	253.39
	2001-2012		-0.57%	-8.35%	1.19%	0.48%
Average	*2012-2025*		1.16%	0.62%	3.00%	0.46%
annual	*2025-2040*		-0.05%	0.00%	1.28%	0.43%
increase	*2040-2050*		-0.38%	0.00%	0.75%	0.41%
	2001-2050		**-0.15%**	**-1.89%**	**1.38%**	**0.45%**

As we said before, in the base scenario the assumption is the maximum institutional efficiency, i.e. each Euro levied for R&D expenditure is effectively allocated to that. In the MiSS model the user can easily simulate what happens with different degree of institutional efficiency. For example: reducing the governance index by ¼ or by ½ during the entire period (2000-2050) the trend of R&D index is almost inverted. The result is summarized in the following table: while in the base scenario there is a reduction of the distance of 0.29% per year, reducing the institutional efficiency the result is a sort of stability in the first case and an increase in the second one.

Table 10 – *The effect of mis-governance on R&D box*

		Governace index	
		0.75	**0.50**
		% distance from the target	
Average annual increase	*2001-2012*	0.15%	1.41%
	2012-2025	-0.61%	-0.52%
	2025-2040	0.00%	0.00%
	2040-2050	0.39%	0.33%
	2001-2050	**-0.07%**	**0.26%**

8. *Conclusions*

1. In the current version of MiSS not all functionings necessarily converge to target levels. In the base case, Environment, Transportation, Security, R&D do not converge to their targets and, in the first three cases the distances increase. On the contrary, Employment, Education, Shelter and Health converge. However, it must be stressed that such results depend on a set of assumptions concerning both the choice of the target levels and the effectiveness of policies, which are obviously subject to debate. Lack of convergence must not be interpreted necessarily as a pessimistic conclusion, but a warning about the need of a constant non-market action to reduce and control the differences between actual and target levels as economic growth proceeds.
2. A key role is played in development by the nature of the process of resource allocation to policy targets. Even if it does not affect the achievement of the target level, we have shown that this mechanism influences the speed of change in the distances between real level and target ones.
3. Interdependence of policy over time is another key issue. Given the MiSS general policy rule, it is impossible that a Government solves first problem A and that it does not start spending on problem B until A is fixed. On the contrary, a strong initial effort on one specific target can be followed by an early abandonment of that policy; this can happen if the initial effort has led to an increase in the distances concerning other functionings, temporarily neglected.

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