UNIVERSITY OF SOUTHAMPTON

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Equity Issues in a Dynamic Economy with Heterogeneous Agents and Imperfect Markets

by

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A thesis submitted for the degree of Doctor of Philosophy

January 2005

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF LAW, ARTS AND SOCIAL SCIENCES

ECONOMICS

Doctor of Philosophy

EQUITY ISSUES IN A DYNAMIC ECONOMY WITH HETEROGENEOUS AGENTS AND IMPERFECT MARKETS

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Since the last decade an increasing body of theoretical literature has explored the endogenous determination of inequality and its role in affecting aggregate developments. The papers presented in this thesis try to make a contribution about the policy issue of improving equity conditions when imperfections in credit market limit the chance of social mobility of the poor. Following a brief introduction, the first chapter investigates if equity progress can be achieved by a direct action on the prime origin of inequality, as incomplete credit markets are commonly understood. Within a standard framework of banking and customer relationship, the chapter puts forward a novel factor affecting the equilibrium cost of credit, namely the incentive of the lender to undertake a costly screening technology in order to improve his private information about his own customers' types. An interesting finding of the chapter is a positive relationship between the *ex post* market power of the informed lenders and the size of his *ex ante* investment in the screening technology. A pro-competitive regulation of imperfect credit market may prove counterproductive for lowering costs of loans, since it risks discouraging investment in the costly acquisition of information on the part of the lenders, then making even more severe the adverse selection problem constraining their supply of funds. As its main policy implication, the paper finds a limited scope for public action on capital markets to countervail the barriers to a large access to credit coming from imperfect information. The second chapter deals with the usual tool for equity, by theoretically exploring conditions for demand for redistribution to be politically sustainable in the long run. Differently from recent literature on political economy, the location of the median voter and/or his preferred policy is allowed to endogenously shift over time, possibly reflecting the stance of redistribution in previous period. As a result, a large variety of political equilibria is proved to occur in steady state; they depend on the strength by which economic structure by itself would widen or restrict inequality over time and the extent to which it can be counteracted by feasible redistribution. Among the main findings, the dynamic feedback between pure economic factors and political input driving social mobility may hinder the path to steady state equilibrium, endogenously determining fluctuations in both redistribution and inequality. The third chapter empirically assesses the impact of social security on aggregate private savings, based on Italian experience in the last fifty years. The variety of recent reforms in the Italian pension system proves to exert a significant effect on consumption spending, along with domestic demographic changes.

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PREFACE

Chapter 1 of this thesis is a refinement of a preliminary version circulated as Bocconi University Working Papers on Industrial and Antitrust Policies n. 10, May 1994. It has been presented in seminars at Bocconi University, October 1994, Pavia University (February 1996) and at the 58th Meeting of ESEM in Stockholm, August 2003.

A first draft of chapter 2 was presented at the X Congress of the European Economic Association in Prague, May 1995. A later version has been presented in seminars at the Bank of Italy, March 1998, the University of Southampton, January 2001, and at the 57th Meeting of ESEM in Venice, August 2002. It has been circulated as *Temi di Discussione del Servizio Studi* n.505, Banca d'Italia.

Chapter 3 has been circulated as *Temi di Discussione del Servizio Studi n. 417*, Banca d'Italia.

Each chapter is self-contained and can be read independently from the others.

ACKNOWLEDGEMENTS

There would be a long list of people to thank for passing me motivation and enthusiasm in keeping doing research even at a distance from the Academy, since I have started a new job in the middle of last decade. Not all of them make scientific research in their life and not all of them can still read this message; I am very grateful to everybody and I hope that I have met a large part of their expectations.

However, a special gratitude goes to my first supervisors, Professor Keith Blackburn and Victor Hung, who helped me a lot to upgrade to an academic standard my interest about income distribution and macroeconomics. I have received fruitful contributions also from Professor John Driffill, who guided an intermediate stage of my research, preciously prompting me to carry it at a final step. This has eventually happened under the fruitful supervision by dr. Akos Valentinyi, to whom I am very grateful for his help in refining my work.

I also acknowledge especially useful comments and suggestions which Professor Roland Benabou kindly provided me during my stay at Princeton University as visiting fellow in 2000.

I have benefited a lot from the courtesy of all the personnel of the Department during the long time we have had the chance to keep in touch since my first year in Southampton.

To my children, that have in turn come to birth around the two key dates towards the final submission of my work, I address all my confidence that in their lives they can pursue equity goals much more effectively than I traced in my research.

INTRODUCTION

Since the last decade, the role of microeconomic heterogeneity has been gaining momentum in the theoretical analysis of aggregate developments. Important contributions deal with a variety of issues, such as economic growth (Banerjee-Newman 1993, Dacemoglu, 1997), the design and the impact of policies (Krusell-Rios-Rull 1999, Mankiw, 2000), cyclical fluctuations (Cooley-Nam 1998, Aghion et al. 1999).

A fairly common finding is that when heterogeneity interacts with imperfect markets macroeconomic equilibria might result largely different with respect to the e standard case with representative agents (and complete markets). The extent of departure proves dependent on the domain of heterogeneity and the kind of market frictions. As a matter of example, in Krusell-Smith (1998) whereas heterogeneity extends to preferences, partially uninsurable risk causes deviations from permanent income model of consumption. Under endogenous borrowing constraints, in Kiyotaki-Moore (1997) wealth distribution plays a key role in affecting both output and asset prices.

More generally, in view of significant non-linearities in optimal rules induced by incomplete markets, it is the assumed pattern of inequality to condition the degree of aggregate approximation resulting from models with heterogeneous agents. As argued in Carroll (2000), discrepancies between heterogeneous and representative agent models are dramatically large when theoretical framework is set to match the structure of wealth distribution empirically observed. This may come either from heterogeneous preferences as above mentioned or from heterogeneous expected income among classes of agents (Huggett, 1996). In both cases, the understanding of macroeconomic behaviour proves crucially dependent on the pattern of microeconomic diversity.

Endogenous setting of economic policy provides a separate argument for heterogeneity to matter in explaining macro developments. When general election is taken into account, agents who differ by some characteristic aggregate through majority rule in deciding policy and the ensuing economic equilibrium. Different pattern of heterogeneity might lead to different policies in democracy, thus significantly affecting aggregate dynamics beside an incomplete market argument. As shown in Bertola (1993), with homothetic preferences and no market frictions individual disparities in initial endowments do not have any impact on growth when policy are exogenously given, apart from inducing a Kaldorian flavour about saving behaviour out of labour and capital incomes.

Imperfections in market mechanism prove to be a key ingredient in explaining initial inequality and its evolution over time, thus augmenting their impact on aggregate behaviour in a dynamic perspective. Since first analysis of Champernowne (1953), uninsurable risk about future personal income mainly explains both the origin and persistence of inequality in a stochastic economy. Recent research has addressed the reasons for serial correlation in income process beside the pure idiosyncratic risk, by focusing on the role of financial markets in affecting single agent's opportunity of investment in either fixed or human capital. Limited negotiability of assets on income of future generations (Becker-Thomes 1979 and Loury 1981) and/or agency costs in borrowing (Galor-Zeira, 1993 and Aghion-Bolton, 1997) restrict the possibility of current generation of improving his own (offspring) earning ability.

A further factor driving the endogenous determination of inequality is represented by externalities in the production of output and/or in the education process, leading to multiple steady state equilibria which may differ for both growth rate and degree of inequality. An important feature relates to the contribution possibly coming from productive public investment. Under a balanced public budget constraint, it activates a kind of externality due to the scope of public action being increasing with average income (then fiscal revenues). This externality may operate at a global level (Glomm-Ravikumar 1993, Saint Paul-Verdier 1993) or in the local community (Durlauf 1993, Benabou 1996b). In the first case it potentially mitigates

the persistence of inequality otherwise arising across individual incomes, in the second it risks to exacerbate social stratification by homogeneous communities.

With respect to policy implications, the recent literature on heterogeneity and macroeconomics sheds a new light on the traditional trade-off between equity and efficiency. From one side, pure political economy arguments point to a negative impact of inequality on growth, mainly due to a large demand for redistribution by the poor implying a high tax distortion on the incentive to invest of the rich (Persson-Tabellini 1994, Alesina-Rodrik 1994). From the other side, market incompleteness may lead to net welfare gains from redistribution, with the benefits of high share of initially poor to invest offsetting the marginal distortionary cost of taxation levied on rich investors (Saint-Paul 1994, Benabou, 1996b). In addition, the endogenous inequality and policy determination interact in a dynamic feedback in explaining the different extent of public action empirically observed across countries, pointing to the role of history in selecting a long run equilibrium in redistribution for a given pattern of inequality (Rodriguez 1998, Benabou 2000).

This thesis focuses on the issue of institutional setting in affecting the relationship between wealth distribution and growth dynamics when credit markets are incomplete due to asymmetric information between borrowers and lenders. Starting from the potentially negative impact on efficiency coming from inequality as in the reference literature, it first investigates if equity progress can be achieved by a public action directly targeted at improving the functioning of credit markets, whose imperfections are understood to mainly cause inequality and its persistence. Once ascertained the limited scope for this option in competitive credit markets with asymmetric information, analysis moves to endogenous redistributive policies in order to understand the factors that determine their political sustainability in the long run. In providing a general framework which explains the variety of equilibrium relationship between inequality and redistribution found in recent literature, conditions for endogenous political cycles are identified. Finally, the effects on aggregate savings of public pension systems, virtually the largest redistributive programme in modern democracies, are empirically assessed in the Italian experience during the last fifty years.

The first paper deals with the competitive equilibrium in the credit market by including a novel factor in standard models of banking and customers' relationship (Sharpe 1990, Rajan 1992), namely the incentive problem of the lenders in costly improving the quality of their private information about borrowers' types. Differently from the reference literature, in which information gathering is a free and homogeneous by-product of the banking relationship, the paper posits that the quality of information is determined by the amount of costly screening explicitly made by the lender. In a dynamic setting, it turns out that the cost of credit eventually offered to the investors in equilibrium is declining with the amount of investment in screening technology which the lenders find profitable to undertake in initial period. In this respect, an interesting finding of the paper is a positive relationship between the *ex post* market power of the lenders and the size of his *ex ante* investment in the screening technology, that mainly rules the average quality of his customers, then the cost of credit they are offered. To the extents that higher rents gained by the lenders finally result in lower credit costs, a larger number of investors are able to borrow under imperfect credit markets. On the contrary, pro-competitive policies on the credit markets may result in a decreased quality of the private information of the insider lenders and then in higher a cost of credit for the investors. As its main policy implication, the paper finds a limited scope for public action to directly address the incompleteness of credit markets, or to reduce the wedge between lending and borrowing rate of interest endemically resulting in equilibrium from adverse selection among investors.

The dynamic feedback between economic and political equilibria and its implication for the pattern of redistribution and inequality in the long run is the subject of the second paper. The issue of endogenous policy is addressed in a stochastic framework very close to Aghion-Bolton (1997), in which imperfect credit markets help poor people from investing in the most productive investment. After providing a micro-foundation of simple rules for intergenerational mobility, the paper first characterises steady state inequality in terms of key parameters of the economic structure driving both upward and downward mobility. Then the endogenous determination of redistributive policies is formalised following the median voter theorem, and its relation with inequality is stressed both in the short

and in the long run. In particular, the paper discusses the separate contribution coming from the economic structure and from policy in shaping the evolution over time of both political equilibrium and inequality. Differently from reference literature, in which key features of wealth distribution prove independent of policy action, in the paper the location of the median voter and/or his preferred policy is allowed to endogenously shift over time, possibly reflecting the stance of redistribution in previous period. As a result, a large variety of political equilibria may occur in steady state depending on the strength by which economic structure by itself would widen or restrict inequality over time and the extent to which it can be counteracted by policy action. Accordingly, a rough taxonomy in the relationship between inequality and redistribution may be identified, with both the standard prediction of a negative link or the more recent finding of non-linearity proving confirmed under proper economic structure. A further result of the paper is that the complex feedback between pure economic factors and political action may hinder the path itself to steady state, endogenously determining fluctuations in both redistribution and inequality. This mainly comes out when forces for social mobility in opposite directions are of quite a similar intensity in free market, and their combined effect on inequality is crucially dependent on policy input. This result delivers a reverse causality argument in interpreting the halt or slowdown in the historical negative trend of inequality registered in the nineties in industrial countries, along with an increasing fiscal conservatism: the effectiveness of previous decades' policies in fostering social mobility might have caused a gradual erosion of the initial consensus for redistribution, paving the way for an opposite political demand to arise, with an ensuing deterioration in equity.

The third paper provides an econometric analysis of the aggregate saving function of Italian households in the vein of the life cycle theory, with the main purpose to investigate the effects of a variety of reforms in the pension system enforced in Italy in the last thirty years. Indeed, results from an ECM representation based on yearly data for 1951-1998 point to depressive effects on private consumption of recent reforms of social security, actual and expected for next few years. In order to compensate for both reductions in actual pension payments and increased uncertainty about their future claims, Italian households stepped up

accumulation of real and financial assets since the beginning of the nineties. Even if based on aggregate data in order to cover the long period in which the Italian pension system has been gradually reformed, the analysis tries to take account of changes in age composition of households. It turns out that the ratio of old to young people played a significant and positive role in explaining the evolution of private consumption demand. A further contribution of the paper is to provide first estimates of capital gains of Italian households and to check for their impact on consumption. The empirical evidence failed to show that they had a significant impact on households' expenditure, in the short and in the long run: their high volatility has likely hindered a fair assessment of their contribution to personal purchasing power on the part of Italian households.

CHAPTER 1

BANKING COMPETITION WITH ASYMMETRIC INFORMATION AND COSTLY SCREENING

In the last twenty years market structure in banking is undergoing unprecedented changes in most of industrial countries due a variety of factors, including financial innovation and, more recently, the developments in information technology. A key contribution has also come from a deep revision of the regulatory approach, turned from the concern that a strong competition may adversely affect financial stability to the new priority of improving efficient allocation of money by raising the contestability of the credit market (Vives, 2001). The wave of deregulation in banking and liberalisation of financial services has been particularly intense in the USA and in Europe, mainly due to the lifting of previous restrictions on deposit rates, scope of business and inter-state expansion of branching. However, the injection of competitive pressures expected from the changes in regulation has been challenged by the recent increase in bank mergers and acquisition at both domestic and international level. This process has occurred to dramatic extents in Europe, where a widespread move in the regulatory framework has been required by the establishment of a single market for financial services[1].

The significant consolidation of the structure in the banking industry amid a progressive deregulation raises the questions if the competitive conduct of lenders has improved or deteriorated in recent years, and if further action in the regulatory framework is required to counter the risk of collusive practices in view of the reduced number of incumbent banks.

A variety of empirical contributions have recently addressed the connection between competition and markets structure by regressing a measure of performance, basically based on the margin between borrowing and lending rates, and some index of

concentration (Hannan-Berger 1991, Berger et al. 1996, De Band-Davis 2000, Bikker-Haaf, 2002). In general, evidence shows a robust relationship between the adopted measures of competition and concentration, albeit with a significant variation across countries in the size of the related coefficient. Indeed, the latter result is often related to the omitted impact of the likely changes in the quality of customers (Bonaccorsi-Dell'Ariccia, 2001, Corvoiser-Gropp 2002), considering that most empirical analysis is centred upon the predictions of the standard structure-conduct-performance hypothesis in industrial economics. This point adds further interest in fully understanding the role of competition in affecting the performance of credit markets under asymmetric information.

In our paper we address the issue in a theoretical perspective, by modelling a dynamic setting where banks compete for both deposits and loans under asymmetric information as the unobservable quality of the borrowers. We then ask about the measure of the strength of competition that proves more appropriate to explain the performance of imperfect credit markets and if the performance itself is soundly gauged by the spread between rates on loans and deposits. Compared with the recent developments in the banking industry, these questions potentially bear significant implications as for the design of a regulatory framework.

In our model the interest rate on loans is determined in a two period game among lenders, who compete in supply credit to investors with unobservable quality. The latter feature has an immaterial impact in the first period, when the investment in the project is risk less; it exposes lenders to an adverse selection problem in the second period, when success in the project turns dependent on the investors' quality. At this time the control of reliable information proves a key tool of competition on the credit markets, affecting the cost of loans offered to the borrowers independently of the interest rate paid to depositors.

A distinguishing ingredient of our model is that improvement in knowledge is the result of a screening technology, which can be operated by lenders at a variable scale and is increasingly costly with the quality of information it unveils. In particular, the screening technology is adopted by the lender at the start of a credit relationship to an extent dependent on future benefits he expects from better knowing the quality of his customers. Allowing for endogenous private information proves a promising input in

[1] In the EU countries the number of banks shrank by approximately 29 per cent between 1985 and 1997, with about 90 per cent of the reduction taking place in the last seven years in the period (European Central Bank, 1999).

better understanding the determination of the cost of credit in equilibrium and to assess its deviation from perfect price competition.

In fact, a first result shows a positive relationship between the *ex post* market power of the informed lender and the size of his *ex ante* investment in the screening technology, that mainly rules the average quality of his customers. As a consequence, the higher is the chance of rent extracting by the lender, the higher the average quality of his customers in equilibrium. From this standpoint, the margin between loans and deposits rate is positively related with the average quality of customers, or with a higher ability of sorting out from credit the investors with lower quality. This is an important feature to be taken into account in assessing the performance of the banking industry in efficiently allocate credit to the most worthwhile projects.

A second result points to the immaterial impact of a reduced number of competitors on the equilibrium cost of credit, as in the model all the competitive pressures on the informed lender can be conveyed by a sole competitor. Enlarging the number of competing lenders affects their own single strategies, but it does not change the probability as a whole that the informed lender can lose some customers to competitors.

A third result, to which normative implications may be attached, is that the effective strength of competition is ruled by the size of the informative advantage of the insider versus the outsider lenders. As private information improves, it turns out that expected profits of the insider *conditional* on winning against competitors increase despite he charges a lower cost of loan, due to a decreasing probability of cheaper bid by the outsiders. The latter are indeed aware that they are exposed to higher risk of attracting lower quality investors, who are the more accurately detected, then sorted out, the more informed is the insider.

Accordingly, a regulatory policy would be effective in increasing competition by directly targeting the quality of public information. Making available to all lenders a better knowledge about the borrowers' quality may indeed curb the profits extracted by the insider lenders without affecting the average quality of their customers, than the cost of loan. On the contrary, enforcing any restriction on the *ex post* profits of the informed lender leaving unchanged the quality of public knowledge can result in lower investment in screening, then in lower quality of customers, and that would in turn raise the interest rate charged on investors.

Finally, we briefly mention the issue of a limited substitutability between public and private information to address the risk that, under the reasonable event that

knowledge publicly provided is noisier than private information, in equilibrium the average quality of customers would deteriorate and the cost of credit increase. It happens under a largely more efficient screening by the lenders than by government, considering that the improved quality of public knowledge crowds out part of the investment in screening by the lenders in view of the lower rents they expect. The controversial benefits coming from higher competition on the credit market may challenge the desirability of public action should the costs of offering reliable public information be explicitly considered. However we do not address this issue as a sound social welfare analysis lies far beyond the scope of our model, which deals with banking competition in a partial equilibrium approach.

The paper is strictly related to a variety of theoretical contributions on market structure and performance of the banking industry under asymmetric information, recently flourishing since the seminal contributions of Sharpe (1990) and Rajan (1992) have shown that banks can extract positive profits from some borrowers even under competitive markets. At least two different strands can be identified. The first is directly linked to the issue of "winner curse" originally applied in bank lending by Broeker (1990) and further elaborated by Nakamura (1993) and Shaffer (1998). Under adverse selection due to unobservable types of borrowers, they show that when credit applicants rejected by one bank can apply to another, the quality of the pool of applicants faced by all banks exhibits a systematic deterioration. By measuring competition with the number of incumbent banks, it is then argued that a lower concentration makes the adverse selection problem more severe, and new entrants would be particularly susceptible to this issue. As a result, the contestability of the credit markets would reduce, too. The approach has been more recently extended to consider the issue of the dispersion of information on borrowers, with the prediction that increasing the number of competing banks may have a negative effect on the cost of loans since lenders would become informed on a smaller pool of borrowers, whose average quality would decline (Marquez, 2000).

The second strand of literature elaborates on the benefits of a firm in financing through long term credit relationships rather than through transactions on the capital markets, where bond issues are simply underwritten (Rajan-Petersen 1995, Boot-Besanko, 2000). In this framework, increasing banking competition reduces the ability of both lenders and investors, whose quality is initially unknown, to intertemporally share the surplus from productive project. In particular, a lender with a significant market power can charge a worth investor a lower cost of loan than in perfect competition at the beginning and a higher cost in the future, in order to recover

the initial loss. Under an increased competition such intertemporal compensation would be limited, and the initial cost of loan would increase, again making the adverse selection problem more severe. It would hurt in particular the low and medium quality borrowers, while the high quality ones would potentially benefit from an increased banking competition.

Alike the latter approach, our paper stresses the potential loss in efficient allocation of credit coming from an increased competition among lenders within a credit relationship. Besides the reduced control by the informed lender on both the decision to continue a project in future periods and on its expected payoffs, the paper adds a further characterisation to the potential loss coming from increased competition: a lower incentive to invest *ex ante* in screening, then a decreased quality of the private information, with a ultimate raise of the cost of credit in equilibrium. From this standpoint the paper shares the prediction made in the first strand of literature of a negative correspondence between the cost of credit and the degree of concentration in banking. We differ however in the analysis of the origin of this issue, which in our paper traces back to the deterioration of the incentive on the part of lenders to invest in the costly screening - and by this to improve their own information about borrowers – rather than from an augmented number of competitors, which we find immaterial as to the cost of loans. An additional feature that distinguishes our paper from the reference literature is that lenders compete for both deposits and loans. We do this in order to show the cost of credit is ruled by the informative advantage of the insider lender independently of the cost of deposits, even when it is endogenously determined.

A variety of issues are set aside of our paper, mainly for simplicity sake and to focus our attention on the key role of information as a tool of competition on imperfect credit markets. In first place we share with the reference literature a world of risk neutrality, on the side of both lenders and borrowers. However, introducing risk aversion in our modelling of banking competition as a bidding game would not make a radical change in our results, as it can be inferred by a full discussion in Milgrom (1979). Apart from a somewhat higher cost of loans in equilibrium, due a proper adjustment for risk, the predictions of the model would be confirmed, albeit in a much more complex formalisation. In second place we do not deal with moral hazard issue, since this would have required more structure in the simple credit contract we consider in order to solve for incentive compatibility on the part of the investors; the specification of the signal extracting technology would also be properly adapted to control *ex post* behaviour rather than the *ex ante* type of the borrowers. These adjustments would require a revision in the formal derivation of our results, that we

think would prove basically confirmed even considering moral hazard. An indirect confirmation comes from Petersen-Rajan (1995), who find equilibrium conditions on credit markets under moral hazard and adverse selection pretty similar as those in Rajan (1992), where only adverse selection is considered. In third place we neglect to model the cost of the public provision of information, as well as to compare it to the related benefits. While it would be very interesting to assess if active public authorities on imperfect credit market may improve social welfare, our partial equilibrium model of competitive banking is hard suitable for providing a sound analysis in this field.

The remaining part of the paper is organised in four sections. The first outlines the basic features of optimal choice as to both the borrowers and the lenders in a dynamic stochastic framework with asymmetric information. The second shows how the competitive equilibrium is determined on the credit markets and outlines its main characteristics. The third section discusses the policy implications of the theoretical model as far as a regulatory framework is concerned. The fourth briefly concludes.

1.1 The model

1.1.1 The investment project

We assume an economy in which a continuum of risk neutral entrepreneurs have developed the same project idea, which requires a minimum scale of fixed capital to be invested at each of two periods. As to the technology of the project, in each period it delivers a positive payoff provided the entrepreneur exerts a proper level of effort. In particular, we find convenient to assume that in the first period the payoff is equal to $L > 1$ with certainty conditional on the provision of a fixed, observable effort by the entrepreneur. At the end of the first period, the project can be either liquidated with a full depreciation of the capital or continued by replicating the initial investment. In the latter case, during the second period a further provision of effort is required to positively affect the distribution of a stochastic payoff, as from the following

$$(1) \qquad 2° \text{ period return} \equiv \Psi = \begin{cases} x & \text{with } prob = p(e) \\ 0 & \text{with } prob = 1 - p(e) \end{cases}$$

At this stage we assume that the returns of the project are observable and verifiable, with $x > L > 1$, while the effort e is exerted according to the unobservable investor's type. As a result, while the project's return conditional on success is known and constant across investors, the unconditional probability of success changes with their types. We restrict our analysis to the case in which all investors belong only to two classes, A and B, within each of them the types are identical, with $p_A > p_B$; then investors of type A exert a higher effort than investors of type B. Only investors know their own type while it is a common knowledge the distribution of types across investors, as it is defined by the proportion ϑ of type A investors out of the continuum of all potential investor.

As to the project finance, under zero initial wealth of entrepreneurs at the start of the project at t_0 they need to borrow the full investment, which we normalise to *1* for convenience sake; at date t_1 they may either liquidate the project and repay the initial debt by the payoff L or continue the project. In this case they need to re-borrow one unit of capital and the pay the cost of the loan at date t_2, when the investment's stochastic payoff realises. Indeed, as in Rajan (1992) external funds are raised on a competitive credit market according to discount debt contracts: at each date t_i the investor borrows *1* and makes a single repayment D_j at date t_j. To make clear the pivotal role played by private information, the analysis is cast in a context where only short term debt contracts, namely with *i-j=1*, are available to the borrowers. Moreover, for simplicity sake we assume that $L > D_1$, with D_1 identifying the face value in the first period debt contract, when the effort provided by the investors is observable and negotiable. We thus rule out the possibility that an adverse selection problem arises as early as at first stage and concentrate the analysis of competition on imperfect credit market in the final period.

1.1.2 The financial intermediation sector

Lenders know the technology of the project and the distribution of investors across the two types, but they ignore the type of a single investor. Indeed, a key problem for the intermediary is to improve knowledge about his customer types in order to mitigate the adverse selection problem arising at date t_2. Differently from Sharpe and Rajan, and in line with Stiglitz-Weiss (1983), Yannelle (1997) and Chiesa (2001), we

cast the issue in a double side competition among lenders, namely for loans and deposits.

In the first period, the lenders raise funds by depositors in order to meet the loan applications by the investors. Under positively sloped supply of deposits, the interest rate paid by the intermediaries to the depositors is increasing with the overall size of loans offered to the investors/borrowers. Since no adverse selection problem arises at initial date, the total demand for funds by investors equally splits among the mass n of competing intermediaries. Accordingly, each lender supplies a subset $m = \frac{M}{n}$ of *initial* customers out of the full set M of applicants for credit. At the start of the lending relationship at date t_0, as no private information has been yet collected by the intermediary, the type distribution within the continuum subset m is reasonably the same as within the overall set M and the *ex ante* expected type for the initial customers of each intermediary is invariantly given by

$$p = \vartheta p_A + (1-\vartheta) p_B \tag{2}$$

As for the length of contracts, we find convenient to assume that they last two periods on the deposit side, only one period on the loan side. While in the latter case the implied loss of generality is negligible in absence of a commitment technology to re-lend on the part of the intermediary (Rayan, 1992), in the former our assumption is at odds with a realistically higher liquidity of deposits than loans. From a technical standpoint, however, a long term contract for deposits, or a fixed cost of funds for the lenders over the full life of the project, is a largely simplifying device since it rules out indeterminacy of equilibrium and credibility issues in the twofold competition faced by financial intermediaries (Yannelle, 1997 and Stiglitz-Weiss, 1983).

Once both the deposit and debt contracts have started, in the first period each lender implement the desired investment on screening his customers, in view of the perspective benefits of relatively better knowledge about their true types.

At the beginning of the second period, the informed lender decides whether asking his initial customers for closing down the project or continuing it, depending on the test respectively signalling a type A or B. To make clear the strategic content of information, the effort that type B would provide in the second period is assumed to be so low that

$$p_B(1+\overline{\rho}) < 1 + \underline{r} < p_A(1+\underline{\rho}) \tag{3}$$

where the pair $(\overline{\rho}, \underline{\rho})$ identifies respectively the highest and the lowest possible cost of loan reasonably offered by the lender in the second period and $\underline{r}$ the lowest possible interest rate he pays to depositors; the equilibrium values for each variable will be fully discussed in later sections. Accordingly, the lender has an incentive to identify the type B investors and to terminate at the beginning of the second period the debt contract initially offered to them. Alternatively, if the private information gathered through the screening technology signals a type A for some initial borrowers, the insider finds convenient to keep lending to them, likely offering a cheaper debt contract in order to avoid that in second period those borrowers apply for credit to competitors.

1.1.3 The screening technology

In most literature on financial intermediation information gathering is assumed either to be a free by-product of the customer relationship (Fama 1985, Sharpe 1990, Rajan 1992) or to be gained at a fixed cost (Diamond 1984, Williamson 1985). In both cases the quality of information is assumed uniformly perfect for the informed lenders, a feature which may be immaterial in understanding the rationale for indirect trade but may turn crucial in analysing its outcome in a competitive setting.

From this standpoint, we depart from the received literature in modelling private information as endogenously resulting from a costly process that a lender decides to undertake at the start of the credit relationship to an optimal extent depending on future expected returns. As already sketched in previous sections, in a dynamic setting a higher investment in screening technology in the first period mitigates the adverse selection problem arising in the final period, when the chances of success in the project depend on the unobservable type of the investors. Increasing investment in screening improves the quality of private information and allows for a better selection of borrowers, eventually leading to lower interest rate in equilibrium.

We model the technology of collecting private information as a test Γ, which the lender is entitled to apply to his own customers in order to extract a signal about their true types. The quality of the signal is increasing with some input α that the lender can provide to a variable extent, and that for simplicity sake we normalize as $\alpha \in (0,1)$. The economic interpretation is that the accuracy of the signal by which the lender updates the expected type of his initial customers with respect to common knowledge is reasonably dependent on the skills/size of the personnel hired by the

lender to run the test, as well as on the quality of the equipment possibly required for implementing the test. When such inputs are provided at the highest scale, or its normalised measure α tends to 1, the performance of the test is optimal and the true type of the investor is perfectly disclosed in the limit. On the contrary, when α tends to 0 the signal extracted by the test is extremely noisy, and the quality of the private information proves dramatically scarce. In this context, the input α measures the size of what we call investment in screening that the lender can undertake to a variable extents once the credit relationship has started, and by which he controls the quality of his private information. Formally, the process of signal extraction can be modelled as

$$\Gamma(\alpha)=\begin{cases} prob\left(\tilde{A}|A\right)=prob\left(\tilde{B}|B\right)=\dfrac{1+\alpha}{2} \\ \\ prob\left(\tilde{A}|B\right)=prob\left(\tilde{B}|A\right)=\dfrac{1-\alpha}{2} \end{cases} \tag{4}$$

where $prob\left(\tilde{i}|j\right)$ is the probability that the test signals a type i when the true type is j, with $i,j=A,B$, and $\alpha \in (0,1)$ measures again the quality of the input to the test provided by the lender. It is important to notice that the technology of the test is available to all lenders, at a cost that we can assume equal to zero without loss of generality. What makes the lenders different one another is the restriction that starting a credit relationship is a requirement for the actual implementation of the test. In other terms, only the intermediary that is providing money to some investors is entitled to access their internal books or to collect insider information about their projects; the competing lenders are ruled out. In line with the reference literature, this is a reasonable restriction to make interesting the issue of private information, then the distinction between insider and outsider lenders, in analysing the competitive equilibrium on credit markets.

In view of the (3), based on the signal extracted by the test in the first period, the more reliable the higher the input α, in the second period the insider lender strictly prefers to keep supplying credit only to his initial customers that reveal a type A and to terminate it to the others. Accordingly, in second period he bids a debt contract to a subset m_1 of initial customers, with $m_1 = m\left[\vartheta\left(\frac{1+\alpha}{2}\right)+(1-\vartheta)\left(\frac{1-\alpha}{2}\right)\right]$, which

easy proves to be increasing (decreasing) with α when $\vartheta > 0.5$ (<0.5)[2]. More importantly, after the sorting of initial customers, the share of types A in the subset of the investors that confirm to worth credit in the second period, let it be $\tilde{\vartheta}(\alpha)$, is given by the following

$$\tilde{\vartheta}(\alpha) = \frac{\vartheta(1+\alpha)}{\vartheta(1+\alpha)+(1-\vartheta)(1-\alpha)} \tag{5}$$

As a result, at the beginning of the second period the insider lender can update the expected type of his customers according to the following

$$p(\alpha) = p_A \tilde{\vartheta}(\alpha) + p_B\left(1-\tilde{\vartheta}(\alpha)\right) \tag{6}$$

Since it is easy to show that both $\tilde{\vartheta}(\alpha)$ and $p(\alpha)$ are increasing with the investment in screening α made by the lender (see Appendix 1.3), the intensity of the adverse selection problem arising in the second period is largely under the control of the insider lender, and it becomes virtually negligible when the scale of the investment in screening in the first period is the highest. As it will become more evident in later discussion, the lender has then a clear incentive to increase the quality of his private information in order to improve his ability to sort his own initial customers; however this benefit compares with the implied costs.

Indeed, we assume that the investment in screening, as measured by the input α, is increasingly costly, as from the convex function $g(\alpha)$, with $g(\alpha) = 0$ when $0 < \alpha < \varepsilon$ and $g(1) = \Theta \to \infty$. The economic content is that acquiring basic knowledge about the investor's type may involve negligible costs once a lending relationship has started, while carefully analysing internal books of a firm in an attempt to figure out its future strategy may require the application of well trained personnel on the part of the lender, raising the cost of information gathering. At the maximum effort, the lender can achieve the input required for almost a perfect screening of his customers.

[2] The expression for m_1 comes from summing up the mass of tested investors that signal a type A, either rightly or wrongly with respect to their true types.

1.2 The equilibrium cost of credit

We model the equilibrium cost of credit as the result of a two period game among lenders, which we find convenient to solve by backward induction. Before moving to formal analysis, we summarise the main features of our dynamic setup and the concept of equilibrium in each of the two periods.

In the first, lenders compete on both deposits and loans; after receiving application for credit by investors, they raise the required funds from depositors. Equilibrium is determined by perfect competition in view of observable effort initially provided by the investors in the project: the lender charges the investors the interest that clears the market under a positively sloped supply of deposits. While the cost of loan can change in the second stage, the interest rate paid to depositors, together with the amount of money collected from them, is determined in first period and remains unchanged thereafter due to long term contracts on the deposit market. Since information is symmetric, in the first period conditions for credit are homogenous among lenders; on one side, all of them supply credit to an equal mass of applicants charging an equal cost of loans, on the other collect an equal amount of deposits paying an equal interest rate. Once the credit contract has started, each lenders decides the size of investment on screening, namely α, in order to improve his knowledge about the types of his own customers in view of future choice of either terminate or renovate the credit contract. Accordingly, at this time each lender gathers private information about his customers, so that the initial homogeneity is broken: by the end of the first period, each lender becomes insider with respect to the pool of investors to whom he is supplying credit and outsider with respect to the remaining investors.

In the second stage, investors roll over the repayment on the initial loan and apply for a loan of equal size to meet the investment required to complete the project. If they receive credit, at this time they supply unobservable effort in the project according to their own types, and the expected returns are higher for good than for bad type. Lenders are now exposed to an adverse selection problem due to asymmetric information with respect to the investors as to the latter's true types; in addition, asymmetric information arises also among lenders, due to private information gained by the insider as for his own initial customers. In this context, lender compete by simultaneously offering a sealed credit contract to investors, according to three possible options: i) terminate credit to his initial customers who revealed a bad type at the screening; ii) keep supplying credit to his initial customers who revealed a good type at the screening, tendering them, as insider, a cost of loan not higher with respect to the

competing lenders; iii) supply credit to the competitors' initial customers, bidding them, as an outsider, a cost of loan not higher than the respective insiders. As an additional option, residual money, coming from the excess of deposits collected in the first period with respect to loans actually made in the second, may be allocated in a mutual fund, which earns a safe return covering the equilibrium cost of deposits. At this stage, the crucial factor affecting the loan rate is the solution of the bidding game among lenders under options ii) and iii). Hereafter we focus attention especially on this issue arising in the second period, since it proves promising in better understanding the performance and its determinants on imperfect credit markets.

As it is fully discussed in following sections, given the private information coming from the investment in screening made in the first period, in the second period the insider bids a unit loan cost low enough to win against the outsiders, but still higher than the cost of deposits. In our framework, such rent extracted *ex post* by the insider stands for a compensation for the costly investment in screening he made *ex ante*. As to the outsiders, who are aware of the informative advantage of the insider, they find optimal to offer the investors a distribution function for any admissible cost of loan, since their expected profits prove invariantly zero given the optimal, pure strategy pursued by the insider. Given the mixed strategy adopted by the outsider, the insider's pure strategy proves optimal too. Once received the offers made by the lenders, the investors subscribe the cheapest one, and start implementing the second step of the project. It is interesting to mention that no strategic interaction comes out among investors, since they perfectly compete for funds at any stage. The game described in full details in next sections is played only by lenders.

1.2.1 The bidding game in the second period

In order to highlight the key impact of the quality of private information on the equilibrium cost of credit, we find useful to model competition among financial intermediaries in the second period as a competitive bidding under asymmetric information. Since it was first put forward by Vickrey (1961) and Wilson (1967) in the context of property rights and the drilling of petroleum fields, the approach has more recently received a formal generalisation (Engelbrecht-Wiggans et al. 1983, Milgrom and Weber 1982 and 1985) and an increasing number of applications (Rajan 1992, Hendricks-Porter 1998). In our framework it proves quite useful to fully address the key

role of the quality of private information in affecting equilibrium on imperfect credit markets.

In the second period, the lenders take for given the interest rate r paid on deposits and the investment on screening, then the quality of their private information. As in Rajan (1992), they simultaneously offer investors a sealed bid, which specifies the cost of credit whereas supplied, and the investors subscribe the contract they find more convenient. The lenders' problem in the second period is to offer to each investor a debt contract that maximises the difference between the expected returns on loans and the costs of deposits, under the constraints of beating the competitors' offer. Although similar in structure, the problem holds in different terms for the insider and the outsider lenders.

From a technical standpoint, it is important to note that the equilibrium exists only in the domain of mixed strategies. On the part of the outsider, it is due to the fact that a pure, then a predictable strategy would always lose: the insider, who knows at least everything his competitors know, would tender a more convenient bid if worthwhile, and retire otherwise. In this context, the outsider would lend only to unreliable investors, and his expected profits would result invariantly negative. On the part of the insider, a mixed strategy is a formal requirement to induce a continuous distribution in the expect type of the investors conditional on private information, then to make feasible the analysis of equilibrium. As shown in Appendix 1.1, in line with Engelbrecht-Wiggans, Milgrom and Weber (1983) all the strategically important characteristics of the informed lender can be formally summarised by a uniformly distributed random variable $T \in [0,1]$[3]. Differently from the referred paper, we make explicit the dependence of the *ex post* cost of credit on the *ex ante* investment on screening, so that we characterise the informed lender in terms of both α and t as by $p(t \mid \alpha) = \inf\{p \mid Prob(p(\alpha) \leq p) > t\}$. Outsider lenders know the distribution of T and $p(\alpha)$, but cannot observe their realisations; they are then aware of the informative advantage gained by the insider as for the types of his own initial customers, but cannot infer how great such advantage is. At the same time, the insider commands both public and private information on investors' type, and know exactly the size of his own informative advantage with respect to the outsider.

After observing the signal extracted by the screening technology about the types of his initial customers, in the second period the problem of the informed lenders

[3] The latter is a probability measure of the joint event of the *ex post* expected type of the investors and the realisation of U, or a stochastic variable which the informed lender uses whereas he needs to randomise his bids.

is to choose a bid, namely a unit cost of the loan, to maximise his expected profits conditional on winning against his competitors. He then solves the problem

$$\max_{\rho} prob(\rho \leq \rho_{-1})[p(\alpha)(1+\rho)-(1+r)] \tag{7}$$

such that

$$X-(1+\rho) \geq x \tag{8}$$

where ρ is the unit cost of loan offered by the informed lender to his initial customer, ρ_{-1} is the set of all bids tendered by the outside lenders; r is the unit cost paid by the lenders to the depositors and $p(\alpha)$ is the *ex post* expected probability of success by the investors in the productive project. According to the individual rationality constraint identified by (8), the reservation value of the investors, as given by x, is proportional to their own types, ruling out the possibility of self selection and stressing the key role of screening in the process of signal extraction.

The outside lenders cannot exploit any private information, thus they bids randomly under the constraint not to tender a more expensive contract than the insider lender does. Accordingly, they randomise their strategies to solve the following

$$\max_{G(\rho)} \int_{a}^{b} \{[p(1+\rho)-(1+r)] \mid \rho(\alpha) \geq \rho\} dG(\rho) \tag{9}$$

such that (8) holds true

where $[a,b]$ is the support of the cumulative distribution function $G(\rho)$ that will be discussed in the next section and $G(\rho)=1-prob(\rho(\alpha) \leq \rho)$ is the probability that the outsider tenders a credit contract not cheaper than the insider, or the distribution of the minimum interest rate offered by the outsider.

1.2.2 The equilibrium strategies in the second period

The equilibrium contracts in second period characterise in terms of both actual supply of credit and its cost whereas offered[4]. In particular, when the lenders act

[4] The role of the size of the loan is rule out under a uniform scale of the investment, normalised to 1 for all borrowers, and no internal funds to be invested by the latter (see section 1.11.1). The last point makes collateral unfeasible as a term of the credit contract.

as insider, they terminate the credit relationship with the initial customers that do not pass the screening, and offer a credit contract to the remaining initial customers at a cost ρ maximising expected profits (7), given the constraint (8), the investment α made in previous period and the credit strategies followed by competitors. When the lenders act as outsider, they offer credit to all initial customers of the competitors at a random cost maximising (9), conditional on (8) and the competitors' strategies. Formally, the cost of credit proves determined in a sub-game perfect equilibrium in the mixed strategies, as it is stated in the following proposition:

Proposition 1. The (n+1)-tuple $\left(\rho^*, G_1^*(\rho),...G_n^*(\rho)\right)$ is an equilibrium point if and only if

$$(1.A)\quad \rho^*(t|\alpha) = \begin{cases} \dfrac{1+r}{E\left(p(s|\alpha)|s \le t\right)} - 1 & \text{if} \quad t > \hat{t}(\alpha) \\ X - x - 1 \equiv b & \text{if} \quad t \le \hat{t}(\alpha) < \underline{t}(\alpha) \\ 0 & \text{if} \quad t \le \underline{t}(\alpha) \end{cases}$$

and

$$(1.B)\quad G^*(\rho) \equiv G_1^*(\rho),...G_n^*(\rho) = \begin{cases} 1 & \text{if} \quad \rho < \dfrac{1+r}{\int_0^1 p(s|\alpha)\,ds} - 1 \equiv a \\ \dfrac{\int_0^{\rho^{*-1}(\rho)} p(s|\alpha)ds}{\int_0^1 p(s|\alpha)ds} & \text{if} \quad a < \rho \le \rho(\hat{t}) \end{cases}$$

where $\hat{t}(\alpha)$ is implicitly derived from $X - \left(1 + \rho\left(\hat{t}|\alpha\right)\right) = x$, and identifies the maximum bid which complies with the individual rationality constraint of the investors; $\underline{t}(\alpha)$ is defined by $p(\underline{t}|\alpha)(X-x) = 1+r$ and stands for the minimum bid compatible with non negative profit by the informed lender.

Proof. The result is obtained by properly adapting the arguments made in Engelbrecht-Wiggans, Milgrom and Weber (1983) and in Rajan (1992). For notational convenience, in what follows we avoid to make explicit the dependence of *p(t)* on α.

In first place we show that, under the suggested strategies, the distribution of the interest rate offered by the insider and the outsider have a common support, namely $\{0,[a,b]\}$; in this case, it is always possible to equalise $\rho(t)$ to any given ρ. From one side, in general offering a higher interest rate than b would violate the individual rationality constraint on the part of the investor. From the other, as for the outsider, offering a lower interest rate than a is pointless for the given strategies since he could just offer a and still have the same chance of winning against the insider, but with higher profits; as for the insider, again under the candidate equilibrium strategies, there is no incentive to offer a lower ρ than a since it would win anyway the game with higher profits. A zero interest rate simply reads as the option of giving up in the game, which is always an open option to both the insider and the outsider.

In second place, under a common support for the mixed strategies it is easy to show that the equilibrium expected profits are zero for the outsiders regardless their bids. Actually, for these lenders the expected profits, conditional on winning the game, is given by the following

(i) $\quad E[p(t)(1+b)-(1+r)|t \le \rho^{*-1}(b)] = (1+b)\,E[p(s)\,|\,s \le \rho^{*-1}(b)]-(1+r)$

Since it is always possible to identify a $\rho^{*}(t)=b$, substituting in (i) for its expression as from candidate equilibrium strategy for the insider, namely $1+\rho^{*}(\rho^{*-1}(b)) = \dfrac{1+r}{E[p(s)\,|\,s \le \rho^{*-1}(b)]}$, it immediately follows that outsider's expected profits are invariantly nil in equilibrium.

In third place, the optimal strategy for the insider comes from setting to zero the expected profits of the outsider for any realisation of T. Accordingly, from $(1+\rho)\,E[p(s)\,|\,s \le \rho^{*-1}(\rho)]-(1+r)=0$ it immediately follows that $\rho^{*}(t) = \dfrac{1+r}{E[p(s)\,|\,s \le t]} - 1$. This expression holds true under $t \ge \hat{t}$. When $\underline{t} \le t \le \hat{t}$ the insider's offer is determined by the investor's individual rationality constraint, then the bid is set at *X-x-1*, and the insider still makes non-negative profits. When $t < \underline{t}$, the expected quality of the investors after the screening test proves so low that the insider expects negative profits from offering credit and he prefers to give up.

Finally, we derive the equilibrium distribution function of the minimum interest rate tendered by the outsiders. Actually, this function is obtained under the constraint that it makes the strategy outlined in the previous step optimal from the insider standpoint. In other terms, we need to prove that he maximises his expected profits under the candidate equilibrium strategies. The insider's expected profits conditional on winning the game read as $V = G(\rho)[p(t)(1+\rho)-(1+r)]$. From the first order conditions for a maximum requiring $\dfrac{dV}{d\rho} = \dfrac{dG}{d\rho}[p(t)(1+\rho)-(1+r)] + Gp(t) = 0$ we obtain that $\dfrac{dG}{G} = -\dfrac{p(t)d\rho}{p(t)(1+\rho)-(1+r)}$. In view of the equilibrium rule for $\rho(t)$ and the uniform distribution of T on $[0,1]$, it follows that $\rho(t) = \dfrac{(1+r)t}{\int_0^t p(s)ds} - 1$, with $d\rho = \dfrac{d\rho}{dt}dt = \dfrac{(1+r)\left[\int_0^t p(s)ds - tp(t)\right]}{\left[\int_0^t p(s)ds\right]^2}dt$. Properly

substituting for this expression, it turns out that $\frac{dG}{G} = -\frac{p(t)\left[\int_0^t p(s)\,ds - t(p(t)\right]d\alpha}{\left[\int_0^t p(s)ds\right]^2} \cdot \frac{\int_0^t p(s)ds}{tp(t) - \int_0^t p(s)ds} = \frac{p(t)d\alpha}{\int_0^t p(s)ds}$. As suggested in Rajan (1992, p. 1936), by integrating between t and 1 and applying the boundary condition that $G(p(1)) = 1$ we find that for the outsider, whose exact bid is pointless since his expected profits are invariantly zero in equilibrium, it is optimal to follow the candidate distribution function given the candidate strategy by the insider.

In equilibrium the insider lender charges a loan rate declining with the quality of his private information - as it formally comes from the ensuing higher value of the integral in the first row in (1.A) - conditional on meeting the individual rationality constraint of the investors. When the latter is binding, the insider offers a rate equal to b if he expects non negative profits (second row in 1.A); otherwise he does not offer credit at all, as it happens when the average quality of customers proves so low that his expected profits turn negative (third row in 1.A). As an economic interpretation, when private information is more reliable, the insider lender is closer to observe the true types of the investors; accordingly his ability to sort the bad investors out of his initial customers is higher, so that he values more to keep supplying credit to the remaining customers, supposedly of good quality. The loan rate tendered to the credit worth customers is then so cheap to minimise the risk that competitors may do better. By the same token, the outsiders know that the insider will tender a cheap rate when he commands very accurate private information; in their strategy they then attach a very low probability to offer cheaper rates since they are afraid that, if they win the insider's bid, it would likely be with low quality investors. This is captured by the expression reported in second row in 1.B, where the outsiders' probability of offering cheaper credit than the insider proves increasing with the latter's bid. First row in 1.B simply states that the outsiders will never tender a cheaper rate than the insider would do under perfect knowledge of his own customers, since that would add zero chance of winning the competition and unnecessary decrease their expected profits.

After identifying the optimal strategies for competing lenders, two interesting corollaries follow as to the profit margin of the insider in equilibrium and the negligible impact coming on it from enlarging the number of the outsiders.

Corollary 1. In equilibrium the profits expected by the insider lender from a single credit contract embody a non negative premium for his private information.

Proof. By neglecting the dependence on α for simplicity sake, the result directly comes from $\frac{p(t)t}{\int_0^t p(s)ds} - 1 > 0$, that in turn comes from $\frac{\partial(1+\rho)}{\partial t} = \frac{(1+r)\left[\int_0^t p(s)ds - tp(t)\right]}{\left[\int_0^t p(s)ds\right]^2} \leq 0$ if ρ satisfies the optimality criteria, which require that ρ is not increasing with $p(t)$. To show this, when $t^1 > t$, and then $p(t^1) > p(t)$, if $\rho^1 > \rho = \rho^*(\alpha)$ it follows that

[i] $$G(\rho)p(t^1)[(1+\rho)-(1+r)] \geq G(\rho^1)p(t^1)[(1+\rho^1)-(1+r)]$$

At the same time the definition of optimum implies that

[ii] $$G(\rho)p(t^1)[(1+\rho)-(1+r)] \geq G(\rho^1)p(t^1)[(1+\rho^1)-(1+r)]$$

From [ii], if $\rho^1 > \rho$, then $G(\rho) \geq G(\rho^1)$. This proves [i].

Corollary 2. The number of uninformed lenders n does not affect the equilibrium credit strategies, provided that $m>0$.

Proof. Since equilibrium depends on $G(\rho)$, identifying the probability that the set m of uninformed lenders bids a unit loan cost not lower than ρ, from $G(\rho) = G_1(\rho) \cdot \ldots \cdot G_n(\rho)$ it follows that the equilibrium mixed strategies does not change with n. Indeed a change in n causes an adjustment in $G_i(p)$, $i=1...n$, but leaves unchanged G^* and ρ^*[5].

By limiting analysis to symmetric equilibrium, as lenders are identical with respect to all characteristics, including the quality of private information as for their own customers, in the second period their credit strategies follow either the first or the second part of Proposition 1 depending if they act either as insider or as outsiders. The total expected profits in the second period, namely the expected profits per investor times the mass with true type A within the pool of a lender's customers, are then given by

$$(10) \qquad \Pi(\rho \mid \alpha, m, r) = G(\rho)(1+r)\left\{\frac{p(t \mid \alpha)}{E(p(s \mid \alpha) \mid s \leq t)} - 1\right\} m_1(\alpha)\, p(\alpha)$$

[5] When lenders are identical except for the information set about their own initial customers and share only the common knowledge about the competitors' initial customers, it follows that $G_i = G_j$.

where we consider that the funds that was initially raised from depositors to finance the mass $m - m_1$ of investors, who are selected out at the beginning of the second period, may be allocated by the insider either to customers won to competitors or to a mutual fund; in either case, his expected profits are zero. The expression for total expected profits takes account that, after observing the private signal about the investors' types, the insider lender bids a contract only to the subset m_1 of his initial customers. While competing against the outsider, he makes his effort to win the game with respect to the whole subset m_1, within which he cannot identify the good and the bad true types, by following the optimal strategy identified in Proposition 1. After winning the game, however, he knows that only a subset of his second period customers is really of good type, namely $\tilde{\vartheta}(\alpha)\, m_1(\alpha)$, and the remaining are of bad type, with respectively probability of success p_A and p_B. Then the final two terms on the right hand side of the (10) must be included in assessing *total* expected profits[6].

An important feature of the equilibrium strategy in our framework is the positive impact on total expected profits exerted by the *ex post* higher quality of customers as a result of the investment in screening.

Proposition 2. In equilibrium the total profits expected by the insider lender in the second period are increasing with the investment in the costly screening made in the first period.

Proof. Abstracting from randomisation of strategies formally required in identifying equilibrium, from the insider's standpoint the key variable in affecting total profits is represented by α, or a summary of the quality of his private information about the investors' types. For an easier derivation of the result, in first place the mass of the classes of investors targeted by the insider, namely $\tilde{\vartheta}(\alpha)\, m_1(\alpha)$ and $(1-\tilde{\vartheta}(\alpha))\, m_1(\alpha)$, can be expressed in terms of m respectively as $\mu_A \equiv m\vartheta\frac{(1+\alpha)}{2}$ and $\mu_B \equiv m(1-\vartheta)\frac{(1-\alpha)}{2}$ In second place, let $V^*(\rho^*(\alpha)) = G(\rho^*(\alpha))(1+r)\left\{\frac{p(t\mid\alpha)}{E(p(s\mid\alpha)\mid s\le t)}-1\right\}$ be the maximum insider's expected profits per his own *ex post* "average" customer, when ρ is optimally set according to Proposition 1. It means that, while competing against the outsiders, the insider tenders the same interest rate to every customers in m_1. Conditional on winning the game, in view of the common cost of credit $\rho^*(\alpha)$ the insider expects higher (lower) profits from type A (type B) than from "average" type

[6] The definition (10) results from properly arranging the following expression:
$G(\rho)m_1\left\{\tilde{\vartheta}[p_A(1+\rho)-(1+r)]+(1-\tilde{\vartheta})[p_B(1+\rho)-(1+r)]\right\}$.

investors, since $p_A > p(\alpha) > p_B \ \ \forall \alpha \in (0,1)$. If we let $V_A^* \equiv V^*\big|_{p=p_A} = V^* + \eta_A$ and $V_B^* \equiv V^*\big|_{p=p_B} = V^* - \eta_B$ with $\eta_A, \eta_B > 0$, total expected profits read as $\Pi(\alpha,\cdot) = \mu_A(\alpha)[V^*(\rho(\alpha)) + \eta_A] + \mu_B[V^*(\rho(\alpha)) - \eta_B]$. After properly substituting and rearranging, we get $\Pi(\alpha,\cdot) = mV^*(\rho(\alpha)) + m\left\{\frac{\vartheta(1+\alpha)}{2}\eta_A - \frac{(1-\vartheta)(1-\alpha)}{2}\eta_B\right\}$, with $\frac{d\Pi(\alpha)}{d\alpha} = m\left\{\frac{\vartheta}{2}\eta_A + \frac{(1-\vartheta)}{2}\eta_B\right\} + m\frac{dV^*(\cdot)}{d\alpha}\Big|_{\rho=\rho^*}$. As the second term proves to be positive (see Appendix 1.2) and the first is invariantly positive, the result follows.

1.2.3 The equilibrium strategies in the first period

At this stage, the lenders choose the optimal levels of α, m and r by discounting that in the second period they can earn $\Pi(\rho,\alpha,m,r)$. Accordingly they solve the problem

(11a) $$\max_{a,r,m} \ \pi = \zeta L m + \delta\Pi - (1+r)m - g(\alpha)m$$

such that

(11b) $$(1-\zeta)L \geq x$$

where L is the safe payoff of the project at the end of the first period, and ζ is the share of L to be repaid to the lender in case of liquidation; $g(\alpha)$ measures the convex costs of the screening and x the reservation return to the investor.

In view of maximising profits in the first period, the lender offers the investor the highest cost for loan compatible with (11b): at this stage, competition among investors lead to a rent extraction at their expenses and, ultimately, at advantages of the depositors[7]; in the equilibrium $\zeta^* = 1 - \frac{x}{L}$ and $\zeta^* L = L - x$.

Due to π being linear in m, the number of total loans offered by each lender, m^* is equal to the highest level compatible with equilibrium on the deposits market in case $L - x - (1+r) + \delta\Pi m^{-1} - g(\alpha) \geq 0$, is equal to zero otherwise. In view of the assumed symmetry among lenders, m^* is equal for all lenders, who equally split the total funds raised on the deposit market. When conditions for $m^* > 0$ are met and

[7] The same result is in Stiglitz-Weiss (1983).

supply of deposits is positively sloped, competition among lenders raises deposit rates up to the point that the lenders' expected profits vanish.

Accordingly, the equilibrium on the deposit market implies $r^* = \delta \Pi m^{-1} - g(\alpha) + L - x$ and the total amount of loans supplied by all lenders is given by $\sum m^* = S^{-1}(r)$, with $S(r)$ being the deposit supply function and $\frac{\delta S}{\delta r} \geq 0$; at the same time m^*, the mass of loans offered by each lender, is a decreasing function of the total number of lenders $n+1$; the latter are left unsolved as usual in perfect competitive markets.

As to the optimal value of α, since $\Pi(\alpha,\cdot)$ is a concave increasing function (proof in Appendix 1.2), it is implicitly given by the solution of $\frac{\partial \delta V}{\partial \alpha} = \frac{\partial g(\alpha)}{\partial \alpha}$. In view of the convexity of $g(\alpha)$, the Kuhn -Tucker theorem proves the existence and uniqueness of α^*.

1.2.4 Main features of equilibrium

Since in the first period the rates on deposits and loans are determined by standard market clearing conditions under perfect competition, in this section we focus our attention on main feature of equilibrium in the second period, when asymmetric information turns crucial. In this respect, an important link between the two periods comes from the quality of private information, as it is determined by the costly investment in screening made in the first period under the lure of positive profits to be earned in the second period. It turns out that higher expected profits in second period make stronger the incentive to invest in costly screening in the first period.

Accordingly, the positive margins between loan and deposit rates in final equilibrium stands for the payoff of an efficient screening of borrowers, that in turn positively affects the average quality of final customers. Since the latter implies a lower loan rate, the model raises a potential trade-off between the size of the informative rent and the cost of credit in equilibrium. This feature distinguishes our model from the reference literature, and contributes to assess the impact of increasing competition on the performance of credit markets under asymmetric information.

In first place, alike in Sharpe (1990) and Rajan (1992), the positive profits earned by the insider in the second period come from the lock-in of good quality borrowers to the initial lender due to their inability to perfectly signal their types to competing lenders. With $t > \hat{t}(\alpha)$ (see proposition 1), the size of the insider expected profits is given by

$$G(\rho)(1+r)\left\{\frac{p(t)}{E[p(s \mid \alpha) \mid s \le t]} - 1\right\} \qquad \text{if} \quad Z \equiv \frac{\int_0^{\hat{t}} p(s \mid \alpha) ds}{\int_0^1 p(s \mid \alpha)\, ds} < 1$$

(12)

$$p(\alpha)[X - x] - (1+r) \qquad \text{if } Z = 1 .$$

A reasonable economic interpretation of Z is a measure of the intensity of competition effectively taking place on the credit markets. Indeed, Z stands for the probability that the outsiders tender a loan rate higher than $\rho^*(\hat{t}) = X - x - 1$. In particular, if $Z = 1$, the uninformed lenders do not exert any competitive pressure on the insider: since all lenders know the competitors' strategies, the insider is aware of the lack of competition and he can then extract a maximum rent. By the same token, if $Z < 1$ the insider reduces the loan rate he offers to his retained customers in order to win against the competitors, with the size of his expected rent positively depending on his informative advantage.

Differently from Sharpe and Rajan and in the vein of Broecker (1990) and Shaffer (1998), in our model credit relationship does not allow for a perfect disclosure of the investor's type. Moreover, should the quality of the extracted signal be so low that initial lenders are unable to discriminate between investors' types, they prefer to shut off credit for all of their customers, giving up with good types too. Despite the outsiders command even less reliable information than the insider, if $Z < 1$ the former might offer loan by taking the risk of matching investors of bad type. In this case outsider lenders offer with constant probability equal to Z a unit cost of loan set at $X - x - 1$, provided that $t \in [\underline{t}, \hat{t}]$. As a result, they bear the risk of negative profits since

the investors' individual rationality constraint makes unfeasible a higher cost for loan as it would be otherwise required with $t < \hat{t}$. Interestingly, the probability of this solution is higher with lower Z, then with more intense competition on the credit market.

Besides this result, that resembles the efficiency loss in property rights attached to increased competition in Rajan and Petersen-Rajan (1995), we address the issue of the lenders' proper incentive to extract reliable private information. Since the more informed the insider, the lower the rates on loans, depressing the incentive to invest in screening translate in higher cost of credit in equilibrium. As the incentive is driven by the insider expected profits, it turns out that higher competitive pressures risk causing a higher cost of credit through a deterioration of average quality of customers.

A similar prediction is found in the brand of literature applying the "winner's curse" assumption to banking (Nakamura 1993, Shaffer 1998, Marquez 2000), but in our case it comes from a different origin: stronger competition reduces the appropriability of the benefits expected from costly screening. A further difference with this literature is the way we measure competition on banking. In our model enlarging the number of incumbent competitors beyond a single outsider is actually immaterial with respect to the size of the informative rents extracted by the insider. On the contrary, the strength of competitive pressures on the credit market proves to be more properly proxied by the gap in the quality of public versus private information about the unobservable types of the investors. This point delivers interesting normative implications as for the regulatory framework of the banking industry.

1.3 Private *versus* public information: some policy implications

As fully discussed in previous section, the model predicts that the size of the informative advantage of the insiders rules the intensity of competition on the credit markets under asymmetric information, and enlarging the number of competing lenders is immaterial as to the equilibrium unit cost of loans. Since the latter is reasonably important in affecting productive investment and then likely enhancing the growth of aggregate income,[8] from a normative standpoint it is valuable to consider which

[8] This result has been briefly mentioned in the introductory chapter, and is fully discussed in Chapter 2.

regulatory policy and under which conditions may actually lead to a lower ρ in equilibrium.

Indeed, the model implies that ρ is a decreasing function of $p(\alpha,\vartheta)$, where the arguments stand for the total information stock, made of both the private component α and the common knowledge ϑ about the distribution of types A and B within the entire set of investors M. For any given value of ϑ, the higher the quality of α, the higher the informative advantage of the insider versus the outsiders, the higher the profits gained by the former. At the same time, however, the cost of loan in equilibrium proves decreasing with α for any given ϑ.

Interestingly, in this framework any hypothetical policy that would enforce perfect price competition in final equilibrium risks raising the equilibrium cost of credit, despite the expected profits by all lenders would vanish. The results directly follows from the trade-off between the *ex post* informative rent and the *ex ante* investment in screening by the insider as outlined in previous section. When the rent falls to zero, no lender would costly extract private information and the average quality of customers would dramatically deteriorate.

Alternatively, in line with the prediction of the model we consider the existence of a public policy that can positively affect the quality of common knowledge, and we check its impact on the equilibrium cost of credit.

A possible way to deal with this issue is to assume that, at the beginning of the second period, public authorities can disclose some additional pieces of information by providing an input λ into a screening technology all similar to that operated by the lender but a positive noise in the signal extracted about the investors' type. Formally, we assume that government is entitled to pass all investors through the following test

$$(13) \qquad \Gamma_G(\lambda)=\begin{cases} prob\left(\tilde{A}|A\right)=prob\left(\tilde{B}|B\right)=\dfrac{1-\gamma+\lambda}{2} \\ \\ prob\left(\tilde{A}|B\right)=prob\left(\tilde{B}|A\right)=\dfrac{1+\gamma-\lambda}{2} \end{cases}$$

where the only difference with respect to the technology (4) in section 1.1.3 is that now a higher γ implies a higher noise in the public signal as for the true type of the investors. The noisy ingredient makes the public screening less efficient than the private one, as it

is convenient to highlight the policy issue[9]. Importantly, albeit noisy the signal publicly disclosed by the government helps each lender in sorting investors in the second period, either they belong to his own or to his competitors set of initial customers. Accordingly, when $\lambda > 0$ any lender can update the share ϑ of type A within a restricted set of investors, by simply selecting out from the larger initial set those who have badly scored at the government test, along the same rule we have considered for the private test in section 1.1.3. For notational convenience, we now identify by Λ the updated common knowledge, with $\Lambda > \vartheta$ when $\lambda > 0$ and $\Lambda = \vartheta$ when $\lambda = 0$. After observing the signal disclosed by the government and updating the common knowledge, the lenders can additionally adopt the same costly screening as in previous sections with respect to their initial customers, and notation in (5) reads now as following

(5a) $$\tilde{\vartheta}(\alpha,\lambda) = \frac{\Lambda(1+\alpha)}{\Lambda(1+\alpha)+(1-\Lambda)(1-\alpha)}$$

It then follows that λ is an imperfect substitute for α, since it is immediate to check that $p(\lambda,0) < p(\lambda,\alpha)$ for any $\alpha,\lambda > 0$.

Noticeably, the improved public information affects p both directly, both through a likely change in the size of the private investment in screening as it comes from the following

(14) $$\frac{dp(\alpha,\lambda)}{d\lambda} = \frac{\partial p(\alpha,\lambda)}{\partial \lambda} + \frac{\partial p(\alpha,\lambda)}{\partial \alpha}\frac{\partial \alpha}{\partial \lambda}$$

with $\frac{\partial p(\alpha,\lambda)}{\partial \lambda} > 0$ and $\frac{\partial p(\alpha,\lambda)}{\partial \alpha} > 0$, $\forall\, \alpha,\lambda$ (see Appendix 1.3).

As to the sign of $\frac{\partial \alpha}{\partial \lambda}$, it is important to recall that optimal α results from the balance between the marginal costs and benefits coming from an improved private information. Indeed, while the cost function $g(\alpha)$ is reasonably invariant with λ, the same does hold true for expected benefits. In particular, as the optimal level for α is

[9] In the opposite case the problem is trivial and the information asymmetries would vanish at all.

implicitly defined by $\frac{\partial V(\alpha,\lambda)}{\partial \alpha} = \frac{\partial g(\alpha)}{\partial \alpha}$, by substituting for the equilibrium value of ρ, that from the insider standpoint may be represented as $\rho = \frac{(1+r)\alpha}{\int_0^{\alpha} p(s)ds}$, and by taking logarithms (see Appendix 1.2), it follows that

$$(15) \qquad \frac{\partial \log\{V(p(\alpha,\lambda),\cdot)\}}{\partial \alpha} = \frac{\alpha}{\alpha p(\alpha,\lambda) - \int_0^{\alpha} p(s)ds} \frac{\partial p(\alpha,\lambda)}{\partial \alpha} > 0$$

Accordingly, the effect of higher λ on the marginal return to α is given by

$$\frac{\partial^2 \log\{V(p(\alpha,\lambda),\cdot)\}}{\partial \alpha \partial \lambda} = \frac{\alpha \frac{\partial^2 p(\alpha,\lambda)}{\partial \alpha \partial \lambda}\left[\alpha p(\alpha,\lambda) - \int_0^{\alpha} p(s,\lambda)ds\right]}{\left[\alpha p(\alpha,\lambda) - \int_0^{\alpha} p(s,\lambda)ds\right]^2} - \frac{\alpha \frac{\partial p(\alpha,\lambda)}{\partial \alpha}\left[\alpha \frac{\partial p(\alpha,\lambda)}{\partial \lambda} - \int_0^{\alpha} \frac{\partial p(s,\lambda)}{\partial \lambda} ds\right]}{\left[\alpha p(\alpha,\lambda) - \int_0^{\alpha} p(s)ds\right]^2}$$

Then sufficient conditions for a positive impact of the improved public information on the private incentive to invest on screening are implicitly defined by

$$(16) \qquad \alpha \leq \frac{\int_0^{\alpha} \frac{\partial p(s,\lambda)}{\partial \lambda} ds}{\frac{\partial p(\alpha,\lambda)}{\partial \lambda}} \equiv \bar{\alpha}.$$

Intuitively, when the lender investment in screening is low and public information is scarce, any improvement in λ spurs higher level of private information too. In this case public screening would lead to both lower cost of loan and higher expected profits by the insider. On the contrary, with $\alpha > \bar{\alpha}$ some ambiguity arises as to the effect of better public information on the quality of the private component, depending on the exact specification of $p(\alpha,\lambda)$.

The economic interpretation is that when private investment in screening is very high, the marginal returns to the insider from a better public information is very limited, due to the concavity of $p(\alpha,\lambda)$. At the same time, the ability of the outsider to sort the competitors' customers keeps increasing with the quality of public knowledge, and the gap with private information of the insider can be progressively recovered. The incentive to private screening then declines, and the signal extracted by the government

partly crowds out private information. Due to the noise in the public signal, the quality of the total stock of information controlled by the insider would then deteriorate, causing a higher cost of credit in the final equilibrium.

At this stage of the research, we do not investigate deeper the formal conditions under which higher public knowledge causes higher interest rate in equilibrium. From our standpoint, it is important to underline that pro-competitive policies on the credit markets under imperfect information would prove more effective when they target the gap between public and private information. At the same time, such action bears the risk of reducing the lenders' incentive to costly extract private information so that the average quality of customers decline and the equilibrium interest rate increases. A further point, which we have neglected to formalise, relates to the social cost of disclosing a public signal on the borrowers' types and how it compares to the social benefits expected from increasing competition among lenders. Although a social welfare analysis lies beyond the partial equilibrium approach of our model, the scope for costly competitive policy on the credit markets would accordingly turn narrow under asymmetric information.

Our findings are heavily subject to the limitations of our theoretical framework, that is admittedly focused on the quality of information as a key tool of competition on imperfect credit markets. Even if gathering information and screening borrowers are ones of the primary functions of banks, and that mainly motivates the approach we adopted, we have left aside further important issues, like risk aversion and moral hazard, that would deserve a full consideration, too. They are on the top of our agenda for future research.

1.4 Conclusions

In stressing the importance of the quality of information as a competitive asset on imperfect credit markets, the paper deals with dynamic banking competition under adverse selection and information gathering as an increasingly costly activity. A main finding is that a positive margin between loan and deposit rates in final equilibrium is the payoff of the efficient screening of borrowers previously made by the lenders. A potential trade-off is then identified between the size of the informative rent and the cost of credit in equilibrium. Normative implications point to a rather limited scope for pro-competitive policies, as they prove centred more upon improving the

quality of public information rather than monitoring concentration index on the credit markets; however too strong an injection of competitive pressures in a attempt to lower the *ex post* market power of the informed lender - as measured by his informative rent – risks to partly crowd out his *ex ante* investment in screening. In the event, effective action in reducing the rent risks resulting in a lower average quality of customers and a higher cost of credit in equilibrium.

APPENDIX 1.1

A parallel with Engelbrecht-Wiggans, Milgrom and Weber (1983). We compare our framework with the formal analysis put forward in the referred paper (henceforth EMW) by defining the unknown value V of the project as pX, with an *ex ante* uniform across intermediaries as based on common knowledge about frequency of investors of type A and B. Accordingly,

$$V \equiv pX = \begin{cases} p_A X & with\ prob = \vartheta \\ \\ p_B X & with\ prob = 1-\vartheta \end{cases}$$

In our framework, the signal extracted by the test $\Gamma(\alpha)$ stands for the private information Z, which differently from the referred paper we consider as the result of optimal investment in a costly screening technology; the conditional distribution of the value of the project, H=E(V|Z) in EMW, in our framework is defined by $H(\alpha) \equiv p(\alpha)X$, namely the *ex post* frequency of good and bad types over the subset of initial customers who keep receiving a credit offer after passing the screening test, with

$$H(\alpha) \equiv p(\alpha)X = \begin{cases} p_A X & with\ prob = \vartheta(\alpha) \\ \\ p_B X & with\ prob = 1-\vartheta(\alpha) \end{cases}$$

Concerning the distributional type approach adopted in EMW as for the informed lenders, in our framework we maintain that all the information required for an optimal bid are carried by the random variable $T=T(H(\alpha),U)$, which is assumed uniformly distributed on [0,1] without loss of generality, with $T(h,u) = prob\{H < h \text{ or } H = h \text{ and} U < u\}$. Alike in EMW, U is a random variable independent of V and Z with an atomless distribution on [0,1], which the informed lender observes and uses whenever he needs to randomise his bids. From a technical standpoint, the transformation of H in T is a useful device in solving for the equilibrium strategies since it allows for proceeding in the analysis as if H had originally been atomless.

Accordingly, we pretend that the informed lender observes $T=t$ and by this we mean that he observes the event $(H(\alpha),U)=(h(\alpha),u)$ such that $T(h(\alpha),u)=t$. It follows that for any given t and u, the *ex post* value of the project $h(\alpha)$ is increasing with the proxy for private information α. In other terms, in our set-up the lender's type keeps uniformly distributing on [0,1] as in the original paper but the corresponding realisation of H proves now increasing with optimal α. By the same token, we define $H(t,\alpha) = \inf\{h \mid P(H(\alpha) \le h) > t\}$, with $H(t,\alpha)$ increasing in α for any fixed value of t.

We strictly follow EMW and the distributional type approach in dealing with equilibrium strategies since in our framework the random variable $\boldsymbol{H}$ would violate the requirement of atomless distribution, then we need to transform it in the variable $\boldsymbol{T}$, which basically opens each of the atoms of $\boldsymbol{H}$ into an interval. However, from the standpoint of the insider lender, there is a one-to-one relationships between the observed realization of $\boldsymbol{T}$ and the realization of $\boldsymbol{H}$. In our framework, since a one-to-one relationship applies also between α and $\boldsymbol{H(\alpha)}$, from the insider standpoint observing $\mathbf{T}$ is basically equivalent to observing α. Accordingly, in the proofs shown in next appendix we directly refers to the input in screening the same stochastic nature assumed for $\mathbf{T}$.

APPENDIX 1.2

1) **Proof that** $\frac{\partial V(\alpha)}{\partial \alpha} > 0$. Taking logs,

$$\frac{\partial \log V(\alpha)}{\partial \alpha} = \frac{\partial \log G(\rho(\alpha))}{\partial \alpha} + \frac{\partial \log \Xi}{\partial \alpha}, \text{ with } \Xi \equiv \left[\frac{p(\alpha)\alpha}{\int_0^{\alpha} p(s)ds} - 1 \right], \text{ we get:}$$

$$\text{i) } \frac{\partial \log G(\rho(\alpha))}{\partial \alpha} = \frac{\partial}{\partial \alpha} \log \left\{ \frac{\int_0^{\alpha} p(s)ds}{\int_0^{1} p(s)ds} \right\} = \frac{\partial}{\partial \alpha} \log \int_0^{\alpha} p(s)ds = \frac{p(\alpha)}{\int_0^{\alpha} p(s)ds}.$$

$$\text{ii) } \frac{\partial \log \Xi}{\partial \alpha} = \log \left\{ \frac{p(\alpha)\alpha - \int_0^{\alpha} p(s)ds}{\int_0^{\alpha} p(s)ds} \right\} = \left\{ \frac{\int_0^{\alpha} p(s)ds}{p(\alpha)\alpha - \int_0^{\alpha} p(s)ds} \right\} \left\{ \frac{\{\alpha p'(\alpha) + p(\alpha) - p(\alpha)\} \int_0^{\alpha} p(s)ds - p(\alpha) \left\{ p(\alpha)\alpha - \int_0^{\alpha} p(s)ds \right\}}{\left\{ \int_0^{\alpha} p(s)ds \right\}^2} \right\} =$$

$$\frac{p'(\alpha)\alpha}{p(\alpha)\alpha - \int_0^{\alpha} p(s)ds} - \frac{p(\alpha)}{\int_0^{\alpha} p(s)ds}, \text{ with } p'(\alpha) = \frac{\partial p}{\partial \alpha}. \text{ By summing i) and ii), } \frac{\partial \log V(\alpha)}{\partial \alpha} = \frac{p'(\alpha)\alpha}{p(\alpha)\alpha - \int_0^{\alpha} p(s)ds}.$$

Since $\frac{\partial p}{\partial \alpha} > 0$ and $\frac{p(\alpha)\alpha}{\int_0^{\alpha} p(s)ds} > 1$ (see proof of corollary 1), then $\frac{\partial \log V(\alpha)}{\partial \alpha} > 0$.

2) **Proof that** $\frac{\partial^2 \Xi(\alpha)}{\partial^2 \alpha} < 0$.

From 1) $\mu = \frac{\partial V(\alpha)}{\partial \alpha} = \frac{p'(\alpha)\alpha}{p(\alpha)\alpha - \int_0^{\alpha} p(s)ds} V(\alpha)$. Taking logs, $V(\alpha)$ proves to be concave when $\frac{\partial \log(\mu)}{\partial \alpha} < 0$.

Separately differentiating $\log(\mu) = \log\alpha + \log p'(\alpha) + \log V(\alpha) - \log\left[p(\alpha)\alpha - \int_0^{\alpha} p(s)ds\right]$ and summing, we get $\frac{\partial \log(\mu)}{\partial \alpha} = \frac{p''(\alpha)}{p'(\alpha)} + \frac{1}{\alpha} + \frac{p'(\alpha)\alpha}{p(\alpha)\alpha - \int_0^{\alpha} p(s)ds} - \frac{p'(\alpha)\alpha}{p(\alpha)\alpha - \int_0^{\alpha} p(s)ds} = \frac{\alpha p''(\alpha) + p'(\alpha)}{\alpha p'(\alpha)}$ Since $p(\alpha)$ is an increasing function of α (see Appendix 1.3), $V(\alpha)$ is concave under $p''(\alpha) < \frac{p'(\alpha)}{\alpha}$.

APPENDIX 1.3

1) **Proof that** $\frac{\partial p(\alpha,\lambda)}{\partial \alpha} > 0$. Owing to $p(\alpha,\lambda)$ monotonically increasing with $\tilde{\vartheta}(\alpha,\lambda)$, we better derive the result based directly on the former. From (5a) in the main text, it turns out that $\frac{\partial \tilde{\vartheta}(\alpha,\lambda)}{\partial \alpha} = \frac{[\Lambda(1+\alpha)+(1-\Lambda)(1-\alpha)]+(1+\alpha)}{[\Lambda(1+\alpha)+(1-\Lambda)(1-\alpha)]^2}$ and the result follows immediately.

2) **Proof that** $\frac{\partial p(\alpha,\lambda)}{\partial \lambda} > 0$. As before we work directly with $\tilde{\vartheta}(\alpha,\lambda)$ and find that $\frac{\partial \tilde{\vartheta}(\alpha,\lambda)}{\partial \lambda} = \frac{(1+\alpha)\Lambda'[\Lambda(1+\alpha)+(1-\Lambda)(1-\alpha]+2\alpha\Lambda(1+\alpha)}{[\Lambda(1+\alpha)+(1-\Lambda)(1-\alpha]^2}$ and the results directly follows from out tenet that $\Lambda' \equiv \frac{\partial \Lambda}{\partial \lambda} > 0$.

3) **Proof that** $\frac{\partial^2 p(\alpha,\lambda)}{\partial^2 \alpha} < 0$ **when** $\Lambda > 0.5$. The result is easily verified from the expression for the second derivative, or $(p_A - p_B)\frac{\partial^2 \tilde{\vartheta}(\alpha)}{\partial^2 \alpha} =$

$$= (p_A - p_B)\frac{-2\{(1+\alpha)(1+\Lambda)+(1-\alpha)(1-\Lambda)\}[\Lambda(1+\alpha)+(1-\Lambda)(1-\alpha)](2\Lambda-1)}{[\Lambda(1+\alpha)+(1-\Lambda)(1-\alpha)]^4}.$$

CHAPTER 2

SOCIAL MOBILITY AND ENDOGENOUS POLITICAL CYCLES

The negative trend in income inequality historically established in industrial countries first showed signs of a slowdown in the fifties (Paukert, 1973). Since then, growing evidence of that the previous trend has halted and even reversed has been speading across countries, albeit to quite different extents. According to recent data (Gottshalk-Smeeding, 1997), between 1981 and 1992 the increase in income disparities was sharp in the UK, Sweden and the USA (where the Gini coefficient rose, respectively, by around 30, 20 and 15 per cent)[1], less striking in Japan, Denmark, Australia and New Zealand (above 10 per cent), moderate in the Netherlands, Belgium and Norway (around 5 per cent), and negligible in the remaining countries[2]. Interestingly, the result was more pronounced in countries that mostly experienced a resurgence of fiscal conservatism. The clearest example is provided by the USA, where tax reforms endorsed in 1981 and 1986 reduced the top marginal rate from 70 to some 30 per cent while increasing taxation on lowest incomes from 0 to 11 per cent (Pechman, 1987); at the same time, public expenditure control has mainly relied on curbing welfare programmes (Economic Report of the President, 1994).

The two pieces of evidence are at odds with the standard prediction in political economy of a positive correlation between inequality and redistribution. They have recently been explained in terms of multiple steady states due to productive externalities and a positive wealth bias in the willingness to voting (Benabou 2000 and Saint-Paul 1994): depending on initial conditions, high inequality and low redistribution would mutually reinforce and viceversa.

In this paper we put suggest an alternative interpretation of recent evidence, based on a reverse causality argument: the increased inequality observed in last two decades in advanced countries can be traced back to a shift in the political climate towards restrictions in welfare

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[1] Preliminary evidence shows that in the USA and UK the increase in inequality continued in the nineties, although at a slower rate than in the previous decade (Smeeding, 2000).

[2] In Italy, after a noticeable decline in the first half of the 1980s, personal income inequality began to rise again, with an increase in the Gini coefficient of slightly less than 10 per cent in the period 1986-1995 (Brandolini, 1999).

programmes. In this perspective, in western democracies the very effectiveness of long implemented redistribution in improving social mobility might have gradually reduced the initial consensus for such a policy, eventually leading to an opposite political equilibrium in recent times. Once established, the policy change would have helped to slow down, or even reverse, the negative trend in inequality occurred in previous years. Accordingly, our main questions are: under which conditions may democratic voting provide a stable consensus to redistribution? To which extents are the restrictive programmes of welfare state recently adopted in most industrial countries driven by a change in political climate, besides the requirement of fiscal discipline? What helps to cause such change?

We address these issues by modelling a stochastic economy with imperfect credit markets and heterogeneous agents who votes over fiscal redistributive policies. During his life, an agent first invests in one of two feasible productive projects, which pay out different returns, then votes and finally realises his utility, by consuming and leaving bequests. Due to asymmetric information on financial markets, inherited wealth constrains optimal investment, so that poor agents are restricted from operating the more profitable project. Political parties compete about the size of purely redistributive programmes aimed at enhancing the chance of escaping poverty.

Under the constraint of a balanced public budget at every date, each party is identified by the share of poor that are offered a fixed subsidy, which is financed by wealth taxes; at every election, conditions apply for the median voter determining political equilibrium. In this framework, we identify some restrictions on parameters which simplify the characterization of stochastic process ruling social mobility as a low-dimension Markov chain. It helps understanding both the dynamics and the determinants of inequality over time, and the ensuing impact on redistribution in both the short and the long run.

We find that the standard conflict between the rich and the poor is confirmed, as the two classes invariantly prefer, respectively, the smallest and the largest redistribution; on the part of agents in the middle class, they vote for the first policy when the mass of poor is relatively low, for the second otherwise. Accordingly, the political equilibrium follows the standard prediction of positive relationship between inequality and redistribution when rules for social mobility imply that in the long run the median voter remains either in the poor or in the rich class. However, when he belongs to the middle class, equilibrium redistribution may prove large even under an initially very moderate inequality, as proxied by a very low mass of the poor with respect to the rich, and *viceversa*. More generally, we find that it is not the *size* of the inequality but the nature of its ultimate origin that affects the pattern of redistribution in the long run. Interestingly, political equilibrium proves fluctuating over time between competing policies

when a large redistribution, as opposed to a small one, can counteract the effect of a structurally low social mobility and successfully reduce inequality.

In view of possibly positive impact of redistribution in enhancing growth in imperfect capital markets, in our model endogenous cycles in redistribution in connection with its impact on social mobility raise the interesting hypothesis that they could trap developed democracies in a region where inequality shrinks and enlarges periodically and counter-cyclically. On the theoretical side, this tenet would stress the role of political competition in breaking the virtuous cycle between growth and inequality first addressed by Kuznets and that, more recently, has come under criticism (Aghion et al., 1999). On the empirical side, it would urge for testing the connection between inequality and redistribution on the basis of a time series evidence rather than, as it is the case in most current literature, by cross countries analysis[3].

The paper we present is strictly related to three strands of recent research on income inequality and growth. One of them (Banerjee-Newman 1991 and 1993, Galor-Zeira 1993, Aghion-Bolton 1997 and Piketty 1997) investigates the macroeconomic implications of endogenous income distribution along lines first identified by Becker-Tomes (1979) and Loury (1981). In these models, family background constrains an individual's opportunity to move in the social rank, and a significant degree of income inequality persists in the long run. A second stream of literature takes inequality as given and deals with its impact on political equilibrium in democracy (Alesina-Rodrick 1994, Bertola 1993 and Persson-Tabellini 1994). As in the seminal contribution by Meltzer-Richard (1981), a positive correlation between inequality and redistribution is predicted. A third class of models addresses the interdependence of economic and political equilibria under imperfect markets (Perotti 1993, Saint Paul-Verdier 1993, Glomm-Ravikumar 1993, Fernandez-Rogerson 1996). The classical trade-off between equity and efficiency is reconsidered, owing to potential net welfare gains from redistribution through a relaxation of credit constraints on investment by the poor[4]. More recent contributions place the issue in the context of sequential voting and forward-looking behaviour (Saint Paul 2001, Piketty 1995, Benabou 1996b and 2000, Krusell et al. 1997, Quadrini 1999). In line with empirical evidence (Perotti 1996, and references in Benabou 1996b), the positive correlation between inequality and redistribution previously advocated is questioned due to non-linearities,

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3 Among valuable exceptions, Rodriguez (1998) investigates the impact of inequality on the extent of redistribution based on data for 20 OECD countries in years 1960-1990. In rejecting a positive correlation, he finds that a reverse causality may not be dismissed whereas inequality is measured in the personal income domain.

4 In some cases (Durlauf 1996, 1993 and Benabou 1996a, 1993) the analysis of political equilibrium is extended to local public goods, and social segregation arises with local externalities in production and/or in human capital accumulation.

under deviations from ideal democracy (Saint Paul and Benabou) or imperfect information on economic structure (Piketty and Quadrini).

In the reference literature, the pivotal agent in determining political outcome is usually identified once and for all under some rank preserving conditions, and demand for redistribution is invariant with wealth dynamics[5,6]. An important exception is provided in Benabou (2000), where changes in inequality affect the equilibrium at every election, and a negative relationship between inequality and redistribution is established across multiple steady states. However, in that paper the long run equilibrium proves univocally determined conditional on initial inequality, mainly because the pivotal agent remains wealthier than the median over time. Key statistics in wealth distribution confirm then independent of the dynamics of inequality and policy[7].

The distinguishing feature of our contribution is that we model potential changes both in the median voter's location across *all* social classes and in his preferred policy. In fact we rule out any ranking preserving conditions by refraining from imposing an exogenous distribution function for individual wealth in our stochastic economy: at each date the size of inequality results from the Markov chain fully characterising social mobility in terms of the economic structure and the policy action. It turns out that the relationship between inequality and redistribution proves richer than found in recent literature, since we identify conditions under which the standard prediction of a positive link can be either confirmed of rejected. Differently from Benabou (2000), in the latter case history dependence may help but it not crucial to explain the results. In addition, we model the case for a periodical revision in the political equilibrium and, as a consequence, in the pattern of social mobility.

Due to analytical complexity of the dynamic interdependence between inequality and redistribution, we adopted a number of assumptions aimed at preserving tractability of the analysis of political equilibrium. In the first place, we model utility function assuming "imperfect altruism" and risk neutrality. By the former we mean that each generation cares about the bequests left to offspring, rather than about the direct utility of future generations, as it would be the case with dynastic models of families or with infinitely lived agents. Imperfect

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[5] Pivotal agent generally identifies the marginal voter in determining political equilibrium. If the median voter theorem applies (see later in the text), he may differ from the median agent when democracy is imperfect, namely when a subset of potential voters does not show up at every election or political influence is increasing with wealth (for the USA evidence, see references in Benabou, 2000).

[6] As rank preserving conditions rule out social mobility, its effects on policy are neglected (Krusell-Rios Rull 2000, Alesina-Rodrick 1991, Glomm-Ravikumar 1993, Fernandez-Rogerson 1996). In other places the same finding is obtained as a result of non-sequential voting (Bertola 1993 and Alesina-Rodrick 1994).

altruism is widespread assumed in the reference literature since it helps ruling out dynamic inconsistency of voting, which is otherwise cumbersome to be analytically addressed in the framework we consider, and numerical simulation would be required (Krusell et al. 1997, Krusell-Smith 1998). Admittedly, the main problem with the assumption is that it implies a myopic bequest motive in voting, whereas in a dynastic utility the full sequence of redistributive policy over time would be taken into account by agents. Interestingly, Benabou (1996c) derives for a dynasty model basically the same results as those found in Benabou (2000) under imperfect altruism. This is a reinsuring evidence for expecting that results of our analysis suffers a moderate loss of generality as for the bequest utility we have assumed.

Omission of risk aversion is also due to a simplified algebra, and we believe that its inclusion in our analysis would prove easy tractable under imperfect altruism[8]. From our standpoint, it would augment the rationale for redistribution, with an insurance motive complementing the relaxation of the credit constraint, with plausibly interesting impact on voting across classes. At this stage, however, we have not explored this issue, which we leave open for future research.

In the third place, government budget is constrained to balance at every date mainly to rule out a fiscal discipline motive in determining policy revisions over time. In this respect, we do not consider inheritance taxation, while the parents' wealth is the tax base for the funding of redistribution. Adding to the assumption of a small open economy, that we hold in order to skip an endogenous determination of interest rate, a balanced public budget leaves unrealistically out of our analysis the issue of current account deficit, then the possibility of an external constraint to growth.

Finally, some interesting contents in the economic decisions of agents are spoiled by our option not to take account of moral hazard in modelling social mobility. Indeed we do fully address the issue in deriving the optimal financial contract under imperfect information, but for simplicity sake we model the effort cost function so that in equilibrium borrowers are motivated, by an incentive compatible contract, to the same conduct of productive project as the self-financed investors. We believe that a more extended analysis of moral hazard would not add an important input in the derivation of our results, albeit augmenting the rationale for redistribution.

The paper is organised in five sections. The first summarises the main findings and the macroeconomic links. The second puts forward a theoretical model, which delivers a full

[7] The result comes from income distribution remaining lognormal over time even in a stochastic framework, mainly because shocks are assumed to be lognormal as well.

derivation of a Markov chain representation of social mobility in free market. In the third section the model is extended to include political equilibrium, and the dynamic feedback between social mobility and redistribution is characterised. In the fourth, we prove main results and suggest a rough taxonomy for the relationship between inequality and redistribution, *inter alia* exploring conditions for endogenous cycles in both macroeconomic and political outcomes. The final section briefly concludes.

2.1 Main ideas and results

In this section we anticipate the main macroeconomic implications of a stochastic economy with heterogeneous agents and imperfect markets, which will be formalised later in details. We first sketch rules for social mobility under laissez-faire, then with active government, focusing on interactions between inequality and redistribution in the long run.

2.1.1 Free market economy (laissez-faire)

Under some restrictions on parameters, we obtain that at any date agents distribute in three classes, whose borders are univocally identified according to initial wealth, and social mobility fit a time invariant Markov chain. For the purposes of our analysis, a dynamic economy is then fully represented by a row vector $\psi_t = (\psi_{1,t}, \psi_{2,t}, \psi_{3,t})$, where $\psi_{i,t} \geq 0$ is the density mass of class i, and the following stochastic matrix

$$M_F = \begin{bmatrix} 1-\vartheta & \vartheta & 0 \\ 1-q' & 0 & q' \\ 0 & 1-q' & q' \end{bmatrix} \tag{1}$$

where $m_{i,j}$ is the probability that next generation belong to class j when the current does to class i, with class i poorer than class j if $i<j$. The pair $(\vartheta, q') \in (0,1)$ identifies the key structural parameters of our economy, namely the probability of successful investment in two risky

[8] In a dynasty model the extension is in general much more cumbersome, since risk aversion would imply that preferences are not time separable as agents may care about both the magnitude of uncertainty and the timing of its resolution (Weil, 1990).

projects: ϑ for the first, which shows low productivity and may be operated by everybody due to no fixed capital requirement, and q' for the second, whose productivity is higher and which can be operated only by agents who can afford a minimum scale investment under imperfect capital markets. Changes in wealth distribution are simply ruled by $\psi_{t+1} = \psi_t M_F$.

The stochastic matrix M_F is shown to induce a unique stationary distribution, ψ^*, which characterises in terms of the above structural parameters as follows

$$\psi_1^* = \frac{(1-q')^2}{\vartheta + (1-q')^2};\ \psi_2^* = \frac{\vartheta(1-q')}{\vartheta + (1-q')^2};\ \psi_3^* = \frac{\vartheta q'}{\vartheta + (1-q')^2}$$

Accordingly, a stronger upward mobility in free market, as identified by high values in the pair (ϑ, q'), implies a larger share of rich and a lower of poor in the long run; the opposite holds true under a stronger downward mobility. Due to the convergence of M_F, these results are independent of initial condition, and trace back to the economic structure ultimately determining inequality at any date.

2.1.2 Active government economy (redistribution)

Active redistribution changes the picture of social mobility, improving the chance of escaping poverty on one side and potentially discouraging effort supply on the other. For simplicity sake, we focus only on the former and adjust the stochastic matrix for active government as follows

$$M_G = \begin{bmatrix} (1-\vartheta)(1-\varsigma_i) & \vartheta + (1-\vartheta)\varsigma_i & 0 \\ (1-q')(1-\varsigma_i) & (1-q')\varsigma_i & q' \\ 0 & 1-q' & q' \end{bmatrix} \tag{2}$$

where $\varsigma_i \in [\underline{\varsigma}, \bar{\varsigma}]$, with $1 > \underline{\varsigma} > \bar{\varsigma} > 0$, identifies the size of pure redistribution (aimed at relaxing the credit constraint on productive investment by the poor), which is endogenously determined by majority voting according to the following.

***Proposition** 1. At every election, political equilibrium is defined by high redistribution if either the median voter belongs to the poor class or belongs to the middle class* and $\Delta_t \equiv \frac{\psi_{1,t}}{\psi_{3,t}} \leq \frac{1-q'}{1-\vartheta} \equiv \phi$, *by low redistribution otherwise.*

Standard conflict between the rich and the poor arises as the two are respectively net losers and net earners from pure redistribution. As for the middle class, they demand large redistribution only if the benefit they expect in case they fall poor exceeds the tax costs of providing assistance to all the other poor. Accordingly, middle class support for large redistribution declines with Δ_t, which stands as a proxy for inequality.

Proposition 1 and the rules for social mobility embodied in matrix M_G make the analysis of the dynamic feedback between redistribution and inequality analytically treatable. We can identify a variety of equilibria in the long run and their connection market to key parameters.

***Proposition** 2. A unique steady state equilibrium is defined by small (large) redistribution if the median voter under the stationary distribution is in the rich (poor) class or she is in the middle class* and $\Delta^*(\underline{\varsigma}) > \phi$ $(\Delta^*(\overline{\varsigma}) \leq \phi)$.

As a special case, high inequality in the long run is associated with large redistribution regardless of initial conditions. A possible reason is that values of the pair (ϑ, q') are so low that the median voter is definitely attracted by the poor class, whose preferred policy is univocally defined. Symmetric arguments hold true for low redistribution. Accordingly, the proposition confirms the standard prediction of a positive correlation between inequality and redistribution.

Under milder forces for social mobility a in free market, the picture becomes more complicate as policy itself delivers a key contribution in its confirmation at every election, so that initial conditions play an important role in determining equilibrium in the long run.

Proposition 3. *Multiple equilibrium between redistribution and inequality arise in steady state if social mobility in a free market would invariantly drive the median voter into the middle class* and *competing policies are different enough that* $\underline{\varsigma} < 1 - \frac{q'}{1-\vartheta} \leq \bar{\varsigma}$.

When values of structural parameters imply that the middle class becomes crucial in determining the majority, a large redistribution arises in the long run even under lower inequality, on condition that the same policy has been long implemented, so that the mass of poor is reasonably small. This result is in line with the history dependence found in recent contribution (Saint-Paul 1994, Benabou 1996b and 2000, Rodriguez 1998); additionally, it is confirmed even abstracting from imperfect democracy and strictly net welfare gains from redistribution[9].

Finally, we find that the complex feedback between economic structure and policy may hinder the path to steady state, endogenously determining fluctuations in both redistribution and inequality.

Proposition 4. *Under any given range of feasible policies, it is possible to identify a subset of pairs* (ϑ, q') *such that political equilibrium is periodically revised over time, inducing fluctuations in redistribution and inequality. Sufficient conditions require three joint constraints to be met: a)* $\psi_3^*(\underline{\varsigma}) < 0.5$, *b)* $\Delta^*(\underline{\varsigma}) \leq \phi$, *c)* $\psi_3^*(\bar{\varsigma}) > 0.5$.

Forces for downward and upward mobility are required to be balanced in a free market, so that their combined effect on inequality under active government is crucially dependent on the extent of redistribution. In this case, as an initially poor median agent eventually becomes rich thanks to large redistribution, she becomes a net contributor to the public budget and starts voting for more restrictive policies. The ensuing revision from high to low redistribution in equilibrium aggravates the forces for backward mobility, and the median voter gradually moves back from the wealthy to the lower class, until initial conditions for large redistribution are restored.

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[9] We consider only the case of welfare improving redistribution for simplicity's sake, as tax distortions on effort supply can easily be taken into account in our framework without affecting the results. Uncertainty at election time is not an essential ingredient either, as is proved in a first version of the paper (Zollino, 1994).

Policy cycles have recently been formalised in Gradstein-Justman (1997) in terms of periodical changes between two radically different education policies. Differently, we restate the result even for minor variations in competing programmes and augment for endogenous fluctuations in policies. Indeed, in our paper they result not only from the median voter moving across classes, but also from his preferred policy potentially changing over time. Finally, the ultimate connection to the economic structure is explicitly made.

2.2 The model

In a small open economy we assume a continuum of agents with identical preferences and different initial wealth; they live one period, which can be ideally split into three subperiods. In the first, agents start a risky productive project, in the second they may vote for a redistributive policy, in the third, after productive uncertainty is solved and policy implemented, they realise utility by consuming and leaving bequests to their offspring. Generations succeed ad infinitum without overlapping [10].

2.2.1 Productive technologies

A sole homogeneous good, suitable for both consumption and investment, can be produced in two sectors in which technologies differ by intensity of effort, fixed capital requirements and expected payoffs.

In the first sector, namely the subsistence activity, there is no fixed capital requirement and the technology is a pure chance mechanism whose revenues, provided a minimum effort $\underline{e}$ is exerted by the agent, are given by[11]:

$$f_{sub} = \begin{cases} n & with\ prob = \vartheta \\ 0 & with\ prob = 1-\vartheta \end{cases} \tag{3}$$

[10] This assumption is not crucial for our results which may easily be restated in a traditional overlapping generations model. More importantly, we conveniently restrict to imperfect altruism in line with the reference literature, since an extension to a dynastic utility would greatly complicate a closed form solution of dynamic equilibrium. More on this issue can be found in Benabou (1996c) and Krusell et al. (1997).

[11] A rough example of a subsistence activity is a backward agricultural sector, where weather crucially determines an abundant harvest, conditionally on the peasant worked the land.

In the second sector, namely the productive activity, technology implies a fixed scale in investment, which we normalise to one; in addition, greater effort by agents can improve the expected payoffs

$$f_{prod} = \begin{cases} r & with\ prob = p \\ \xi & with\ prob = 1 - p \end{cases} \tag{4}$$

with $p = f(e)$ a real increasing function that maps effort into the probability of success[12]: Effort is observable only to the agent who exerts it at a disutility cost, measured in monetary metric by a convex increasing function $h(e)$[13]. Accordingly, the agent disutility required to achieve p is defined by the convex function $g(p) = h\left[f^{-1}(p)\right]$.

Aside from operating in one of the two risky sectors, the agent can lend inherited wealth to financial intermediaries in exchange for a riskless interest factor A[14]. Under free entry in the financial sector, the latter is exogenously determined in the small open economy we consider. Following Townsend (1978) and Greenwood-Jovanovic (1990), the establishment of trading arrangements costs the lender a fixed commission fee[15], equal to c; as a result, lending an amount w to a financial intermediary proves profitable only if $wA - c > w$. For smaller amount, it is convenient simply to leave it idle by the time consumption and bequest decisions are made.

As a characterisation of a dynamic economy, we find it reasonable to take that operating in the productive sector is the dominant option, or that

$$\begin{aligned} &pr + (1-p)\xi - g(p) + max\{A(w-1) - c,\ w-1,\ 0\} - max\{A(1-w),\ 0\} \geq \\ &\vartheta n - h(\underline{e}) + max\{Aw - c,\ w\} \end{aligned} \tag{5}$$

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[12] In particular, $f:[0,1] \to [0,1)$ with $f(e) = 0\ \forall e \in [0,\underline{e})$ and $f''(e) < 0$. With $\underline{e} > 1/2$ we rule out that the agent works in the two sectors at the same time: a choice where to produce must be made.

[13] Convexity of the disutility function stands for the standard concave condition for the consumer's utility maximisation programme.

[14] Despite the uncertainty in technology outcomes, no default of financial intermediaries results from the law of large number under independent individual risks.

[15] Apart from monitoring costs, a positive commission fee may be due to transaction costs coming from book keeping or a minimum share requirement in a mutual fund.

Under perfect capital markets nobody would then invest in the subsistence activity. Indeed, information frictions and a fixed capital requirement cause credit rationing to limit the opportunity of operating the dominant technology. As we show in Appendix B, in equilibrium credit is offered only to agents whose wealth is not lower than a threshold $\underline{w}$, which increases with the interest factor and decreases with the financial intermediary's net expected returns. The latter are determined within an optimal financial contract, by which the lender is allocated the full property rights on the risky project in exchange for a proper compensation for the effort provided by the borrower/investor.

2.2.2 Class' structures and rules of behaviour

While sharing identical preferences, agents are heterogeneous in inherited wealth w_t. Under imperfect capital markets, they can then be divided into different classes according to the investment opportunities they can afford. For simplicity's sake, we restrict attention to only three classes, namely the poor, the middle and the rich.

The **poor class** consists of agents with $w_t \in [0, \underline{w})$ or below the threshold for credit rationing: they cannot afford the minimum investment required in the productive sector and operate the subsistence activity described in (3). In addition, they could lend their inherited wealth to financial intermediaries and earn the interest factor A, should it be profitable after payment of the commission fee. In order to preserve a simple class structure over time we find useful to rule out this possibility

(6) *Assumption 1:* $c \geq \underline{w}(A-1)$

The **middle class** consists of people with $w_t \in [\underline{w}, 1)$: they can raise funds on the credit market and operate in the productive sector. Since this is the dominant option, everybody in the middle class is a borrower who solves the following

$$\max_{p} \; pr + (1-p)\xi - \rho(w_t) - g(p)$$

where $\rho(w_t)$ is the cost of the loan needed, in addition to the initial endowment, to meet the fixed capital requirement. As shown in Appendix B, an optimal financial contract is a payment schedule $\{0, s(w_t)r\}$, which identifies the compensation offered to the investor respectively in case of failure and success of the risky project. After rearranging, the objective function of the middle class can be restated as

$$\max_p psr - g(p) \tag{7}$$

with first order conditions requiring

$$sr = g'(p) \tag{8}$$

To simplify the calculus and keep the class structure as simple as possible, we model the effort cost function in a very simple piece-wise linear form[16]:

$$g(p) = \begin{cases} h(e) + bp & 0 \le p \le q' \\ +\infty & p > q' \end{cases} \quad \text{with } 0<b<1. \tag{9}$$

The equilibrium financial contract and condition (6) imply a stepwise optimal probability of success in the productive project, as from

$$p^*_{s.b.} = \begin{cases} 0 & \text{if } sr < b \\ p \in [0,q'] & \text{if } sr = b \\ q' & \text{if } sr = \tilde{b} > br \end{cases} \tag{10}$$

[16] This assumption proves to be less restrictive than at first appears, as we content ourselves with working with a limited number of classes. Actually, the linear piece-wise specification as an approximation to the general convex form has the virtue of making agents' behaviour homogeneous within some range of wealth values. The approximation we suggest can be enriched at will if we are prepared to increase the number of classes we consider. At most, the approximation will converge to the general form, with an infinite number of classes. Since the smaller their number, the simpler the rule for social mobility, as shown later on, we assume the poorest specification for $g(p)$.

where the index *s.b.* labels the solution as second best to take account of moral hazard stemming from unobservable effort. Indeed, the issue is still in place despite the extremely simplified cost function as a negligible effort could in theory be provided by the borrower with a zero probability of success.

As we show in Appendix B, the intermediary finds it profitable to motivate the investor to the highest effort by offering him a spread *s(w)* between the success and failure compensation, which proves increasing with initial wealth, provided it is equal at least to $\underline{w}$. As this offer meets the investor's participation constraint, he actually exerts the effort required for a success probability q'.

The **rich class** identifies agents with $w_t \in [1,\infty)$: since their endowments are at least as high as the fixed capital requirement in the productive activity, they operate in this sector without borrowing. Accordingly, no moral hazard arises with people in the rich class, whose rules of behaviour match the solution to the problem

$$(11) \qquad \max_{p} pr + (1-p)\xi - g(p) \qquad \text{with FOC's requiring } r - \xi = g'(p)$$

In view of (9), the first best solution for p is given by

$$(12) \qquad p^{*}_{f.b.} = \begin{cases} 0 & \text{if } r-\xi < b \\ p \in [0,q'] & \text{if } r-\xi = b \\ q' & \text{if } r-\xi > b \end{cases}$$

Along with investing in the productive sector, the rich lend to the financial intermediaries the residual wealth $w_t - 1$, provided the gross returns exceed the commission fee. In view of [5], only agents with $w_t > 1 + c(A-1)^{-1} \equiv \tilde{w}$ lend money, while the remaining rich, like the poor, leave their residual wealth idle until the final subperiod.

2.2.3 Social mobility in free market

In our framework social mobility, namely the individuals' opportunity to change class across generations, is the combined outcome of a sequence of optimal choices made by agents over the three subperiods in which their lifetime can be ideally split. In the latest, namely

date t_2, utility is maximised subject to the budget constraint resulting from optimal action in earlier subperiods. In particular, at the initial date t_0 agents make optimal productive investment based on their inherited wealth, and at next date t_1, only in the case of election, they optimally vote for redistribution. In such a framework, equilibrium may be formally analysed by solving a backward strategy, moving from the latest to the earliest date. As the free market is meant to rule out public action, in this section we can skip the intermediate subperiod, namely the election time.

At date t_2 the agent maximises utility by deciding how much to consume and to bequest out of the wealth commanded. Under Leontieff preferences, the agent solves the following problem

$$(13) \qquad \max_{C_2,B_2} U(C_2, B_2) = min\{(1-\delta)C_2, \delta B_2\} \qquad \text{such that} \quad C_2 + B_2 \leq M_2$$

where C_2 and B_2 are, respectively, consumption and bequests enjoyed at date t_2; M_2 identifies the resources the agent commands as the result of his own inherited wealth and productive decisions at t_0 - whose uncertain payoffs are realised at the beginning of the final subperiod. The standard solutions are $C_2^* = \delta M_2$ and $B_2^* = (1-\delta)M_2$, with B_2^* identifying the optimal intergenerational transfer which drives social mobility.

At date t_0 the agent decides which technology to operate in view to maximise M_2, as we have already discussed in the previous section.

In this set up, the following law of motion then rules social mobility across generations at time t and t+1

$$(14a) \quad w_{t+1} = \begin{cases} (1-\delta)(n+w_t) & \text{with } prob = \vartheta \\ (1-\delta)w_t & \text{with } prob = 1-\vartheta \end{cases} \qquad \text{for } w_t \in [0, \underline{w})$$

$$(14b) \quad w_{t+1} = \begin{cases} (1-\delta)sr & \text{with } prob = q' \\ 0 & \text{with } prob = 1-q' \end{cases} \qquad \text{for } w_t \in [\underline{w}, 1)$$

$$(14c) \quad w_{t+1} = \begin{cases} (1-\delta)(r+w_t-1) & \text{with } prob = q' \\ (1-\delta)(\xi+w_t-1) & \text{with } prob = 1-q' \end{cases} \qquad \text{for } w_t \in \left[1, \tilde{w}\right)$$

$$(14d)\quad w_{t+1} = \begin{cases} (1-\delta)(r + A(w_t - 1) - c) & \text{with } prob = q' \\ & \text{for } w_t \in \left[\tilde{w}, \bar{w}\right] \\ (1-\delta)(\xi + A(w_t - 1) - c) & \text{with } prob = 1 - q' \end{cases}$$

where for simplicity's sake we posit that the provision of effort is the same in both first and second best, so that the probability of success is uniformly equal to q'; $\bar{w} = (1-\delta)(r - A - c)(1-\alpha)^{-1}$, with $\alpha \equiv (1-\delta)A < 1$, identifies the upper bound beyond which individual wealth cannot persist over time, and higher values can be neglected without a significant loss of generality in a long run analysis[17].

System (14) implies that a class structure, albeit initially simple, generally tends to become more and more complex over time, with the number of classes continually increasing. In order to preserve analytical tractability, we identify some restrictions in the parameter space that make clear cut rules for social mobility, in the case of both success and failure in the risky projects. In particular, we assume that in the case of failure the offspring of the wealthy will fall into the middle class irrespective of their parents' wealth.

$$(15)\qquad \textit{Assumption 2: } \underline{w} \le \xi(1-\delta) < 1 - (1-\delta)\left[max\left\{A(\bar{w} - 1) - c, \bar{w} - 1\right\}\right]$$

Additionally, the offspring of people belonging to the middle and poor classes are invariantly supposed to jump respectively into the rich and the middle class in the event of productive success of their parents. In this case, the required of restrictions on parameters read:

$$(16)\qquad \textit{Assumption 3: } \tilde{b} \ge \frac{1}{(1-\delta)}$$

$$(17)\qquad \textit{Assumption 4: } \frac{w}{1-\delta} \le n < (1-\delta)^{-1} - \underline{w}$$

Interestingly, Assumption 4 is mainly stated to make explicit the way we simplify social mobility as: i) the lower bound requirement proves redundant under a slightly stricter

[17] For the very rich, in the indirect utility derived from [13] the value of consumption exceeds the payoff of productive investment, and must be partly funded by a depletion of initial wealth, with offspring inheriting less than their parents (Aghion-Bolton, 1997 and Banerjee-Newman, 1991)

version of Assumption 2; ii) the upper bound requirement, namely that the offspring of the poor cannot jump into rich class, is not binding in the long run[18].

Under the moderate loss of generality implied by previous assumptions[19], the stochastic process ruling social mobility may be summarised by the low-dimension matrix M_F introduced in section 2.2. It is an important achievement that the size of long run inequality induced by (14) and its relation to key parameters may easily be investigated according to the standard theory of Markov chains (Appendix A). Moreover, changes in the location of median voter under social mobility can be tracked at any date.

2.3 Social mobility and political equilibrium

In this section the endogenous determination of redistribution is analysed by introducing political competition in the above stochastic framework. As in the standard approach, heterogeneous agents aggregate through majority voting whereby representatives are appointed to office. Following Alesina (1987), we assume for simplicity that political competition involves two partisan parties, in the sense that they seek to implement a given policy, which they invariably prefer[20].

2.3.1 The redistributive programme

The core of political competition is identified by the extent of a purely redistributive programme to be funded by taxation of personal wealth. In our set-up, the rationale of this programme comes from relaxing the credit constraint that restricts investment opportunities by the poor, then allowing for a larger number of agents to operate in the more productive sector. This raises the case for net efficiency gains from redistribution, provided that distortionary effects caused by the related increase in the tax burden prove to be not very

[18] People in the poor class either come from higher classes, with wealth virtually nil due to failure in the productive sector, or are confirmed poor due to failure in the subsistence sector; in the latter case, inherited (and idle) wealth converges to zero, the faster the higher δ.

[19] Appendix C shows the coherence of the whole system of constraints and identifies sufficient conditions for its solution, with a moderate loss of generality in the parameter space.

[20] The two party assumption does not involve any loss of generality in our framework, as later analysis shows that classes' preferences would lead to corner solutions even with a continuum range of feasible policies.

strong[21]. In addition, since in our framework everybody has a positive probability to eventually falling in the poor class, redistributive policies can be thought of as supplementing an imperfect insurance market (Loury, 1981). The two factors combine to motivate all agents to support *some* redistribution, while its actual extent is a matter of political competition.

We identify a redistributive policy in terms of the measure ς_i, or the proportion of poor to whom the party i grants a fixed subsidy in order to enhance their mobility into higher classes. By imposing a balanced public budget constraint, the programme can be represented as follows

$$\tau_i^M \int_{\underline{w}}^{1} dF_1(w) + \tau_i^R \int_{\bar{w}}^{1} dF_1(w) = \varsigma_i \gamma \int_{0}^{\underline{w}} dF_1(w) \qquad \text{with } i = 1,2 \tag{19}$$

where $\gamma \geq \frac{\underline{w}}{1-\delta}$ is a fixed subsidy which allows poor people to leave bequests so great that their offspring can be offered credit, then operate in the productive sector; $F_1(w)$ is wealth distribution at date t_1, after realisation of uncertain technologies; τ_i^M, τ_i^R is the fiscal burden levied on the middle and rich classes, respectively, with taxation of the poor normalised to zero to reinforce the equity target ς_i, which could alternatively be defined as the fraction of after-tax poor to be helped. Some unusual features in the design of the redistributive programme deserve additional comments.

In the first place, redistribution is meant to benefit exclusively the poor class and is not lump sum across all agents. This highlights the contribution of public policies in relaxing the credit constraint, with their positive effects on social mobility showing very clearly. Interestingly, although the action programme enforces a pure redistribution, it allows poor parents to leave their offspring an improved ability to earn, like inherited wealth under imperfect capital markets.

From this standpoint, (19) may be alternatively interpreted as subsidising education investment by parents to augment the intergenerational transfers of human capital. As a technical point, a fixed subsidy gives every poor agent a chance to end up in the middle class regardless of his own initial wealth, so that we may disregard its evolution over time.

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[21] Under moral hazard, the gains in efficiency accruing to net recipients should be compared with the loss in efficiency arising for net contributors, namely a reduction in the provision of effort or in q' in our framework. Since this issue does not affect our main arguments, we abstract from it for simplicity's sake. See Benabou (1996b, 2000) and Aghion-Bolton (1997) for an extensive discussion.

In the second place, the policy design leaves room for progressive taxation. As it stands, taxation is independent of wealth within each class, in line with our basic approach to approximate a continuum of classes by a discrete representation[22]. It is worth mentioning that taxation on both the middle and rich classes could be adjusted over time to preserve a balanced public budget against changes in wealth distribution. However, since adjustment in τ_i^M may augment the inflows from the middle to the poor class - which would counteract the original equity target- we assume that both parties tax the middle class at a fixed and, without loss of generality, equal rate, with $\tau_{i,t}^M = \tau^M$ [23,24]. A related issue regards the impact of taxation on the investor participation constraint on the financial market. In this regard, we greatly simplify our analysis by ruling out all distortionary effects of taxation by assuming that $\tau^R \leq \bar{\tau} \equiv \frac{\tau^M + (1-q')\gamma\bar{\varsigma}}{q'}$ (cfr. Appendix D)[25].

In the third place, since policy is implemented in the subperiod following the election, voting is affected by wealth distribution at t_1 and that expected for t_2. As the latter depends on the pattern of social mobility, which includes past redistribution, it turns out that a full appraisal of the feedback between economic and political equilibria must take into account both the distinction of *ex ante* from *ex post* inequality and how much it is affected by the kind of policy implemented in previous periods.

The role of social mobility in political competition has recently been addressed in two classes of theoretical contributions, where people may vote differently from maximising the payoffs of their current class. In the first (Picketty, 1997 and Quadrini, 1999), it is imperfect information about the true rules for social mobility that motivates people to vote for large

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[22] Technically, the evolution of political equilibrium may be checked by tracking only the mass of agents in each class and ignoring the respective average wealth, with gains in tractability . While this last task is very hard to manage analytically, the first may be dealt with easily in our framework owing to the recursive property of a Markov chain.

[23] While abstracting from substantial variation across parties in the middle class taxation may resemble a realistic ingredient of political competition, leaving it unchanged over time sounds more restrictive. We could alternatively assume that parties differ in this respect too, and reasonably require that $\left|\dot{\tau}_{i,t}^M\right| \leq \left|\dot{\tau}_{i,t}^R\right|$; voting behaviour would prove unaffected for all classes but the poor, who would then demand a large taxation only under a high enough ratio of rich to middle class agents. While the conclusions of our analysis are confirmed, the calculus would be unnecessarily more complicated.

[24] With reference to restrictions on the parameters underlying the stochastic matrix M_F, a fixed τ^M delivers the advantage that sufficient conditions identified in Appendix C for a free market economy directly apply with active government, after rescaling by a fiscal constant.

redistribution even if they are currently net contributors to the public budget. This argument does not hold true in our framework, where everybody knows the true process driving social mobility. In the second approach (Hirshman, 1973 and Ok-Benabou, 2001), even a very poor median voter may not demand prohibitive taxation on the rich in view of the prospect of his own upward mobility. In this case, we share the emphasis on *ex post* inequality in ruling out extreme political outcomes, such as either expropriation of the rich or no redistribution at all.

In other words, in our model a non zero probability for everybody of moving into either the rich or the poor class in some future time delivers the rationale for unanimous consensus for both a floor in the assistance to the needy, namely $\bar{\varsigma} \geq \varsigma_1 \geq \varsigma_2 \geq \underline{\varsigma}$, and a ceiling in the taxation of the wealthy, $\tau^R \leq \bar{\tau}$. Aside from this argument, the "prospect of upward mobility" does not play a crucial role in explaining our outcomes. As shown in the following section, the preferred policies of the *ex ante* poor and rich classes show at any time a standard conflict about the demand for redistribution. As for the *ex ante* middle class, whose voting is actually affected by the prospects of social mobility, it is both *upward* and *backward* transition rules that play a key role[26].

Finally, the programme [19] defines a pair-wise political choice, since at any date it implicitly identifies a one-to-one relationship between τ_i^R and ς_i for any given wealth distribution and taxation on the middle class. People are then called to vote over the size of redistribution while knowing its marginal tax cost, as defined by

$$\frac{\partial \tau^R}{\partial \varsigma} = \frac{\gamma \int_0^{\bar{w}} dF_1(w)}{\int_1^{\bar{w}} dF_1(w)} \tag{20}$$

As later shown, political preferences on ς reveal single peaked, and the median voter theorem applies in determining the political equilibrium (Atkinson-Stiglitz, 1980).

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25 These conditions are to be considered sufficient, since any combination of stricter ranges of admissable values identified in Appendix C for a subset of parameters may still comply with the rationality constraints for the relatively poor within the middle class even when $\tau^R > \bar{\tau}$.

26 Our results can be basically confirmed even abstracting at all from middle class behaviour, for example slightly changing the policy design to target the offspring of the poor (Zollino, 1994).

2.3.2 Social mobility with active government

Taking account of political competition significantly changes the stage for social mobility, owing to the feedback between economic and political equilibrium in shaping wealth dynamics. To identify equilibrium, we replicate under active government the same backward strategy as in free market.

In the first place, no change occurs for optimal choices at date t_2: everybody consumes and bequeaths constant shares of disposable wealth, the latter now being a function of both the productive and voting decisions taken in the past two subperiods. The result immediately follows from maximising (13) under a resource constraint, which now includes the effects of policy

$$C_2 + B_2 \leq M_2(\tau, \varsigma) \tag{21}$$

where τ and ς identify the political programme voted at date t_1 and enforced at t_2.

At date t_1, agents vote for redistribution on the basis of the expected payoff from the productive investment made in the previous subperiod and taking account of (20). Under linear indirect utility at date t_2, the agent's problem at date t_1 is

$$\max_{\varsigma_i(\tau_i)} M_2(\tau_i, \varsigma_i) \quad \text{such that} \quad \varsigma_i(\tau_i) \in \{\varsigma_1(\tau_1), \varsigma_2(\tau_2)\} \tag{22}$$

$$\text{with } M_2 = \begin{cases} w_0 + \vartheta\left(n - \tau^M\right) + (1-\vartheta)\gamma\varsigma_i & \text{if} \quad 0 \leq w_0 \leq \underline{w} \\ q'\left(sr - \tau_i^R\right) + (1-q')\gamma\varsigma_i & \text{if} \quad \underline{w} < w_0 \leq 1 \\ q'\left(r - \tau_i^R\right) + (1-q')\left(\xi - \tau^M\right) + \max\{(w_0 - 1)A - c, w_0 - 1\} & \text{if} \quad 1 < w_0 \leq \overline{w} \end{cases}$$

where $\varsigma_1(\cdot) > \varsigma_2(\cdot)$ identify the two competing parties at date t_1, with party 1 supporting the larger redistribution; M_2 is the expected wealth for period t_2, when the voted policies will be enforced and the technological uncertainty solved; w_0 is the initial wealth affecting productive decisions at t_0 due to imperfect capital markets.

The policy design implies conflicting preferences for the poor and the rich class, with the former voting for the largest redistribution (party 1) and the latter for the smallest

(party 2)[27]. As to the middle class, the preferred policy is univocally identified at any date, then for any given inequality, but may change over time with the fiscal cost of redistribution. In particular, for this class the first order conditions for maximum utility imply that the largest redistribution is preferred if $(1-q')\int_{1}^{\bar{w}} dF_1(w) \geq q' \int_{0}^{\underline{w}} dF_1(w)$, otherwise the competing programme is voted. By rearranging in view of (20), the conditions for the middle class to support party 1 require[28]

$$\frac{\int_{0}^{\underline{w}} dF_0(w)}{\int_{1}^{\bar{w}} dF_0(w)} \leq \frac{1-q'}{1-\vartheta} \equiv \phi \tag{23}$$

Two factors help determine the net gains that the middle class expects from redistribution, then its voting behaviour: i) the *ex ante* relative mass of poor compared with rich people, as it affects the expected tax cost for the middle class; ii) the ratio of the probability of the middle and poor classes proving *ex post* eligible for assistance, as this affects the expected benefits to the middle class from redistribution.

As stressed in the next sections, condition (23) enriches the dynamic feedback between economic and political equilibria in determining both social mobility and policy sustainability in the long run. The latter may indeed prove questionable owing to: i) movements of median voter across classes; ii) switches in the middle class preferred policy as a result of changes in inequality partly induced by redistribution itself.

In view of the net expected benefits from redistribution to each class, voting preferences prove to be single-peaked and monotone in agents' own endowment under any given inequality. In equilibrium, the extent of redistribution at any time t is then determined by the median voter's preferred policy, as identified by

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[27] It comes from an increasing (decreasing) M_2 with ς within the poor (rich) class.

[28] It follows from substituting for $\int_{0}^{\underline{w}} dF_1(w) = (1-\vartheta)\int_{0}^{\underline{w}} dF_0(w) + (1-q')\int_{\underline{w}}^{1} dF_0(w)$ and for $\int_{1}^{\bar{w}} dF_1(w) = q'(\int_{\underline{w}}^{1} dF_0(w) + \int_{1}^{\bar{w}} dF_0(w))$ in $(1-q')\int_{1}^{\bar{w}} dF_1(w) \geq q' \int_{0}^{\underline{w}} dF_1(w)$, and rearranging.

$$(24)\qquad \varsigma_t = \begin{cases} \left.\begin{array}{ll} \varsigma_1 & \text{if } w_{m,t} \in [0, \underline{w}) \\ \varsigma_2 & \text{if } w_{m,t} \in [\underline{w}, \bar{w}] \end{array}\right\} & \text{when } (1-\vartheta)\int_0^{\underline{w}} dF_0(w) \geq (1-q')\int_1^{\bar{w}} dF_0(w) \\ \left.\begin{array}{ll} \varsigma_1 & \text{if } w_{m,t} \in [0,1) \\ \varsigma_2 & \text{if } w_{m,t} \in [1, \bar{w}] \end{array}\right\} & \text{otherwise} \end{cases}$$

with $w_{m,t}$ being the median wealth at a given point in time.

Finally, under non distortionary taxation productive decision at t_0 are undertaken according to the same rules as in free market, with everybody operating in the productive sector but the *ex ante* poor.

As a combined result of optimal investment, voting and consumption over each agent lifetime, the intergenerational dynamics in personal wealth is ruled by the following

$$(25a)\quad w_{t+1} = \begin{cases} (1-\delta)(n + w_t - \tau^M) & \text{with } prob = \vartheta \\ (1-\delta)(\gamma + w_t - \tau^M) & \text{with } prob = (1-\vartheta)\varsigma_t \\ (1-\delta)w_t & \text{with } prob = (1-\vartheta)(1-\varsigma_t) \end{cases} \qquad \text{for } w_t \in [0, \underline{w})$$

$$(25b)\quad w_{t+1} = \begin{cases} (1-\delta)(sr - \tau_t^R) & \text{with } prob = q' \\ (1-\delta)(\varsigma - \tau^M) & \text{with } prob = (1-q')\varsigma_t \\ 0 & \text{with } prob = (1-q')(1-\varsigma_t) \end{cases} \qquad \text{for } w_t \in [\underline{w}, 1)$$

$$(25c)\quad w_{t+1} = \begin{cases} (1-\delta)(r + w_t - 1 - \tau_t^R) & \text{with } prob = q' \\ (1-\delta)(\xi + w_t - 1 - \tau^M) & \text{with } prob = 1-q' \end{cases} \qquad \text{for } w_t \in \left[1, \tilde{w}\right)$$

$$(25d)\quad w_{t+1} = \begin{cases} (1-\delta)(r + A(w_t - 1) - c - \tau_t^R) & \text{with } prob = q' \\ (1-\delta)(\xi + A(w_t - 1) - c - \tau^M) & \text{with } prob = 1-q' \end{cases} \qquad \text{for } w_t \in \left[\tilde{w}, \bar{w}\right]$$

Under (25) the stochastic process driving social mobility with active government basically preserves a low dimension Markov chain as from the matrix M_G introduced in section 2.1. Based on this result, we can easy investigate both the location of the median voter and his preferred policy at every election.

2.4 Social mobility and political equilibrium in the long run

The simplified model outlined the in previous sections makes it possible to analyse the long run equilibria induced by the dynamic feedback between economic and political equilibria. It allows identifying conditions for steady state *versus* cycles in policy and inequality based on a straightforward application of standard theorems for the convergence of Markov chains. In this respect, our dynamic economy summarises in the two laws of motion

$$\begin{cases} \varsigma_t = Z(\psi_t, \phi) \\ \psi_{t+1} = \psi_t M_G(\varsigma_t) \end{cases} \tag{26}$$

with Z implicitly defining the political equilibrium in terms of the density measure ψ and the structural parameter $\phi \equiv (1-q')/(1-\vartheta)$. Accordingly, a redistributive policy voted at date t remains in place in the long run if it affects the transition matrix M_G in a way that the induced stationary wealth distribution complies with the median voter to keep voting for the same policy. Then, a steady state political equilibrium can be defined as

$$\varsigma^* = Z[\psi^*(\varsigma^*), \phi] \tag{27}$$

and the induced stationary distribution of wealth can be characterised by exploiting the standard properties of Markov chains (Appendix A). As opposed to steady states, in the long run policy and inequality may periodically fluctuate, as implied by

$$\begin{cases} \overline{\psi} = \underline{\psi} M_G [\varsigma(\underline{\psi})] \\ \underline{\psi} = \overline{\psi} M_G [\varsigma(\overline{\psi})] \end{cases} \tag{28}$$

with $\overline{\psi}$ and $\underline{\psi}$ identifying the invariant measures induced by $M_G(\cdot)$ and supporting, respectively, high and small redistribution in equilibrium. We show that sufficient conditions for policy cycles and the key factors explaining them can be analytically identified, too.

Interestingly, our analysis allows us to disentangle the input coming from the economic structure and from the policy itself, thus unveiling a richer pattern in the relationship between inequality and redistribution than commonly found in recent literature. In this section, we first deal analytically with sufficient conditions for the variety of outcomes that may occur in the long run, then we resort to a numerical simulation to illustrate the dynamics of the adjustment process in selected examples.

We find it useful to think about the political equilibrium in the long run in a notional dimension of time, by positing that the next election will be called after convergence to the stationary distribution induced by current policy has taken place. This is equivalent to convergence of $\psi(\varsigma_i)$ to $\psi^*(\varsigma_i)$ materialising in one period of time. Although we then fail to consider the effects of changes in the political equilibrium which might occur at a higher frequency of elections, we are still in a position to identify sufficient conditions that if a policy remains unchanged over our notional time, it will be the same at every possible date (and all the same in case of policy fluctuations). What we miss in this way is the ability to figure out the path of political equilibrium election by election, which is not at the core of our analysis; in this, however, numerical simulation may help.

2.4.2 Characterising equilibrium in the long run: analytical results

Starting from any redistribution ς_i implemented at time *t*, the long run equilibrium can be analysed by checking which policy would gain majority voting under the stationary wealth distribution $\psi^*(\varsigma_i)$, to which the Markov chain $M_G(\varsigma_i)$ converges at time $T(\varsigma_i)$. A variety of possible equilibria may be identified in the long run, which differ in either the extent of the redistribution or the main factors explaining it. In the first place, Proposition 2 in section 2.1.1 directly results from optimal voting. By exploiting conditions for the convergence of Markov chains outlined in Appendix 2.A it can be restated as follows:

Proposition 2a. *Sufficient conditions for low redistribution as a* unique *equilibrium in steady state require either of the two:*

a1) parameters (ϑ, q') *are so high that in the long run the median voter belongs to the rich class regardless of the extent of redistribution:*

$$\psi_3^*(\varsigma_2) \equiv \frac{q'[\vartheta(1-\varsigma_2)]+\varsigma_2}{(1-\varsigma_2)[\vartheta+(1-q')^2]+\varsigma_2} > \frac{1}{2};$$

a2) parameters (ϑ, q') *are high enough that in the long run the median voter does not belong in the poor class and, under any policy, the mass of poor is relatively large:*

$$\psi_1^*(\varsigma_2) \equiv \frac{(1-q')^2(1-\varsigma_2)}{(1-\varsigma_2)[\vartheta+(1-q')^2]+\varsigma_2} < \frac{1}{2} \text{ and } \frac{\psi_1^*}{\psi_3^*}(\varsigma_1) \equiv \frac{(1-q')^2(1-\varsigma_1)}{q'[\vartheta(1-\varsigma_1)+\varsigma_1]} > \frac{1-q'}{1-\vartheta}$$

Proof. Low redistribution results in the long run if: i) $w_{m,t+j} \geq 1$ at any $j > \bar{j} \geq 0$; ii) $w_{m,t+j} \geq \underline{w}$ and $\Delta_{t+j} > \phi$ at any $j > \bar{j} \geq 0$. As for case i), it is easy to show that the mass of rich agents at any date increases with redistribution, thus if in the long run the median voter remains rich class with an invariantly small redistribution (condition a1), *a fortiori* it does so when large redistribution occasionally occurs at some elections. As for case ii), consider the following: a) since the relative mass of poor to rich agents decreases with redistribution, if in the long run it remains sufficiently high under redistribution invariantly large (second part of condition a2), *a fortiori* it does so either if large redistribution gains only occasional support or low redistribution is voted at every election; this implies that middle class would vote for low redistribution all times (rich class would do so anyway); b) since it is easy to show that the mass of poor is decreasing with redistribution, if in the long run poor agents are a minority under redistribution invariantly low (first part of condition a2), *a fortiori* they remain so when large redistribution gains occasional support. As a combined result of a) and b), once the median voter is pulled out of the poor class he never moves back and invariant support for low redistribution appears.

Proposition 2b. *Sufficient conditions for high redistribution as a unique equilibrium in steady state require either of the two:*

b1) parameters (ϑ, q') *are so low that they eventually push the median voter into the poor class regardless of the extent of redistribution:*

$$\psi_1^*(\varsigma_1) \equiv \frac{(1-q')^2(1-\varsigma_1)}{(1-\varsigma_1)[\vartheta+(1-q')^2]+\varsigma_1} > \frac{1}{2};$$

b2) parameters (ϑ, q') *are low enough that in the long run the median voter does not belong to the rich class and, under any policy, the mass of poor is relatively small:*

$$\psi_3^*(\varsigma_1) \equiv \frac{q'[\vartheta(1-\varsigma_1)+\varsigma_1]}{(1-\varsigma_1)[\vartheta+(1-q')^2]+\varsigma_1} < \frac{1}{2} \text{ and } \frac{\psi_1^*}{\psi_3^*}(\varsigma_2) \equiv \frac{(1-q')^2(1-\varsigma_2)}{q'[\vartheta(1-\varsigma_2)+\varsigma_2]} \leq \frac{1-q'}{1-\vartheta}$$

Proof. Previous arguments for low redistribution hold symmetrically true for large redistribution.

Sufficient conditions for a unique equilibrium in steady state ultimately rule out a significant impact of policy itself in affecting the demand for redistribution. The latter is then primarily determined by social mobility as driven by the purely economic structure. However, when policy significantly contributes to determining the majority at every election, the long run equilibrium proves to be not univocally determined any more.

Proposition 3a. *Sufficient conditions for multiple equilibrium in steady state (history dependence of redistribution) require that*

c1) social mobility in a free market is strong enough to leave the median voter in the middle class regardless of the extent of redistribution, as from the requirement identified by the first part sub a2) and b2);

c2) competing policies are different enough that

$$\varsigma_2 < 1 - \frac{q'}{1-\vartheta} \leq \varsigma_1$$

Proof. Arguments previously made imply that when large [small] redistribution self-reinforces as median voter remains poor [rich], in the long run it shows up even if redistribution is initially small [large]; then condition c1) identifies a first requirement for history dependence. In the second place, c2) results comes from $\Delta^*(\varsigma_1) \equiv \frac{(1-q')^2(1-\varsigma_1)}{q'[\vartheta(1-\varsigma_1)+\varsigma_1]} \leq \frac{1-q'}{1-\vartheta} < \frac{(1-q')^2(1-\varsigma_2)}{q'[\vartheta(1-\varsigma_2)+\varsigma_2]} \equiv \Delta^*(\varsigma_2)$, with $\Delta_{t+1}(\varsigma_{i,t}) \equiv \frac{\psi_{1,t+1}(\varsigma_{i,t})}{\psi_{3,t+1}(\varsigma_{i,t})}$, implying that large [small] redistribution occurs in the long run only if it is voted at *every* election. Consider large [small] redistribution: when the median voter remains in the middle class, policy self-reinforces over time provided that $\Delta_{t+1}(\varsigma_{1,t}) \leq \phi \ \forall t$ [$\Delta_{t+1}(\varsigma_{2,t}) > \phi \ \forall t$]. From $\psi_{1,t+1} = (1-\varsigma_{i,t})[(1-\vartheta)\psi_{1,t} + (1-q')\psi_{2,t}]$ and $\psi_{3,t+1} = q'(\psi_{2,t} + \psi_{3,t})$, it follows that $\Delta_{t+1}(\varsigma_{i,t}) \equiv \frac{\psi_{1,t+1}(\varsigma_{i,t})}{\psi_{3,t+1}(\varsigma_{i,t})} =$

$$= \frac{(1-q')(1-\varsigma_{i,t})}{q'(1-\psi_{1,t})}\left[\psi_{3,t}\left(1+\frac{\Delta_t-\phi}{\phi}\right)+\psi_{2,t}\right] = \frac{(1-q')(1-\varsigma_{i,t})}{q'} + \varepsilon_t(\varsigma_{i,t},\cdot) \quad \text{with } \varepsilon(\varsigma_{i,t},\cdot) \equiv \frac{(1-q')(1-\varsigma_{i,t})}{q'(1-\psi_{1,t})}\left[\psi_{3,t}\frac{\Delta_t-\phi}{\phi}\right] > 0 \quad [<0]$$

when $\varsigma_{i,t} = \varsigma_2$ [$\varsigma_{i,t} = \varsigma_1$]. As small redistribution self-reinforces when $\frac{(1-q')(1-\varsigma_{2,t})}{q'} + \varepsilon_t(\varsigma_{2,t},\cdot) > \phi$ or $(1-\varsigma_{2,t}) > \frac{q'}{1-q'}[\phi - \varepsilon_t(\varsigma_{2,t},\cdot)]$, by substituting for $\phi \equiv \frac{1-q'}{1-\vartheta}$ and rearranging, we obtain the requirement that $\varsigma_{2,t} < 1 - \frac{q'}{1-\vartheta} + \frac{q'}{1-q'}\varepsilon_t(\varsigma_{2,t},\cdot)$, with $\varepsilon_t(\varsigma_{2,t},\cdot) > 0$. A symmetric argument holds true for large redistribution.

When the middle class is pivotal in political equilibrium, long run policy might depend, *ceteris paribus*, on initial conditions. Noticeably, history dependence is also obtained in Benabou (2000) and Saint-Paul (2001), where imperfect democracy plays a key role in addition to welfare net gains from redistribution. In restating the same argument even abstracting from such restriction, we cast multiple equilibria as particular cases out of a variety of feasible outcomes in the long run.

Proposition 4. *No invariant equilibrium arises in the long run, with inequality and redistribution periodically fluctuating, when forces for downward and upward mobility in free market are balanced enough that they can be offset by high and low redistribution, respectively. Sufficient conditions identify the joint requirements:*

d1) high redistribution is not confirmed in the long run, namely the violation of either a1) or a2);

d2) low redistribution is not confirmed in the long run, namely the violation of either b1) or b2).

Proof. It follows from opposite arguments to those proving steady state equilibria.

To our knowledge, a case for endogenous policy cycles has been previously made only in Gradstein-Justman (1997) in terms of a periodical switch between radically different political regimes, ultimately driven by random extraction by nature of individual innate ability. By contrast, we find a similar result in a much more general framework, in which political cycles may arise even among reasonably similar competing policies and for quite a large set of admissible values for parameter characterising the economic process. Moreover, an additional innovation in oyr analysis is the identification of the contribution coming from the feedback between the *economic structure* and political equilibrium.

2.4.2 Exploring short run dynamics: a numerical simulation

In our stochastic framework, no standard measure of probability would be preserved over time. This raises the need for a numerical simulation in order to shed light on the evolution of inequality and redistribution election by election. In particular, it allows us to explore the

direction of changes in median voter's location and/or preferred policy and the way they are affected by both economic and political inputs.

In view of the recursive structure of a Markov chain, our numerical simulation simply consists of the following steps: i) assuming a set of initial values for the parameters ς_i, q', ϑ and wealth distribution ψ_0, which in turn determines which party is initially in office; ii) detecting the median voter's location at the first electoral test as implied by $\phi_1 = \phi_0 M_G(\varsigma_0)$; iii) finding the ensuing equilibrium value of ς_i: if it is different from ς_0, substituting for it in matrix M_G, otherwise leaving M_G unchanged; iv) searching for the median voter's location at the following electoral test as follows from $\phi_2 = \phi_1 M_G(\varsigma_1)$; v) starting again from iii) by updating the parameters where required.

In validating the variety in the long run relationship between inequality and redistribution previously identified on analytical grounds, the numerical exercise addresses the key role of the pure economic structure *versus* policy in affecting short run dynamics. By focusing attention on more informative examples, the standard prediction of positive correlation between redistribution and inequality proves confirmed when factors which would drive backward/upward mobility in a free market are too strong to be offset by public action (Figg. 1.A and 1.B)[29]. Taking as a proxy of inequality the mass of poor agents, under strong upward mobility this measure proves invariably very low in steady state and small redistribution is confirmed over time (Fig. 2.A). Even if the median agent would initially vote for a more active policy, she will very soon move into the upper class and will stay there forever, causing a once-for-all change in political regime. The opposite is symmetrically true with strong backward mobility (fig. 2B).

In the second place, under milder forces for social mobility in a free market, both the short and long run equilibrium crucially depend on the way those forces interact with policy in determining wealth distribution at any point in time, then the net gains from redistribution expected by the middle class. This can be traced back to two factors: a) changes in the parameters ϑ and q', which in our model summarise the economic structure, affect the threshold level $\phi = \frac{1-q'}{1-\vartheta}$ for the ratio Δ of the mass of poor to rich people; b) at every election, the actual value of this ratio responds to the joint effect on social mobility of the

[29] In the numerical simulation the initial distribution is arbitrarily chosen as pointless since we skip the case of history dependence in order to save space. A larger than reported set of results is available from the author on request.

economic structure itself and the extent of redistribution enforced in previous periods. Depending on the way the two factors combine to determine social mobility under active government, the preferred policy of the median voter may change either because she jumps across classes or, when remaining in the middle class, the sign of $\Delta - \phi$ reverts. As a possible result, small redistribution follows either from low inequality (Fig. 2C, with poor people in the specific example below 10 per cent in steady state) or from high inequality (Fig. 2D, with poor people above 40 per cent). And, under minor variations in the economic structure underlying inequality, even an initially large unanimous consensus for a given policy, which would otherwise confirm over time, may be reverted very quickly (Figg. 2E and 2F).

An interesting contribution of the numerical exercise is to clarify the case for endogenous political cycles. As shown analytically, they occur when opposite forces of attraction towards the rich and the poor classes under a free market are balanced enough that their combined effect on social mobility can be offset by redistribution. In the numerical exercise, political cycles typically occur when upward (backward) mobility in a free market is not so strong that the median agent can jump in the rich (poor) class regardless of the extent of redistribution. For instance (Figg. 3.A-B), after a large redistribution has taken place for some time, the median voter might eventually move in the rich class; this means that the middle class has been voting for large redistribution for a number of periods, when the rich were not the majority. Once the median agent turns rich, she starts voting for lower redistribution, and the intensity of upward mobility diminishes; this could occur to such an extent that consensus for the newly established policy is gradually eroded as the mass of rich people shrinks. At the same time, output per capita falls below the initial level, when redistribution was large, since the change to low redistribution augments the net inflow of agents from the middle to the poor class, then the share of agents producing in the subsistence sector. At some point in time, the median voter moves back from the wealthy to the middle class, and conditions can gradually resume for his preferred policy turning a large redistribution; when it eventually happens, per capita output will again rise since the new policy effectively relaxes the credit constraint that limits the opportunity to invest in the productive sector.

2.5 Concluding remarks

By modelling social mobility as a stochastic process in discrete space, we have explored the feedback between economic and political factors in determining the extent and the

invariance of redistributive policies in the long run. When both the location and the preferred policy of the median voter are allowed to change endogenously over time, a large variety of political equilibria may result in steady state, with no clear-cut relationship with inequality.

Specific outcomes depend on the way structural economic parameters, which would drive social mobility under no public action, combine with the policy input in determining the change in wealth distribution over time. It turns out that the standard prediction of a positive correlation between redistribution and inequality is confirmed when the pattern of social mobility that would prevail in a free market proves robust to public action. Otherwise the dynamic feedback between economic and political equilibrium leads to a non-linear relationship between inequality and the extent of redistribution, which proves much richer than commonly found in recent literature.

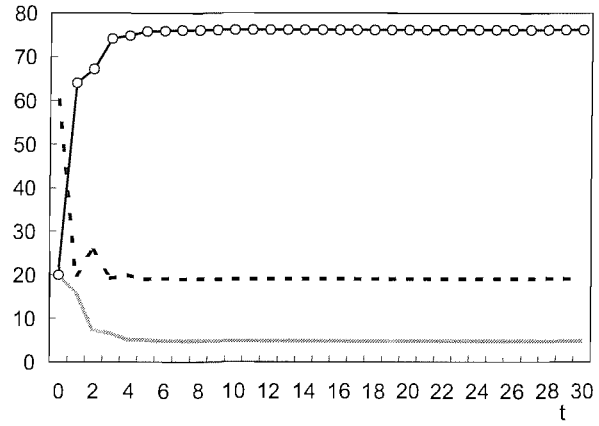
In this respect, political cycles may endogenously arise when the free market rules for backward and upward mobility are similar enough that their overall effect on inequality may be offset by a redistributive policy.

Fig. 2.1

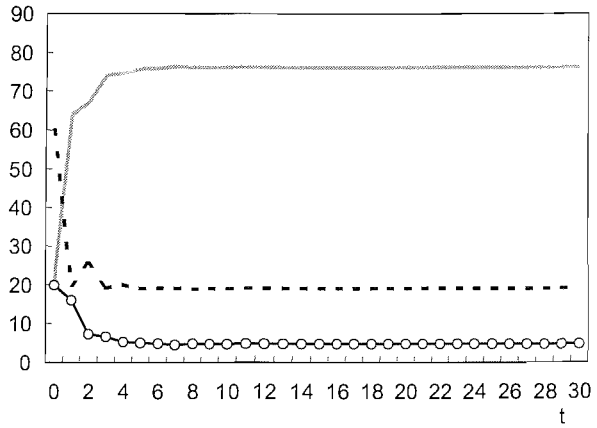
Social mobility in free market

With $\psi_0 = [20, 60, 20]$; percentage share of total population

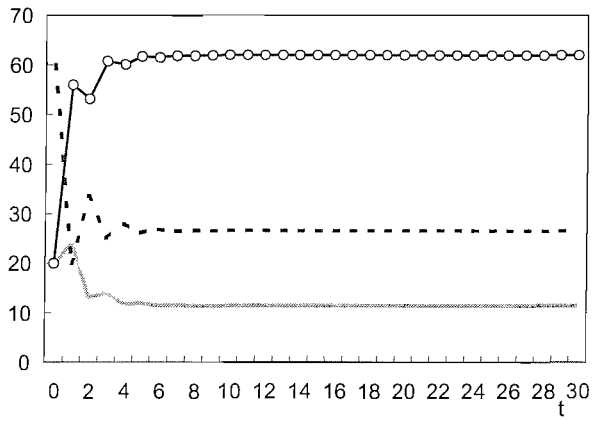
A. With $\vartheta = 0.8$; $q' = 0.8$



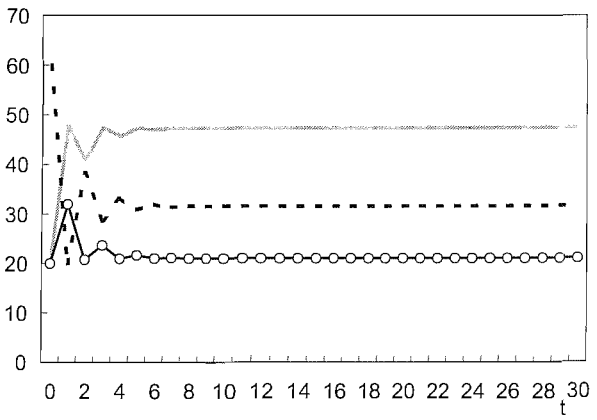
B. With $\vartheta = 0.2$; $q' = 0.2$



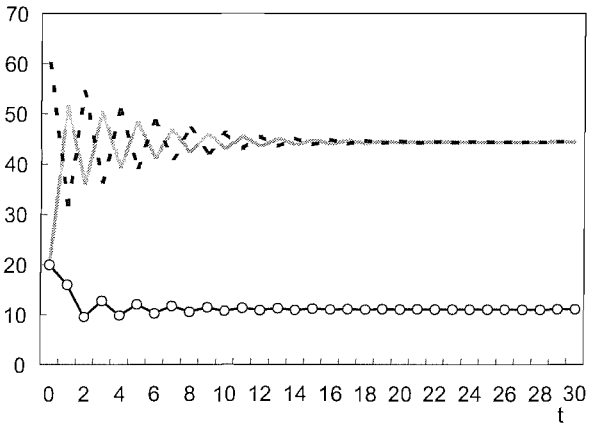
C. With $\vartheta = 0.7$; $q' = 0.7$



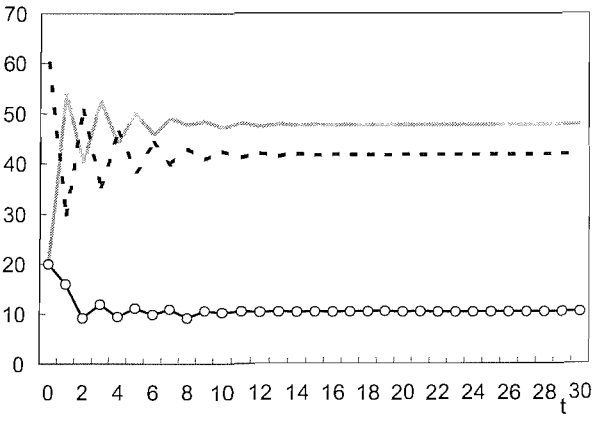
D. With $\vartheta = 0.4$; $q' = 0.4$



E. With $\vartheta = 0.8$; $q' = 0.2$



F. With $\vartheta = 0.7$; $q' = 0.2$



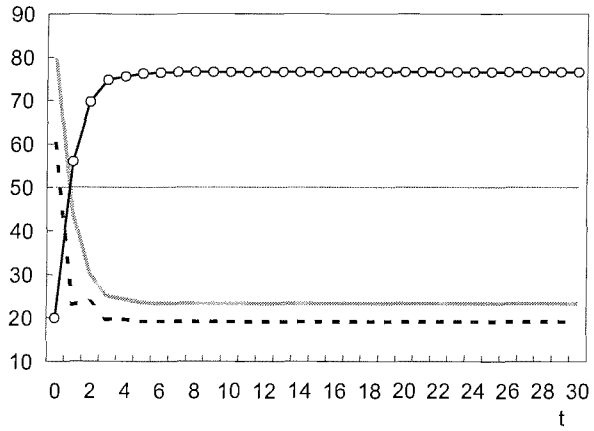
mass in poor class - - mass in middle class —o— mass in rich class

Fig. 2.2

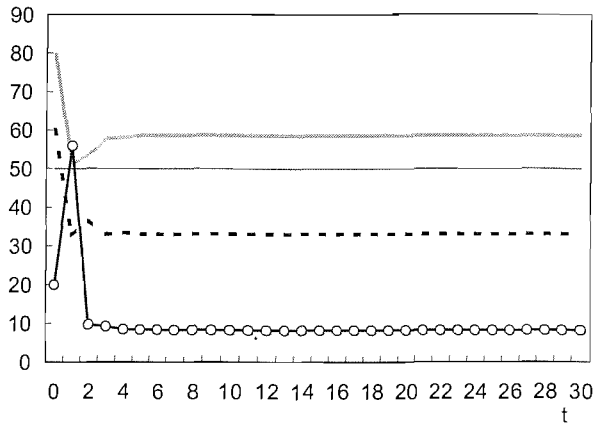
Social mobility with redistribution

With $\psi_0 = [20, 60, 20]$ and $\varsigma_1 = 0.2$ $\varsigma_2 = 0.1$; percentage shares of total population

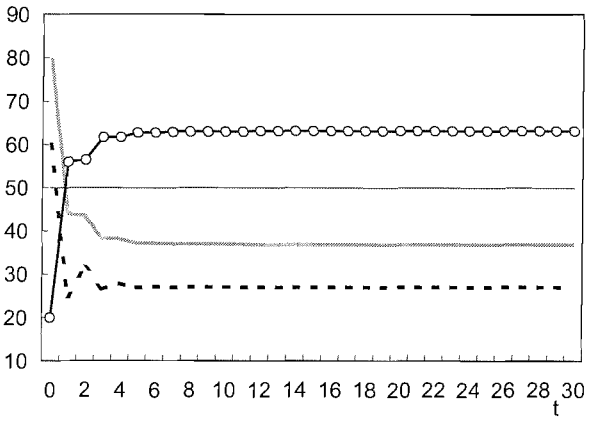
A. With $\vartheta = 0.8$; $q' = 0.8$



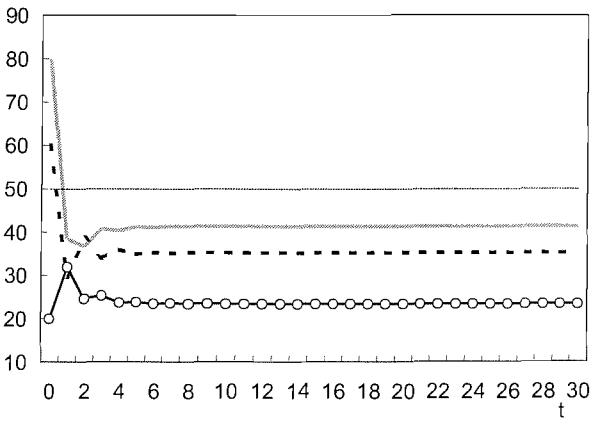
B. With $\vartheta = 0.2$; $q' = 0.2$



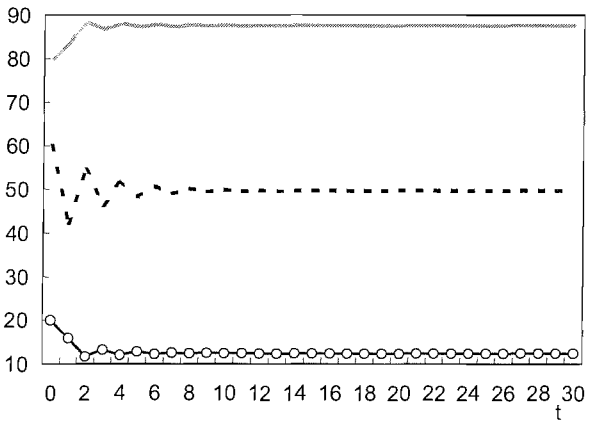
C. With $\vartheta = 0.7$; $q' = 0.7$



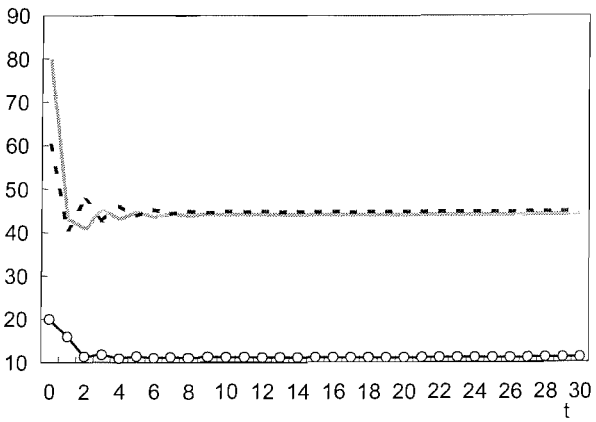
D. With $\vartheta = 0.4$; $q' = 0.4$



E. With $\vartheta = 0.8$; $q' = 0.2$



F. With $\vartheta = 0.7$; $q' = 0.2$



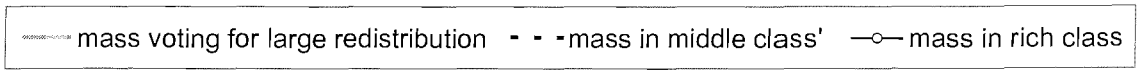
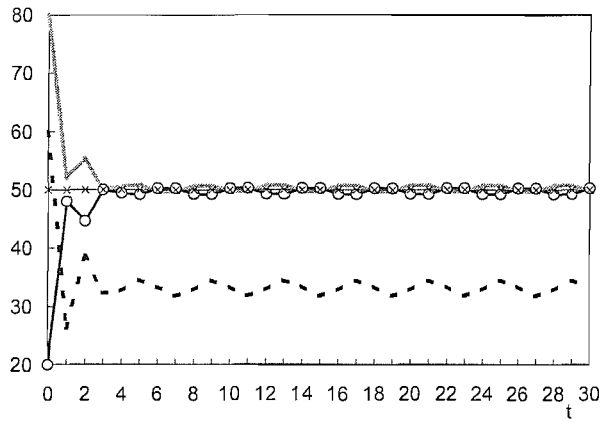


Fig. 2.3

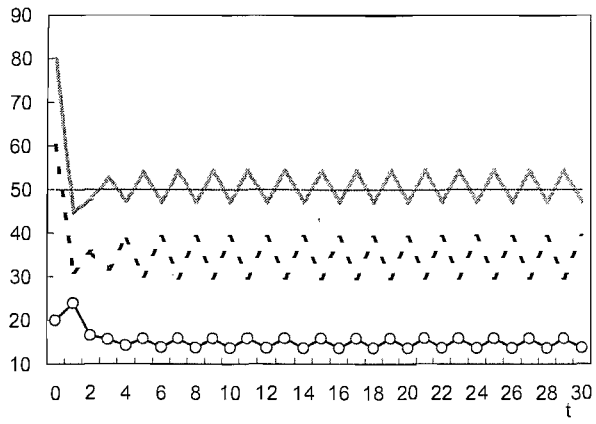
Social mobility and political cycles

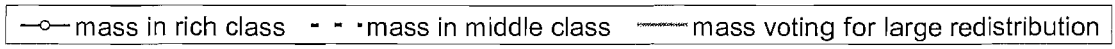
With $\psi_0 = [20, 60, 20]$ and $\varsigma_1 = 0.2$ $\varsigma_2 = 0.1$; percentage shares of total population

A. With $\vartheta = 0.6$, $q' = 0.6$



B. With $\vartheta = 0.3$, $q' = 0.3$

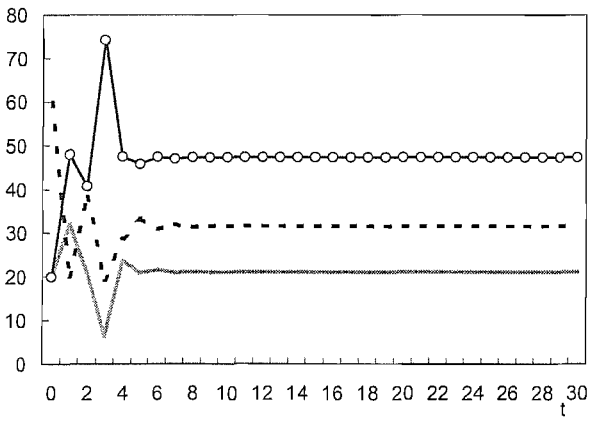




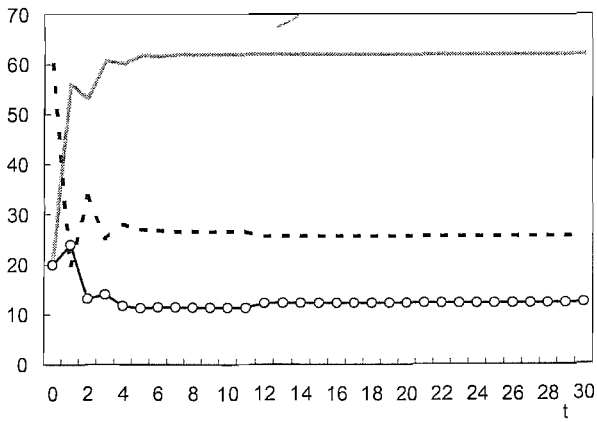
Social mobility in free market

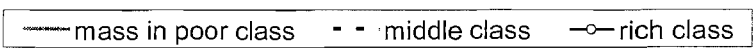
With $\psi_0 = [20, 60, 20]$; percentage shares of total population

C. With $\vartheta = 0.6$, $q' = 0.6$



D. With $\vartheta = 0.3$, $q' = 0.3$





APPENDIX 2A

A1. Existence and parameter dependency of stationary distribution. As from the received theory of stochastic processes, a time-invariant Markov chain admits a unique invariant (or stationary) measure π if $\lim_{n\to\infty} \pi' Q^n = \pi'$, where $\underset{m\times 1}{\pi}$ is a column vector representing the probability of each of the *m* possible states and $\underset{m\times m}{Q^n}$ is a matrix representing the transition probability from one state to another in *n* time period (Stockey-Lucas, 1989). Conditions for stationarity of a Markov chain can easily be checked on the basis of the transition matrix, since they require that each element of Q^n proves strictly positive for some value of $n \geq 1$. With reference to matrices M_F and M_G introduced in the text, it can be immediately verified that these conditions are met with *n=2*; we can then exploit the proof of stationarity to characterise the induced invariant measures in the terms of key parameters.

By transposing $\pi' Q = \pi'$ in $Q'\pi = \pi$, the invariant measure π can be interpreted as the eigenvector associated with the unit eigenvalue of Q' and normalised to satisfy $\Sigma\pi_i = 1$ (Ljunqvist-Sargent, 2000). Representing for simplicity's sake both M_F and M_G by a generic matrix A, with

$$A = \begin{bmatrix} \alpha & \beta & 0 \\ \gamma & \delta & \varepsilon \\ 0 & \nu & \varepsilon \end{bmatrix} \quad \text{and} \quad A' = \begin{bmatrix} \alpha & \gamma & 0 \\ \beta & \delta & \nu \\ 0 & \varepsilon & \varepsilon \end{bmatrix}$$

the invariant measure ψ^* referred to in the text can be obtained by solving the system of three homogeneous equations given by $[A'-I]\,\psi^* = 0$, which is equivalent to

$$\begin{cases} (\alpha-1)\psi_1^* + \gamma\psi_2^* = 0 \\ \beta\psi_1^* + (\delta-1)\psi_2^* + \nu\psi_3^* = 0 \\ \varepsilon\psi_2^* + (\varepsilon-1)\psi_3^* = 0 \end{cases} \text{ or, in view of } \Sigma\psi_i^* = 1, \quad \begin{cases} (\alpha-1)\psi_1^* + \gamma(1-\psi_1^*-\psi_3^*) = 0 \\ \varepsilon(1-\psi_1^*-\psi_3^*) + (\varepsilon-1)\psi_3^* = 0 \\ \psi_2^* = 1-\psi_1^*-\psi_3^* \end{cases}$$

Solutions in terms of parameters q', ϑ and ς_i can eventually be retrieved after proper substitutions in the expressions

$$\psi_1^* = \frac{\gamma(1-\varepsilon)}{(1-\alpha)+\gamma(1-\varepsilon)}, \quad \psi_2^* = \frac{(1-\alpha)(1-\varepsilon)}{(1-\alpha)+\gamma(1-\varepsilon)}, \quad \psi_3^* = \frac{(1-\alpha)\varepsilon}{(1-\alpha)+\gamma(1-\varepsilon)}.$$

A2. Conditions for a stable low redistribution. In view of the characterisation of a stationary distribution, the conditions identified in the text can be rearranged to require either

i) $q'\left[\vartheta\left(1-\underline{\varsigma}\right)+\underline{\varsigma}\right] > 0.5 * \Xi(\underline{\varsigma})$ or

ii) $\left(1-q'\right)^2\left(1-\underline{\varsigma}\right) < 0.5 * \Xi(\underline{\varsigma})$ and $\left(1-\vartheta\right)\left(1-q'\right)\left(1-\underline{\varsigma}\right) > q'\left[\vartheta\left(1-\underline{\varsigma}\right)+\underline{\varsigma}\right]$

with $\Xi(\underline{\varsigma}) = \left(1-\underline{\varsigma}\right)\left[\vartheta+\left(1-q'\right)^2\right]+\underline{\varsigma}$.

A3. Conditions for a stable high redistribution. As before, they can be rearranged to require either

iii) $\left(1-q'\right)^2\left(1-\bar{\varsigma}\right) > 0.5 * \Xi(\bar{\varsigma})$ or

iv) $q'\left[\vartheta\left(1-\bar{\varsigma}\right)+\bar{\varsigma}\right] < 0.5 * \Xi(\bar{\varsigma})$ and $\left(1-\bar{\varsigma}\right)\left(1-\vartheta\right)\left(1-q'\right) \leq q'\left[\vartheta\left(1-\bar{\varsigma}\right)+\bar{\varsigma}\right]$

with $\Xi(\bar{\varsigma}) = \left(1-\bar{\varsigma}\right)\left[\vartheta+\left(1-q'\right)^2\right]+\bar{\varsigma}$.

A4. Conditions for political cycles. They can be split into two sets to be jointly satisfied. The first deals with revisions of initial high redistribution and the second with revisions of initial low redistribution. The former, which represent a combination of complements to conditions A3, requires either

v) $q'\left[\vartheta\left(1-\bar{\varsigma}\right)+\bar{\varsigma}\right] > 0.5 * \Xi(\bar{\varsigma})$ or

vi) $\left(1-q'\right)^2\left(1-\bar{\varsigma}\right) < 0.5 * \Xi(\bar{\varsigma})$ and $\left(1-\bar{\varsigma}\right)\left(1-\vartheta\right)\left(1-q'\right) > q'\left[\vartheta\left(1-\bar{\varsigma}\right)+\bar{\varsigma}\right]$.

The latter, which combines complements to conditions A2, requires either

vii) $\left(1-q'\right)^2\left(1-\underline{\varsigma}\right) > 0.5 * \Xi(\underline{\varsigma})$ or

viii) $q'\left[\vartheta\left(1-\underline{\varsigma}\right)+\underline{\varsigma}\right] < 0.5 * \Xi(\underline{\varsigma})$ and $\left(1-\vartheta\right)\left(1-q'\right)\left(1-\underline{\varsigma}\right) \leq q'\left[\vartheta\left(1-\underline{\varsigma}\right)+\underline{\varsigma}\right]$.

Any combination of conditions v) and vi) from one side and vii) and viii) from the other identifies a subset of parameters' values, which induces cyclical revisions in redistributive policies.

APPENDIX 2B

Equilibrium conditions in the financial sector. Asymmetric information about the effort provided by borrowers in the risky project points to both superiority of indirect versus direct lending and efficiency equivalence between an incentive compatible contract and a standard debt one, with bankruptcy provision. In this respect, the arguments put forward by Diamond (1984) and Williamson (1986) may be easily incorporated in our framework by stressing the role of intermediation in minimising the costs of the information frictions. For simplicity's sake, we skip a formal proof of this tenet, which would require adding costly monitoring in our formal setting[1], and we provide a formal derivation of both an optimal financial contract and credit rationing in equilibrium.

Under the conditions we are going to identify, a possible equilibrium is that the financial intermediary: i) raises the funds required for investing in the risky project by paying lenders the interest factor $A-c$ net of commission; ii) takes over the full property rights on the risky project, by properly compensating the effort exerted by the investor/borrower. Accordingly, the financial contract between the latter and the intermediary identifies a pair of compensations, one in the case of success and one in the case of failure, which meet the individual rationality constraints of both parties and the investor's limited liability constraint. Following Grossman-Hart (1983)[2], the compensation schedule matches a simple form, consisting of a common basis augmented by some bonus in the case of success. We define the common basis as $y \equiv \pi + i_f$, with $\pi = max\{w, Aw-c\}$ the borrower's opportunity cost to invest his initial endowment in the risky project and i_f a quantity to be properly determined; in the case of success an additional bonus $i_s = sr$ is offered to the investor.

Accordingly, the non-negative profit condition for the financial intermediary requires

$$pr + (1-p)\xi - A(1-w) \geq y + pi_s \equiv \pi + i_f + pi_s \tag{1A}$$

where the left hand side measures the expected returns on the risky project, net of the cost of raising the required funds on the credit market, and the right hand side shows the total compensation the intermediary expects to pay the borrower/investor in exchange for the full property rights on the project. Since the left-hand side is increasing with the endowment of investors, the constraint is binding for the intermediary dealing with the poorest of them (hereafter the marginal investors). Should the compensation schedules be valuable all the same regardless of the initial wealth of the investors, the financial intermediary would gain positive profits by targeting the richest of them. Free

[1] Following Freeman (1986), a further heuristic argument for indirect lending would come from the locally increasing returns characterizing the risky investment in the model, motivating lenders to pool.

entry in the financial sector, however, leads to a sort of "Ricardian rent" accruing for the richest opposed to the poorest agents in the middle class, who gain a more valuable compensation schedule. As a result in competitive equilibrium (1A) is binding for all intermediaries. In characterising equilibrium conditions we first identify the compensation schedule offered to the marginal investors, then that offered to the relatively richer ones.

From the intermediary's standpoint, an optimal strategy is to offer the marginal investors the compensation spread that motivates them to the highest effort and then minimise the cost of the failure compensation[3]. In view of expression (10) in the main text, setting $\tilde{s} = \frac{\tilde{b}}{r} \equiv Inf\left\{x \in (0,1) \; s.t. \; x > \frac{b}{r}\right\}$ implies that the marginal borrower will exert the effort required for a success probability q' and the optimal failure compensation follows from:

(2A) $$\max_{i_f} q'\left(r - \tilde{b}\right) + (1-q')\xi - A(1-w) - i_f - \pi$$

such that

$$\pi + i_f \geq 0 \qquad \text{(2Aa)}$$

$$q'\left(r - \tilde{b}\right) + (1-q')\xi - A(1-w) \geq \pi + i_f \qquad \text{(2Ab)}$$

$$q'\tilde{b} + i_f - g(q') \geq \pi + \vartheta n - h(e) \qquad \text{(2Ac)}$$

where the first inequality identifies the investor's limited liability constraint and the remaining two the participation constraints of the intermediary and the borrower, respectively. It is immediately apparent that the intermediary optimal choice is to set a penalty $i_f = -\pi$, should it satisfy the second and third constraint.

Indeed (2Ab) implies that the intermediary participation constraint is met iff $w \geq \underline{w}$ with

(3A) $$\underline{w} = 1 - \frac{q'\left(r - \tilde{b}\right) + (1-q')\xi}{A}$$

Accordingly, people with smaller endowment are restricted to stay out of the credit market and cannot invest in the risky project, although more productive, because of imperfect information about the effort they provide. Indeed, credit rationing occurs in equilibrium for a twofold reason: a) the poorer the borrower, the lower the failure penalty she can afford to pay under the limited liability constraint; b) lending to the poorer is more costly to the intermediary owing to the larger amount of funds to be raised on the credit market to meet the fixed capital investment

---

[2] The variation of risk neutrality we introduce does not change their efficiency results but drops the uniqueness ones.

[3] Indeed the intermediary would like to extract the largest effort provided that $pr(1-s) - \xi \geq 0$; it is easy to check that this condition is always met under the non negative profit condition [11] for lenders dealing with marginal investors.

requirement. Therefore, credit rationing does not hurt at random as in Stiglitz-Weiss (1981) and Williamson (1983) and, as in Aghion-Bolton (1997), people to be rationed are fully identifiable with the poor. In our model $\underline{w}$ identifies the marginal investors and, according to rules of behaviour, the lower bound of the middle class.

With reference to the marginal investor participation constraint (2A*c*), in view of (7) and *Assumption 1* in the main text it may be rearranged as

(4A) $$q\tilde{b} \geq \underline{w} + \vartheta n + bq'$$

Since (5) in the text implies that $\underline{w} + \vartheta n + bq' \leq q'r + (1-q')\xi - A(1-\underline{w})$, a sufficient condition for (4A) to hold is that $q'\left(r - \tilde{b}\right) + (1-q')\xi \geq A(1-\underline{w})$, namely that the intermediary participation constraint is not violated. As a result, the borrower finds it profitable to agree upon the financial contract he is offered: by exchanging the full property rights on the risky project for a compensation equal to zero in the case of failure and to $\tilde{b}$ in the case of success, she will be happy to exert the effort required to achieve a success probability equal to q'.

Turning to richer borrowers, should they be offered the same contract as the marginal ones, financial intermediaries would gain positive profits in dealing with them and free entry would lead the infra-marginal borrowers to gain a positive rent. Since under risk neutrality both investors and intermediaries are indifferent whether this rent is the result of higher compensations in the event of either success or failure, we focus attention on the first case: intermediaries compete by bidding a higher spread s to the investors who require lower funds to be raised on the credit market. Under free entry, competition for attracting the relatively richer customers would raise the spread to the highest level allowed by the intermediary zero profit condition

$$q'r[1-s(w)] + (1-q')\xi = A(1-w)$$

Accordingly, the equilibrium financial contract consists of a pair of compensations $(s(w),0)$, with $s(w) = 1 + \frac{1}{q'r}[(1-q')\xi - A(1-w)]$ identifying the success bonus, which is increasing with the investors' initial endowment. It is easy to prove that this contract, although not the only one that may occur in equilibrium in view of risk neutrality, meets the participation constraint of the richer than poorest borrowers/investors, too.

APPENDIX 2C

In order to preserve a simple social structure over time, in the main text six restrictions on the parameter space have been identified, leading to the following system of equations:

$$
\text{(5A)} \qquad \begin{aligned}
&1. \quad c \geq \underline{w}(A-1) \\
&2a. \quad (1-\delta)\xi \geq \underline{w} \\
&2b. \quad (1-\delta)\xi < 1-(1-\delta)\left[A(\bar{w}-1)-c\right] \\
&3. \quad \tilde{b}(1-\delta) > 1 \\
&4a. \quad n(1-\delta) \geq \underline{w} \\
&4b. \quad (n+\underline{w})(1-\delta) < 1
\end{aligned}
$$

In this section we check for the coherence of the system as a whole and identify the set of sufficient conditions for its solution. We focus on *sufficient* conditions both to simplify algebra and to gauge the minimum admissible variability in parameters' values as a proxy of the highest loss of generality implied by restrictions. Then, conditions could be relaxed to some extents without necessarily violating the requirements for a low dimension stochastic matrix as discussed in the text. To this respect, the number of equations easy reduces to five in view of the following: since (5) in the text implies that $\xi \geq \vartheta n$, the constraint 4a [2a] proves redundant under $\xi \leq n$ [$\xi > n$]. In this section we proceed by taking out constraints 4a, with the results being confirmed, *mutatis mutandis,* if constraint 2a is alternatively dismissed. Moreover, since setting c at its lower bound $\underline{c}$ identified by 1 makes stricter restriction 2b, which would *a fortiori* be satisfied under more general conditions, the system [5A] simplifies to

$$
\text{(5A.a)} \qquad \begin{aligned}
&Ia. \quad (1-\delta)\xi \geq \underline{w} \\
&Ib. \quad (1-\delta)\xi < 1-(1-\delta)\left[A(\bar{w}-1)-\underline{c}\right] \\
&II. \quad \tilde{b}(1-\delta) \geq 1 \\
&III. \quad (n+\underline{w})(1-\delta) < 1
\end{aligned}
$$

Sufficient conditions for *Ib*. From substituting for $\bar{w}=(1-\delta)(r-A-\underline{c})[1-\alpha]^{-1}$, under $\alpha \equiv (1-\delta)A < 1$ and rearranging algebra, we get that $A[\bar{w}-1]-c=[\alpha r - A - c][1-\alpha]^{-1}$. By plugging in the stricter than required condition that $\underline{c} = \underline{w}(A-1)$, substituting for the expression of $\underline{w}$ and rearranging, it results that $A[\bar{w}-1]-\underline{c}=\{1+\alpha r-2A+(1-A^{-1})[q'(r-\tilde{b})-(1-q')\xi]\}(1-\alpha)^{-1}$ or, from the equilibrium conditions on the financial markets (cfr. Appendix B), $A[\bar{w}-1]-\underline{c}=\{1+\alpha r-2A+(1-A^{-1})A(1-w)\}(1-\alpha)^{-1}=\{1+\alpha r-2A+(A-1)(1-w)\}(1-\alpha)^{-1}$. If this entity is not greater than unity, a sufficient condition for the constraint *Ib* is that

$\xi < \delta(1-\delta)^{-1} \equiv \bar{\xi}$. For that to be the case, the strictest requirement reads $\{1+\alpha r - 2A + (A-1)(1-\underline{w})\} \leq 1-\alpha$ or, taking the extreme case of $\underline{w}$ close to zero and rearranging,, $1-\delta \leq (1+A)(1+Ar)^{-1} \equiv \bar{\Delta}$.

Sufficient conditions for *Ia.* From substituting for $\underline{w} = 1-[q'(r-\tilde{b})+(1-q')\xi]A^{-1}$ and rearranging the algebra, the requirement immediately reads as $\xi \geq [A - q'(r-\tilde{b})][A(1-\delta)+(1-q')]^{-1}$. Since equilibrium on financial market implies that $q'(r-\tilde{b}) = A(1-w)-(1-q')\xi$, by taking the strictest case with *w* close to 1 and substituting for the ensuing expression in the previous constraint, we get $\xi \geq A[A(1-\delta)-2(1-q')]^{-1}$, which is always satisfied for non zero values of ξ under negative denominator or $(1-\delta) < 2(1-q')\ A^{-1} \equiv \bar{\bar{\Delta}}$.

Sufficient conditions for *II.* Since $\tilde{b} \equiv b'r$ with $b'>b$, the constraint may be simply restated as $\underline{r} \geq [b'(1-\delta)]^{-1} \equiv \bar{r}$.

Sufficient conditions for *III.* From $(1-\delta) < (n+\underline{w})^{-1} = A[1+nA-A(1-w)]^{-1}$, taking the strictest case of *w=1*, we obtain $(1-\delta) < A[1+nA]^{-1} \equiv \Delta$.

In sum, the system (5A) proves to be coherent as a whole, with sufficient conditions for its solution requiring i) $\xi \in (0,\ \delta[1-\delta]^{-1})$; ii) $(1-\delta) \in \left(0, \min\{\underline{\Delta}, \bar{\bar{\Delta}}, \Delta\}\right)$; iii) $r \geq \bar{r}$. Noticeably, the possibility of reducing it at a three-equation system with six unknowns leaves the parameter space reasonably undetermined despite the assumed restrictions.

APPENDIX 2D

With active government, the investor participation constraint on the financial market requires that $q'(sr-\tau_R)+(1-q')\gamma\varsigma_i - g(q') \geq \vartheta n + \max\{w, Aw-c\} - h(\underline{e}) - \mathrm{T}_{i,\tau}$ or, provided that this condition is met in a free market,

(6A) $$(1-q')\gamma\varsigma_i \geq q'\tau_{i,t}^R - \mathrm{T}_{i,\tau}$$

where $T_{i,t}$ identifies the expected taxation on the reservation payoffs. From the optimal rules for investment outlined in the text, it easy to show that within the middle class $T_{i,t}$ follows the step-wise function

(7A) $$T_{i,t} = \begin{cases} \tau^M & \text{if } \max\{w, Aw-c\} < 1-n \\ \vartheta\tau_{i,t}^R + (1-\vartheta)\tau^M & \text{if } 1-n \leq \max\{w, Aw-c\} < 1 \\ \tau_{i,t}^R & \text{if } \max\{w, Aw-c\} \geq 1 \end{cases}$$

In view of (7A), condition (6A) may be rearranged as follows

$$\begin{cases} \tau_{i,t}^R \leq \dfrac{\tau^M + (1-q')\gamma\varsigma_i}{q'} & \text{if } \max\{w, Aw-c\} < 1-n \\ \tau_{i,t}^R \leq \dfrac{(1-\vartheta)\tau^M + (1-q')\gamma\varsigma_i}{q'-\vartheta} & \text{if } 1-n \leq \max\{w, Aw-c\} < 1 \\ \tau_{i,t}^R \geq -\gamma\varsigma_i & \text{if } \max\{w, Aw-c\} \geq 1 \end{cases}$$

It turns out that the establishment of a redistributive programme does not at all affect the original incentive to invest in the upper bound of the middle class and, *a fortiori*, of the rich class as a whole. It could exert a negative impact in the middle range and, to greater extent, in the lower bound of middle class. In order to rule out at all distortionary effects of taxation, we need conditions to hold for $\tau^R \leq \bar{\tau} \equiv \dfrac{\tau^M + (1-q')\gamma\bar{\varsigma}}{q'}$.

CHAPTER 3

PERSONAL SAVING AND SOCIAL SECURITY IN ITALY: FRESH EVIDENCE FROM A TIME SERIES ANALYSIS

The effect of public transfers, social security in particular, on private wealth accumulation has long been the subject of a large body of literature, both theoretical and empirical. Comprehensive analysis is complex, but the prevailing approach has been centered upon the idea, espoused by the life cycle model since the seminal contribution of Modigliani-Brumberg (1954), that the need to finance consumption after retirement is the main motivation for personal saving. The major implication was that mandatory contributions to social security would fully offset households' voluntary savings, with a potential impact on social welfare[1]. This result is soundly proved in an overlapping generation framework under certainty, rigid factor supply and negligible altruism; it is fraught with difficulties in a more general set-up. In this respect, the main drawbacks stressed in the literature may be summarized in the following points, which are stated under the assumption of a pay-as-you-go social security scheme:

i) if current generations feel altruistic with their offspring, who are eventually called upon to finance the current payouts, the introduction of the social security system may lead to increased private saving in order to augment intergenerational transfers (Barro, 1978);

ii) elastic labor supply would imply the establishment of a social security system to induce earlier retirement, therefore leading people to increase savings in working age in order to finance consumption over a longer retirement period (Feldstein, 1974 and Munnel, 1974). Moreover, if contributions and benefits are

[1] An extensive welfare analysis is not in the reach of the paper (for references and discussion, see Blanchard and Fisher, 1989 and Diamond, 1997). It is important to recall, however, that a key role is played by the magnitude of the corresponding change in national saving, for which the funding status of the social security system would matter. The expected sign of this change would be negative under a pay-as-you-go scheme, since the reduction in personal saving would not be offset, *ceteris paribus*, by an increase in public saving; the opposite holds true under a fully funded scheme. But this point is controversial if bequest motives are operative (for a full appraisal, see Seater, 1993).

imperfectly linked, the resulting change in effective tax on labor could affect its supply, which would in turn impact on personal saving (Feldstein-Samwick, 1992);

iii) credit market imperfections reduce the relevance of the life cycle motive for saving, with borrowing constraints limiting the extent to which social security crowds out private savings (Diamond-Hausman, 1984 and Dicks Mireaux-King, 1984). The same holds true when annuity market imperfections prevent a fair assessment of the wealth effects related to social security (Bernheim, 1987);

iv) under uncertain longevity and income, an additional reason why social security may induce lower personal saving is a diminished motive for precautionary saving (Kotlikoff *et* al. 1987 and Hubbard *et* al. 1995). However, this effect would prove smaller if uncertainty surrounded both the financial sustainability of the social security system itself and its impact on the households' economic status in retirement (Carroll-Samwick, 1992 and Bernheim, 1995);

v) lack of economic literacy and mental accounts for different assets may limit the extent of offset between pension and non-pension wealth (Bernheim, 1997 and Thaler, 1994); a similar prediction comes from hyperbolic discounting (Laibson, 1996), and in this case social security would prove to be a commitment technology for workers to raise enough saving for their own retirement. This would reinforce the psychological argument first put forth by Katona (1965), whereby social security may increase personal saving by inducing a higher preference for saving on the part of otherwise very impatient households[2].

In view of the inconclusive results of theoretical models, empirical analysis has gained a key role in predicting the impact of social security on private savings. However, disagreement arises in this field too, with a variety of conclusions coming from different data set and econometric methods since the first contribution by Feldstein (1974). In line with the theoretical debate, attention has focused on the size of the offset between pension and non-pension wealth in consumption demand. The results have shown great variability, with high sensitivity to measurement errors

[2] While deviation from rational behavior with foresight augments complexity in theoretical models of social security and saving, some irrationality in households' decisions helps to explain the very existence of a social security system in modern economies (Kotlikoff, 1987). The evidence that a substantial part of households reach retirement with a very low stock of net financial assets (Poterba *et* al., 1994) may provide some support.

of social security wealth and to the aggregation level in data (Modigliani, 1986, Castellino-Fornero, 1990 and Engel-Gale, 1999).

With respect to the Italian economy, the empirical literature was started by Brugiavini (1987) and built up over the nineties, in view of an increasing debate on the need for major reform of the domestic social security system. Like the evidence collected in other countries, a lack of consensus has arisen as to the size of the replacement effect between pension and other wealth for Italian households. In Rossi-Visco (1995) and Beltrametti-Croce (1997), aggregate time series analysis shows high values of the offset between pension and non-pension wealth, with estimates around respectively 0.7 and 1.0 for the period 1954-1993. This value does not exceed 0.2 in Brugiavini (1991) and Jappelli (1995) as a result of cross section analysis based on the micro data provided by the Bank of Italy Survey on Household Income and Wealth (SHIW, respectively for the years 1985 and 1989-91). Finally, Favero *et* al. (1994) rejected any significant role of pensions in determining consumers' behaviour in Italy, on the basis of the same aggregate data set as in Rossi-Visco but following a VAR specification of the statistical model.

In this paper we adopt the time series approach followed in Rossi-Visco, with the purpose of providing fresh evidence on the effects on personal savings of the social security reforms passed in 1992 and 1995 (Bank of Italy, 1995). The main motivation is to investigate the extent to which the changed set-up of social security, both actual and expected, explains the prolonged weakness of private consumption, following the financial crisis of the early nineties. In addition, the recent, sizeable switch in Italian households' portfolios from Treasury paper to equities and investment funds provides the opportunity to test the importance of capital gains in affecting aggregate consumption and saving behavior. The intensity of the latter's response to major demographic trends is a further issue addressed in the paper.

In view of the aggregate level of our empirical analysis, a major subject we neglect is the size of distributive effects that may stem from both pension reforms and changes in portfolio allocation, and their impact on consumption demand. Future research to validate our time series evidence on the basis of micro data would be well worthwhile. For the time being, the only micro data base available for Italian household comes from a biannual survey conducted by the Bank of Italy. Owing to the relative short period since the survey have started in 1987, this

data set does not allow to take account of both the reforms of the Italian pension system occurred in previous years and the changes in demographics, which show effect over the medium run. For these reasons, we have preferred to work with time series analysis, by reconstructing by ourselves most data back to 1951.

The paper is organized in seven remaining sections. In sections 2 and 3 we briefly comment on measurement issues and recent trends in the major variables we consider in the analysis of consumption demand. In the fourth we outline the empirical model, which we estimate in an error-correction representation in the fifth section. In the sixth a plausible interpretation of the empirical findings is suggested and in the following section structural changes in households' expenditure are detected in view of the recent reforms of Italian pension system. Section 8 concludes, summarizing the main results.

3.1 The data set

Substantial statistical work was required to identify and estimate measures for some key variables covering the whole sample period from 1951 to 1998. In this section we briefly address some measurement issues; more details about computational procedures are reported in the appendix.

The greatest difficulties involve social security wealth. The measure first computed by Beltrametti (1995) for the years 1951-1993 has been revised and updated from 1989 up to 1998 on the basis of preliminary estimates from a micro-model of Italian economy as in Ando-Nicoletti (1999) and Ando et al. (1999)[3]. The main rationale is that microanalysis enables us to take full account of the diversified effects, across cohorts and occupations, of the major reforms of the pension system in 1992 and 1995. Moreover, it may incorporate the ensuing revision in households' expectations affecting key choices, especially the age of retirement.

In this respect, the growing debate on the sustainability of the social security system since the later eighties might have changed Italian households'

[3] In both cases the data set comes from the Bank of Italy survey of household income and wealth (SHIW).

expectations about future benefits, and then their decision as to labor market participation, before the actual passage of the reforms[4,5].

Indeed, retirement age is considered to be determined by law in the computations of Beltrametti, and it may endogenously prove to be higher in the micro model estimates. It is mainly this feature that explains why the latter show a declining trend before 1992, when the so-called "Amato reform" took eventually place. In advocating the need to take the variety of factors working at a micro level into account - especially in the recent institutional set-up, featuring a stratification of rules for computing pension benefits - we nevertheless acknowledge some arbitrariness in the specific measures we computed[6]. In any case, our main claim focuses on the *timing* of the new regime in expected pensions, which, as far as consumption behavior is concerned, may have started prior to the reforms themselves, exerting effects on households' expenditure that might be empirically important.

Capital gains have been estimated separately for dwellings, bonds and equities. For each component, the magnitude of revaluation has been computed on a yearly basis, by applying the changes of a price index each year to the value of the relevant stock at the end of previous year. An alternative measure, given by the difference between total changes in the value of stock and the "out of pocket" saving (Horioka, 1996), was dismissed because of the resulting extreme volatility in capital gains of Italian households, much larger than that which we discuss in the next section.

In respect to the coverage of the household sector and the definition of both private consumption and some components of disposable income, the accounting scheme used is ESA79, since time series consistent with ESA95 were

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[4] As evidence of the early debate about the need for pension reform, the failure to get it passed is acknowledged by Guido Carli as one of the major objectives as Minister of the Treasury between 1989 and 1992 (Carli, 1993).

[5] A decline in the expected ratio of benefits to income at retirement was registered in the 1989 and 1991 waves of the SHIW, which explicitly polled Italian households on this subject (Bank of Italy, 1989 and 1991). According to Jappelli (1995), between 1989 and 1991 the expected ratio declined on average by four percentage points, to a value around 0.75; interestingly, he also found a negative change in the actual ratio.

[6] We discuss this issue in the appendix. More generally, endemic problems limiting the quality of measures of pension wealth within the empirical analysis of consumption are addressed in Leimer-Lesnoy (1982) and Gale (1998).

not available when we completed the study. Therefore, we do not take into account the major revisions of some key macro-variables effected in the last few years (Istat, 1998 and Bank of Italy, 1999).

3.2 Recent trends in some key macro-variables

According to the ESA79 national accounts, Italian households' propensity to save fluctuated around the highest found in all industrial countries until the eighties. Since then, it has shown a declining trend, more pronounced in the nineties. In fifteen years, it fell by more than 12 percentage points, to under 12 per cent in 1998 (Fig. 3.1)[7].

Taking account of durables and the loss in purchasing power of net assets due to expected inflation, the decline in the propensity to save began earlier, in the late seventies, and came to a halt in the second half of the nineties: since 1995 there is a clear upward trend.

In recent years the widening gap between the adjusted and unadjusted measures of the saving rate is due mainly to the rapid decline in inflation and, to a lesser extent, to the fall in long-term interest rates (Fig. 3.5), which affect the computation of the durable goods' usage costs. Saving rates show a considerable volatility when the measure of disposable income includes capital gains, closely tracking the latter's erratic developments.

This symmetric movement indicates a rather low propensity to consume out of capital gains, arguably because of the great uncertainty over their magnitude. Between 1994 and 1998 the ratio of capital gains to the national accounts' measure of disposable income[8] climbed by 30 percentage points, after a drop of 10 percentage points in 1993 (40 in the previous five years).

Moreover the composition of total capital gains changes dramatically: the share of real estate falls virtually to zero in the last five years after accounting for

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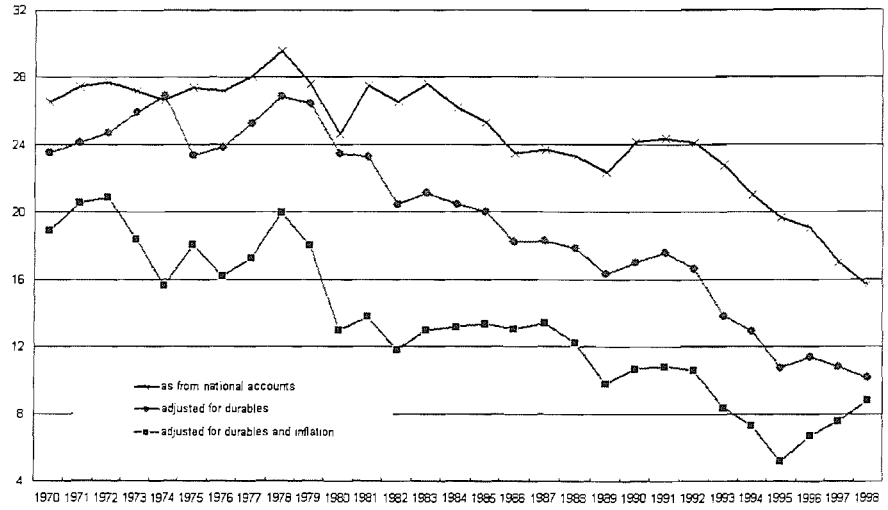
[7] According to preliminary estimates based on ESA95, between 1983 and 1999 households' propensity to save dropped from above 28 per cent to 14.2 per cent (Bank of Italy, 2000a).

[8] In the old ESA79 capital gains are recorded in the capital accounts, in the subsection of revaluation of net assets, and do not enter in the computation of income. In the new ESA95 system, the share of capital gains coming form capitalization of interest and dividend payments contribute to disposable income.

nearly all of them over the previous decade. This may have played a role in increasing uncertainty over capital gains, checking households' propensity to consume out of them[9].

Fig. 3.1

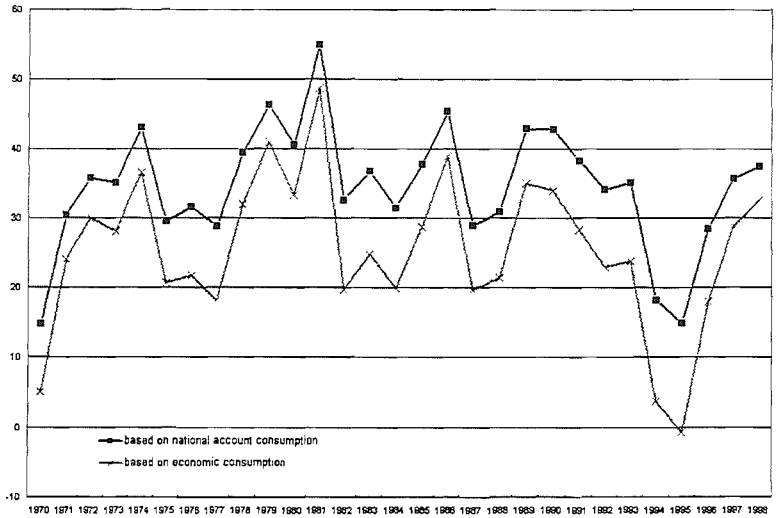
HOUSEHOLD SAVING RATE
(percentage values)



Source: Based on Istat data.

Fig. 3.2

ADJUSTED HOUSEHOLD SAVING RATE
(adjusted for inflation and capital gains; percentage values)



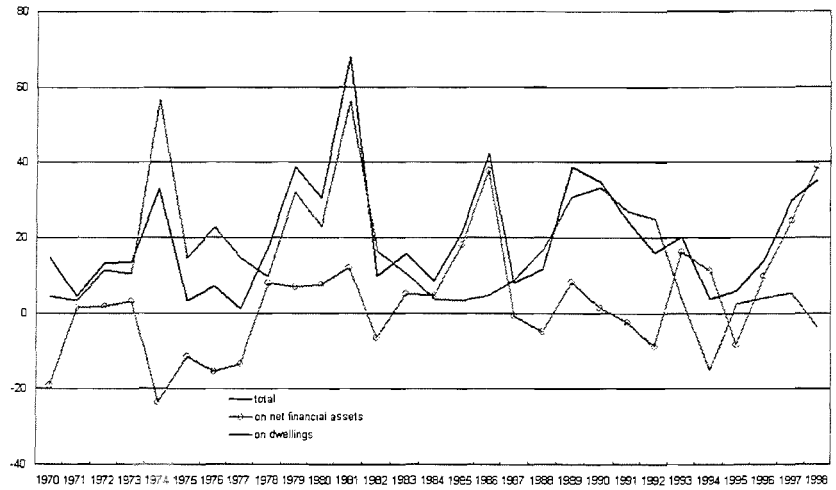
Source: See Appendix.

[9] An additional factor limiting the impact of capital gains on aggregate consumption may relate to distributive issues, in view of the greater concentration in holdings of equities and investment funds than of government bonds among Italian households (Bank of Italy, 2000b).

The ratio of total wealth to income rose until the late eighties, mainly driven by the social security component. Since then, the clear decline in this component has reversed the tendency of the overall ratio, offsetting the increased accumulation of net financial assets.

Fig. 3.3

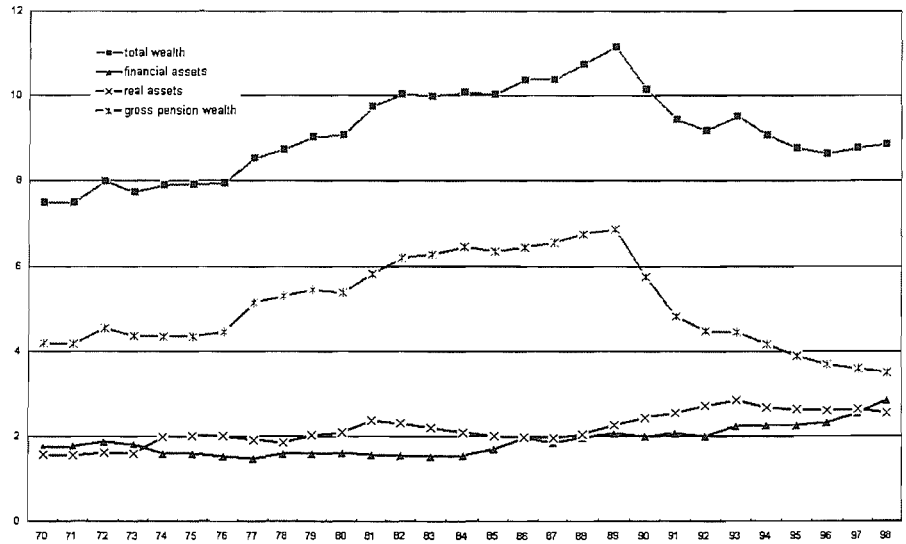
RATIO OF HOUSEHOLD CAPITAL GAINS TO DISPOSABLE INCOME
(percentage values)



Source: See Appendix.

Fig. 3.4

RATIO OF HOUSEHOLDS' WEALTH TO DISPOSABLE INCOME



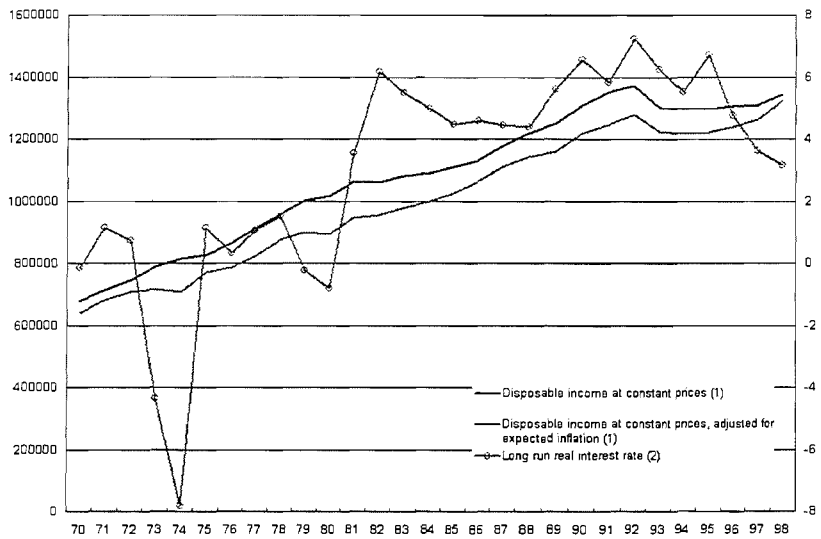
Source: See Appendix.

Going by the measures we adopted, social security wealth declined, in levels, by around 25 per cent over the decade of the nineties (Fig. A1 in Appendix). Noticeable, the reduction in the ratio of pension wealth to disposable income between 1989 and 1991 is amplified by the acceleration of the latter variable, which registered average annual growth of around 4 per cent in that period (Fig. 3.5).

In the presence of positive stock-flow adjustments following the sharp revaluation of equities and bonds, between 1992 and 1998 the ratio of financial assets to disposable income increased by one percentage point, to 3 per cent. In the same period, the incidence of the stock of real assets, which includes durable goods, registered a slight reduction.

Fig. 3.5

HOUSEHOLD DISPOSABLE INCOME AND REAL INTEREST RATES
(Lira at 1995 prices and percentage values)



Source: See Appendix.
(1) Left hand scale (2) Right hand scale.

Disposable income, adjusted to account for losses in purchasing power of net assets due to expected inflation, did not recover the huge drop registered during the recession of 1992-93 until the late nineties. The average for the decade was thus about the same as in the late eighties.

3.3 The empirical model

In this section, we sketch the theoretical foundations of the empirical model, which hinges on the standard life cycle approach extended to cover social security effects (Feldstein, 1974). Following the seminal contribution of Modigliani-Brumberg (1954), under conditions of regularity in the preferences of household groups, the aggregate consumption function may be linearized as follows

[1] $$c_t = \alpha y_t^l + \delta w_t ,$$

where c_t is the flow of goods and services consumed in period t, y_t^l is labor income after taxes (as approximation of the annuity coming from human capital) and w_t is the stock of wealth at the end of period. Parameters α and δ generally depend on a variety of factors, notably the age composition of the population and the length of different stages in life (Ando-Modigliani, 1963). In order to discuss the role of social security empirically, total wealth is split into net real and financial assets (w_t^r) and a social security component (w_t^s), namely the expected discounted flow of pension payments accruing to both current and future retirees. In particular, taking account of the possibility of imperfect substitution between the two components (Feldstein, 1974), the total wealth entering the consumption function is given by the sum

[2] $$w_t = w_t^r + \xi w_t^s$$

with ξ measuring the degree of substitutability between pension payments and the real and financial assets in sustaining households' purchasing power. In line with theory (Williamson-Jones, 1983 e Carroll-Samwick, 1992), values for this parameter significantly lower than one may signal uncertain expectations by households as to the future evolution of social security payments. But the value of this parameter is affected by the inclusion of current transfers in the measure of disposable income, which is computed gross of these transfers and net of social contributions according

to the national accounts[10]. In order to avoid this problem of *double counting,* here we take social security wealth gross of social contributions and disposable income net of current transfers (y_t^s).

In view of the national accounts' definition of households' disposable income y_t^d as the sum of labor and capital incomes after taxes (including social contributions) and transfers, namely $y_t^d = y_t^l + r_t w_t^r + y_t^s \equiv y_t^p + y_t^s$, labor income may be defined by $y_t^l = y_t^p - r_t w_t^r$. From (1), gross saving is then given by the following

$$[3] \qquad s_t \equiv y_t^d - c_t = y_t^p + y_t^s - \alpha(y_t^p - r_t w_t^r) - \delta(w_t^r + \xi w_t^s)$$

From this, it results that

$$[4] \qquad -\log(c_t / y_t^p) \approx \frac{s_t - y_t^s}{y_t^p} = (1-\alpha) - (\delta - \alpha r_t)\omega_t^r - \delta\xi\omega_t^s,$$

where $\omega = w / y^p$.

Allowing for a flexible representation of the parameter δ as a function of the real interest rate R and the growth rate of national income g (Modigliani-Brumberg, 1980) and expanding around *steady state* values of ω^s, ω^r, R and g (Rossi-Visco, 1995), the empirical model reads

$$[5] \qquad \log(c_t) = const + \psi_o \log(y_t^p) + \psi_1 g_t + \psi_2 r_t + \psi_3(\omega_t^r + \vartheta\omega_t^s),$$

[10] Whereas current transfers are included also in the computation of social security wealth, it is possible to show that the parameter ξ is expected to be higher than one (Williamson-Jones, 1983). An extensive discussion of the implications of this issue for the right specification of the statistical model is in Favero et al. (1994) and in Rossi-Visco (1995).

where $\vartheta(\alpha,\delta,r,g) > \xi$ approximates the coefficient of substitution between gross social security wealth and net real and financial assets.

In this setup the assumption of homogeneity in the *steady state* of consumption plans and total household resources, which is theoretically desirable for dealing with aggregation since it rules out scale factors in the individual household's optimal choices (Modigliani-Brumberg, 1954 e Ando-Modigliani, 1963), is realized with a value of one for the parameter ψ_0. With reference to an interpretation of the coefficients of the two wealth components, they are a combination of the propensities to consume out of the single component and income[11].

3.4 The estimated consumption function[12]

A preliminary stationarity analysis has been performed for the following variables, valued in real terms: a) logarithm of households' consumption expenditure adjusted for durables (LC); b) disposable income (LYP), net of pension payments and adjusted for losses of purchasing power of net financial assets due to expected inflation; c) ratio of real and financial assets to disposable income (WYP); d) ratio of social security wealth to disposable income (WSSY); e) long-term interest rate (R).

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[11] An immediate proof can be derived from a simplified version of the life cycle model $c_t = \alpha W_t + \beta y_t$, which implies $c_t = \beta y_t[1+(\alpha/\beta)(W_t/y_t)]$. Taking logs, under the reasonable assumption of a small value for the term added to unity in the square bracket, we get a specification quite similar to that considered in the text, $\log c_t \approx \text{constant} + \log y_t + \gamma\omega_t$, with $\gamma = \alpha/\beta$. Accordingly, ruling out measurement errors in life-long income, the intercept would approximate the propensity to consume out of income in a logarithmic specification of households' demand. As to the wealth variables, their normalization with respect to income allows for controlling the effects of *common trend* and, as is pointed out in Muellbauer-Lattimore (1995), for properly decomposing the total impact of wealth on consumption in the distinct contributions coming from different components of wealth.

[12] The results reported in this section are mostly based on the Microfit 4.0 package (Pesaran-Pesaran, 1997).

As from Tables A1a-c in Appendix, for variables LC, LYP and WYP, which all show a positive drift, the augmented Dickey-Fuller tests have definitely not rejected the null hypothesis of unit root at a confidence level of 95 per cent. The same result, although to a narrower extent, holds true for variable R, which does not follow a deterministic trend (Table A1d), and for variable WSSY (Table A1e). As to the latter, the Phillips-Perron (1988) test with semi-parametric correction has also been performed, confirming the non-rejection of unit root (table A1f)[13].

In view of the reduced power of the ADF test under structural change (Campos-Ericsson-Hendry, 1996), we have additionally explored non-stationarity of WSSY by controlling for changes in both level and growth rate. According to properly revised critical values (Model C in Perron, 1989), the null hypothesis of unit root cannot be rejected against the alternative of a break in the deterministic component, starting from 1989 (Table A1g).

Following the evidence of non-stationarity, we tested for co-integration among LC, LYP, WYP, WSSY and R to identify, according to the usual interpretation first put forward by Engle-Granger (1987), their relationship in the long run equilibrium. We follow the multivariate, maximum likelihood method of Johansen (1988), which we have applied to the full and restricted samples in order to test robustness of the cointegration rank. Consumption and income are considered in isolation in order not to impose the restriction of their homogeneity, which has been tested separately. In line with stationary first differences of the five variables, all of which show a deterministic trend in levels, but the real interest rate R, a time trend in the long-run relationships has been excluded, with an intercept included. In this context, some conditioning variables have been considered, namely the first difference of the logarithm of government consumption (DZ) and the changes in population share of old people (65 and over, DPO)[14]. The former may summarize the effect of fiscal policy stance as in Rossi-Visco (1995), while the latter should take account of the demographic transformation, which has been more pronounced

[13] The *t*-statistics in this table compare with the critical values for ADF test in previous tables.

[14] For both variables in level, the ADF test does not reject the hypothesis of unit root at a confidence level of 95 per cent. The same holds for life expectancy at birth (ASP).

in the last two decades[15]. It is interesting to note that although the role of changes in demographic structure has been well understood in the life cycle model since Modigliani-Brumberg (1954), it is rarely controlled for explicitly in time series analysis of consumption[16].

Table 3.1

TEST STATISTICS AND CRITERIA FOR SELECTING THE ORDER OF THE VAR MODEL

Based on 44 observations from 1955 to 1998. Order of VAR = 4
List of variables included in the unrestricted VAR: LC LYP WYP WSSY
List of deterministic and/or exogenous variables: DPO DZ

Order	LL	AIC	SBC	LR test	Adjusted LR test
4	279.7819	207.7819	143.5511	------	------
3	266.6148	210.6148	160.6575	CHSQ(16)= 26.3342	15.5611
2	256.7761	216.7761	181.0923	CHSQ(32)= 46.0116	27.1887
1	247.5225	223.5225	202.1123	CHSQ(48)= 64.5188	38.1247
0	-167.3560	-175.3560	-182.4927	CHSQ(64)= 894.2758	528.4357

AIC=Akaike Information Criterion SBC=Schwarz Bayesian Criterion

The criteria for selecting the order p of the VAR mostly pointed to a parsimonious specification, with p=1 (Table 3.1). This option, which is convenient in view of the limited sample size, was validated by diagnostic control on the residuals of each single equation of the VAR(1), which does not signal evidence of misspecification. The co-integration rank proved equal to 1 with a confidence level of 95 per cent for both the trace and the maximal eingenvalue tests (Table 3.2), with signs of stability over time[17].

[15] An additional demographic variable has also been considered, namely the first difference in life expectancy at birth (DASP), without any appreciable changes in the results; moreover, the robustness of the cointegration rank proves less sound when this variable is substituted for DPO.

[16] A detailed discussion of parameter instability following demographic change is in Auerbach-Kotlikoff (1983). As to the measures we considered, namely ASP and PO, when they are included in the set of co-integrating variables, either jointly or separately, their coefficients show a very low level of significance. Contrary to the evidence reported in Cigno-Rosati (1996), in our case demographic changes seem not to be determined simultaneously with the economic variables entering the long-run consumption function.

[17] This result is attained by progressively restricting the final year from 1998 to 1990. Robustness extends to the order of the VAR, since the evidence of a single co-integrating vector is confirmed for p=2 and p=3.

Table 3.2

COINTEGRATION TESTS
(with restricted intercepts and no trends in the VAR)

47 observations from 1952 to 1998. Order of VAR = 1.
List of variables included in the cointegrating vector:
LC LYP WYP WSSY Intercept
List of I(0) variables included in the VAR: DPO DZ
List of eigenvalues in descending order:
.70793 .26928 .14747 .032734 0.00

LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	57.8455	28.27	25.80
r<= 1	r = 2	14.7452	22.04	19.86
r<= 2	r = 3	7.4987	15.87	13.81

LR Test Based on Trace of the Stochastic Matrix

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	81.6536	53.48	49.95
r<= 1	r>= 2	23.8080	34.87	31.93
r<= 2	r>= 3	9.0629	20.18	17.88

With reference to the values of the coefficients of the sole cointegrating vector, the maximum likelihood estimates have been compared with those deriving from univariate approaches, both in the static version of Engle-Granger (1987) and in the dynamic versions of Stock-Watson (1993) and Pesaran-Shin (1995).

As a common result, the role of the real interest rate in determining the expenditure of Italian households proves negligible in the long run. This is probably because the substitution and income effects almost offset one another, as the latter is bolstered by the traditionally high share of Treasury bonds held by Italian households[18]. In view of this evidence, which is in line with previous analysis (Rossi-Visco, 1995), the variable *R* has not been reported in the tables we present.

One important finding is the sizeable discrepancy in the point estimates for coefficients of WYP and WSSY, which signals a much stronger influence of real and financial assets than of social security wealth on the long-run equilibrium in consumption plans. This evidence, which is confirmed by estimates deriving from the univariate approach (Tables A2a-c in Appendix), is weaker under restricted

[18] The coefficient of *R* was negative but not significant at both 95 and 90 per cent levels.

samples. Taking, for comparability, the same period as in Rossi-Visco, 1952 to 1993, the broad equivalence they found in the effects of the two wealth components is confirmed, although at higher values for the coefficients (Table 3.3, column B).

Table 3.3

ML ESTIMATES SUBJECT TO EXACTLY IDENTIFYING RESTRICTION(S)
ESTIMATES OF RESTRICTED COINTEGRATING RELATIONS
(restricted intercepts and no trends in the VAR; S.E.'s in brackets)

Order of VAR = 1, chosen r =1. List of I(0) variables included in the VAR: DPO DZ
List of imposed restriction(s) on cointegrating vectors: a1=-1. 47 observations from 1952 to 1998

	A		B
LC	-1.0000		-1.0000
LYP	.85593	(.073940)	.77448
(.054642)			
WYP	.06148	(.030992)	.056429
(.023743)			
WSSY	.027035	(.010295)	.046393
(.0094723)			
Intercept	1.5853	(.83063)	2.5502
(.64317)			

A: 47 observations from 1952 to 1998 B: 42 observations from 1952 to 1993

This finding is more extensively discussed in sections that follow. At this point, it is also worth mentioning the test for the significance of social security wealth, which has occasionally proven problematic in the literature (Favero et al., 1994). In our case, evidence based on the LR test clearly supports a coefficient significantly different from zero for variable WSSY (Table 3.4, column B)[19].

With reference to income, the LR test does not reject the assumption of long-run homogeneity between consumption and income at a confidence level of 95 per cent. But the point estimate of the coefficient of disposable income is lower than in previous studies and, under the multivariate approach, shows signs of decline in the nineties. In line with Miniaci-Weber (1998), we can trace this result to set of factors that, in addition to pension reforms, combined to likely reduce households' measure of permanent income since the recession in 1992-93. They include higher

[19] A similar result, not reported in the table, applies to coefficient of WYP, too.

taxation of the self-employment income and stricter job and wage control in the public sector.

Table 3.4

ML ESTIMATES SUBJECT TO OVER-IDENTIFYING RESTRICTION(S)
ESTIMATES OF RESTRICTED COINTEGRATING RELATIONS
(restricted intercepts and no trends in the VAR; S.E.'s in brackets)

Order of VAR = 1, chosen r =1. 47 observations from 1952 to 1998.
List of I(0) variables included in the VAR: DPO DZ

List of imposed restriction(s) on cointegrating vectors

	(A) a1=-1; a2=1		(B) a1=-1; a4=0	
LC	-1.0000	(*NONE*)	-1.0000	(*NONE*)
LYP	1.0000	(*NONE*)	1.0525	(.062732)
WYP	-.4048E-3	(.032685)	-.019516	(.053893)
WSSY	.011160	(.0072457)	0.00	(*NONE*)
Intercept	.091036	(.18551)	-.43103	(.64679)

LR Test of Restrictions

CSHQ(1)= 2.4308
CHSQ(1)=4.1545

Following the identification of a single co-integrating vector, the error correction representation has been estimated to characterize the adjustment process of consumption demand towards its long run equilibrium (Table 3.5).

In this context the set of regressors has been enlarged to include, not only the conditioning variables considered in the co-integration analysis, but also the ratio of capital gains to disposable income and a measure of uncertainty[20]. As in Muellbauer (1994), the latter is computed as the absolute value of deviations of the income growth rate from trend at any period, with trend in turn being approximated by the average growth rate in the previous five periods, i.e. $UNC_t = \left| dLYP_t - "trend" \right|$. Finally an exogeneity analysis is performed to check if the likely occurrence of

[20] The specification of the statistical model proceeds from the general to the specific, by progressive reductions starting from an initial setting in which lags up to second order are considered for each variable.

measurement errors and simultaneity bias may have caused a violation of the orthogonality assumption of regressors and disturbances.

In particular, the Wu-Hausman procedure has been implemented for variables LYP, R, WSSY and UNC to test for zero coefficients in the consumption function of the residuals derived by regressing each of the four variables on lags of themselves and consumption (Table A3 in Appendix). Since the test supports the assumption of exogeneity, the evidence validates the consistency of the OLS estimates and precludes the need for instrumental variables.

Table 3.5

OLS ESTIMATION OF ERROR CORRECTION REPRESENTATION
(White heteroscedasticity adjusted S.E.' in brackets)

Dependent variable is DLC; 45 observations used from 1954 to 1998
ECM=-1.0*LC+0.856*LYP+0.061*WYP+0.027*WSSY+1.585

Regressor	Coefficient	S. E.	T-Ratio	Regressor	Coefficient	S. E.	T-
DLC(-1)	0.376	0.095	3.949	DPO	0.039	0.009	4.30
DLC(-2)	-0.248	0.098	-2.534	DPO(-2)	0.021	0.011	1.93
DLYP	0.318	0.067	4.772	DASP	-0.042	0.011	-
DZ	-0.159	0.052	-3.072	DASP(-2)	0.037	0.015	2.50
DZ(-1)	0.119	0.036	3.257	DWSSY	0.009	0.004	2.18
DR	0.149	0.062	2.410	DWSSY(-1)	0.007	0.004	1.90
DR(-1)	-0.126	0.056	-2.235	ECM(-1)	0.132	0.043	3.05
UNC	-0.002	0.001	-2.908				

R-Squared 0.8998; R-Bar-Squared 0.8531; S.E. of Regression 0.0079; F-stat. F(14, 30) 19.2522
Residual Sum of Squares 0.0019; DW-statistic 1.7364

Test Statistics	LM Version	F Version
Serial Correlation	CHSQ(1)=0.99182	F(1,29)=0.65358
Functional Form	CHSQ(1)=0.72701	F(1,29)= 0.47621
Normality	CHSQ(2)=0.77192	-
Heteroscedasticity	CHSQ(1)=0.98531	F(1,43)= 0.9626
Predictive Failure (*)	CHSQ(3)= 4.6257	F(3, 27)= 1.5419

(*) Chow's second test based on a restricted sample 1954-1995.

3.5 Interpretation of the empirical results

The estimated error correction model helps to characterize the way a variety of factors considered in the current debate in Italy may impact upon private consumption and wealth accumulation in the short and in the long run.

The first point to arise is the possibility that in the last decade social security changes may have curbed the structural decline in the saving rate of Italian households[21]. The sizeable reductions in pension benefits, first enacted in 1992 and then in 1995, in combination with the ongoing debate over the future need for further restrictive measures, may have lead Italian households to revise their expected sustainability of pensions in financing consumption plans.

Empirically, this is a reasonable interpretation of the signs of decline in the coefficient for social security wealth during the nineties. As mentioned, the maximum-likelihood point estimates of the cointegrating vector show a larger effect for the variable WSSY in the restricted than in the full sample (the coefficient slipping from 0.046 to 0.027 if the final year is moved from 1993 to 1998; Table 3.3). The opposite result holds for WYP, whose coefficient rises from 0.056 to 0.061. Accordingly, the ratio between the two coefficients, which in the linear model is a proxy for ϑ, is cut almost in half, from 0.82 to 0.44, between the restricted and the full sample. We tend to interpret this as a sign of increased uncertainty of Italian households' over their future pension entitlement given reiterated reforms and the prospect of more to come. Indeed, as recent survey evidence shows for American households, the people with the least confidence in the future of social security exhibit the highest saving rates (Bernheim, 1995).

Moreover, solving the co-integrating vector for the desired ratio of real and financial assets to income, namely WYP*, this variable has risen sharply, much more than the actual WYP ratio (Fig. 3.6). As a consequence the gap, which was negative in the two previous decades, turned positive in the nineties.

[21] For the factors explaining such a structural correction, though Italian households' saving rate still remains higher than in the other main industrial countries, see Guiso et al. (1994).

The sluggish growth of private consumption long after the crisis of 1992-93 might result from households' decision to accumulate real and financial assets, partly to compensate for lower social security wealth, partly as precautionary buffer stocks against increased uncertainty over future pension benefits. From this standpoint, the evidence that in the most recent years of the sample the gap between WYP* and WYP, though narrowing, remains significantly positive implies that the adjustment of consumption plans may still be continuing after 1998. Indeed, the estimated low value for the loading coefficient of the cointegrating vector in the error correction model points to quite a slow rate for the transition to the long-run equilibrium.

As to the factors affecting the adjustment process, the coefficient of the measure of cyclical uncertainty proves significant and negative, signaling a depressing effect of income variability on consumption[22]. On the contrary, the impact of capital gains proves negligible, probably because pronounced volatility has hindered sound assessment by households of the ensuing changes in purchasing power. This is confirmed when capital gains on real and on financial assets are considered separately[23], although the standard error related to the latter decreases.

A final remark about demographic changes: despite the difficulty in interpreting, at aggregate level, the signs of the coefficients for the ratio of people over 65 (PO) and life expectancy at birth (ASP), their significance confirms the convenience of taking account of the changing patterns of households' heterogeneity in assessing saving behavior. And we can also put forward a tentative interpretation of the signs of the coefficients. To the extent that PO proxies for the relative frequency of pensioners with respect to workers, its positive correlation with consumption dynamics conforms to the life cycle model. The assessment of life expectancy is more ambiguous. Insofar positive changes proxy better health conditions, they may imply increasing length of both working and retirement stages,

---

[22] The unemployment rate, an alternative proxy for cyclical uncertainty in the empirical literature (Feldstein, 1974 and Barro-Mac Donald, 1979), was not statistically significant, either in levels or in first differences or as multiplicative factor of changes in income. These results are in line with the evidence for Italy in Boone et al. (1998).

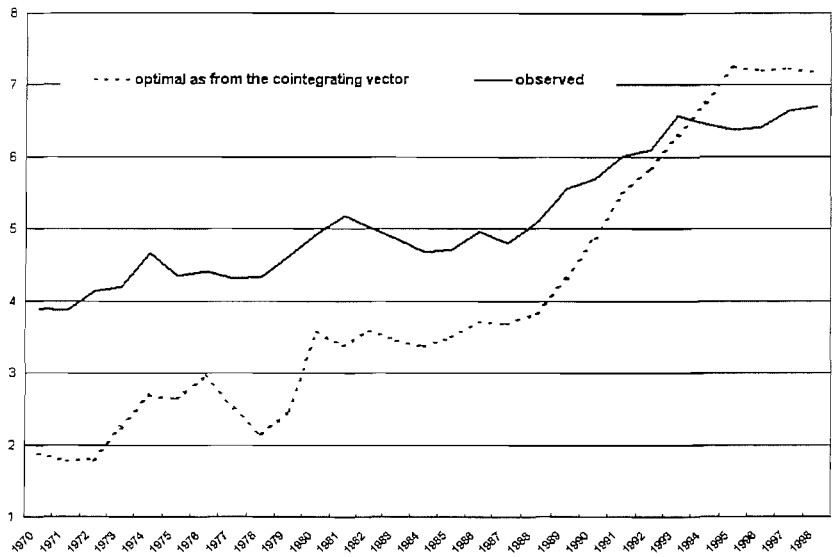
[23] In Boone et al. (1998), variations in the stock exchange index, adjusted for inflation, play a much weaker role in affecting consumption in Italy than in the other main industrial countries, according to evidence based on quarterly data covering the period from 1976-Q1 to 1996-Q2.

so the effect on the ratio between the two, which is the key variable in determining consumption (Modigliani, 1970), remains undetermined.

From this standpoint, our empirical analysis does not help to solve the theoretical ambiguity. Nevertheless, the inclusion of demographic variables proves worthwhile even at the aggregate level of our analysis, despite the ensuing difficulty of interpretation, in order to control for the bias that would otherwise affect estimates of the intensity of the offset between pension and non-pension wealth. As is pointed out in Gale (1998), this bias generally arises when the empirical model controls for current income and pensions separately rather than for total lifetime resources, and a correction for the effects of changes in demographic structure would be required.

Fig. 3.6

RATIO OF HOUSEHOLDS' REAL AND FINANCIAL ASSETS TO DISPOSABLE INCOME



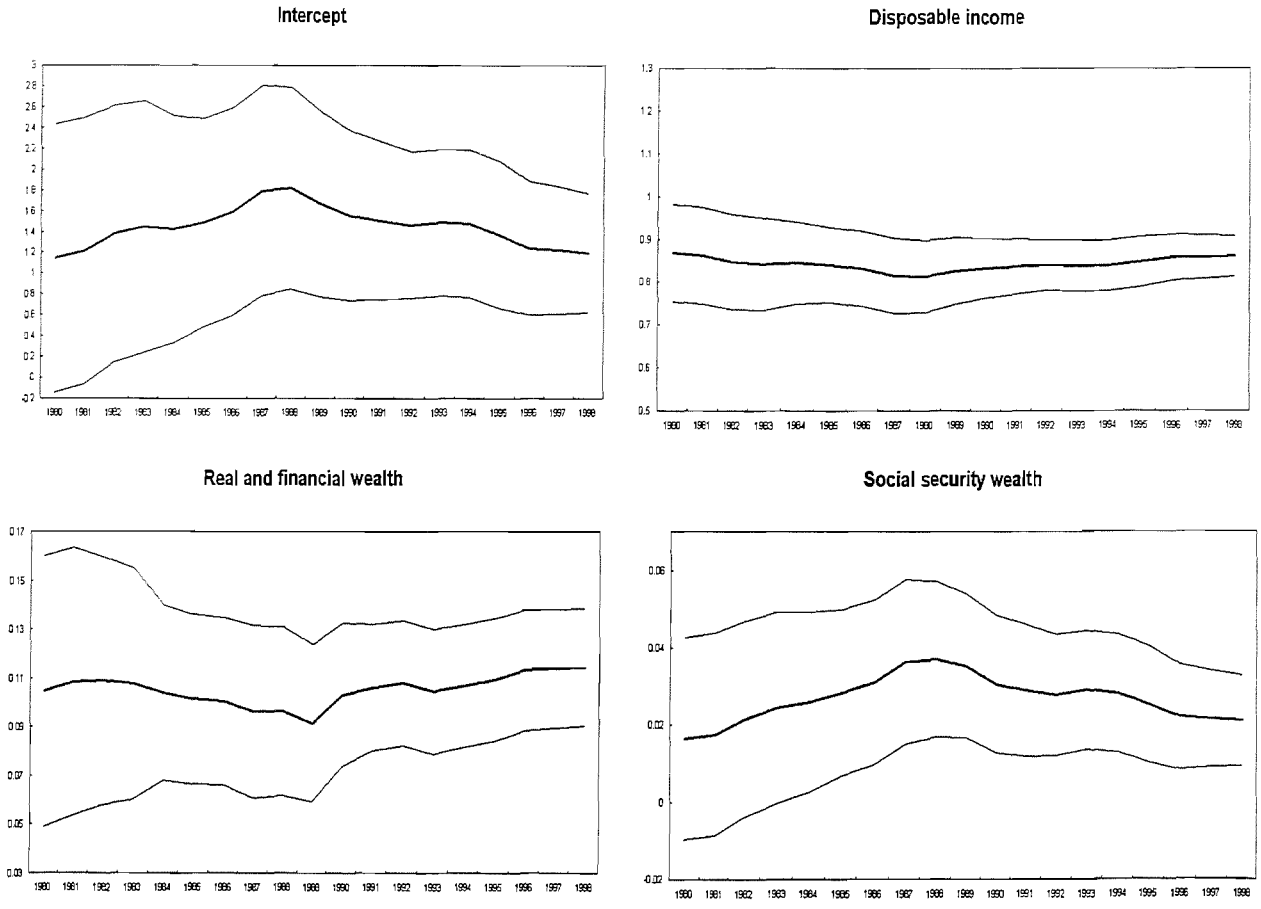
3.6 Consumption demand and pension reforms: a case for a model shift?

The signs of a weakening impact of social security wealth on households' expenditure in Italy suggest exploring the stability of the empirical

model estimated with respect to the reform of the pension system. From an econometric standpoint, a regime shift in the data generating process may affect co-integration analysis mainly by leading conventional tests to accept an erroneously low rank of co-integration and by changing the co-integrating vector (Gregory-Hansen, 1996, Quintos, 1997 and Inoue, 1999)[24]. In view of the evidence that the rank confirms equal to one in the full and restricted samples, in this section we concentrate on the stability of the cointegrating vector. In particular, we deal with a univariate context, since a multivariate approach would be problematic due to the large size of the co-integrating vector relative to the limited number of observations available in the sample for the years following the candidate structural break.

Fig. 3.7

COEFFICIENTS AND STANDARD ERRORS' BANDS BASED ON RECURSIVE OLS OF COINTEGRATING REGRESSION



[24] The additional issue of reduced power in ADF test for unit root has been addressed in the stationarity analysis of WSSY (section 5.2).

In first place, the recursive OLS estimates of the co-integrating regression show that some changes in parameters might have actually occurred, even if they are statistically limited in size (Fig. 3.7). Apart from the temporary rise in the intercept around the end of the eighties, more pronounced changes apparently affected the coefficients of the two wealth components, in opposite directions as we noted.

In second place, we have run the test of parameter stability suggested by Hansen (1992), on the basis of both the fully modified estimator of Phillips-Hansen (1990) and the dynamic OLS of Stock-Watson[25]. In particular, we have computed the test statistics *SupF* by recursively splitting the full sample with a cut point t moving from 1984 to 1993, and each time evaluating a *Wald* statistic to test parameter stability; the maximum value in this sequence compares with proper critical values. While we do not impose the date for the structural break to augment the power of the test, we found it reasonable to restrict the possible range for alternative dates[26].

Table 3.6

HANSEN'S TEST FOR PARAMETER STABILITY

SupF test for the null hypothesis of stability against unknown structural break under p=0 and m_2=3.

Asymptotical critical value at significance level of 5% is *17.2* (Table 1, Hansen 1992)

T	P-H	S-W.	*t*	P-H	S-W.
1984	1.67	0.98	1989	2.58	6.63
1985	0.27	2.82	1990	8.16	1.22
1986	0.19	2.76	1991	6.06	1.29
1987	0.95	3.06	1992	3.13	2.18
1988	1.16	6.49	1993	5.37	6.98
SupF	8.16	6.98			

P-H = Fully Modified Phillips-Hansen estimator; S-W=Stock-Watson dynamic OLS.

[25] This proves convenient to check for robustness to different corrections for serial correlation implied by the two estimators; asymptotic critical values for the stability test prove to be equivalent (Hansen, 1992).

[26] In the lower bound, since we know that the institutional change eventually materialized not earlier than 1992; in the upper bound, due to a degree-of-freedom constraint in latest sub-sample.

The results are univocally against the instability of the co-integrating vector (Table 3.6), although the high variability of the *Wald* statistic since the nineties suggests that the latest observations are too few to be informative enough that a change in model could prove statistically significant[27]. In this respect, an additional problem is the fact that two shocks came close upon one another (the 1992 and 1995 pension reforms) in the first half of the nineties.

Table 3.7

COINTEGRATION ANALYSIS UNDER REGIME SHIFT

Dependent variable: LC

A			B		
Dynamic OLS with adjusted S.E.)			Ordinary Least Squares		
43 observations used for estimation (1954-96)			47 observations used for estimation (1952-98)		
List of variables included in the regression					
$\Sigma_{j=-2}^{+2}\Delta\, lyp_{t-j}, \Sigma_{j=-2}^{+2}\Delta\, wssy_{t-j}, \Sigma_{j=-2}^{+2}\Delta\, wyp_{t-j}$					
Regressor	Coefficient	S.E.	Regressor	Coefficient	S.E.
INTP	1.8637	0.3892	INTP	1.5935	0.51304
LYP	0.8157	0.0323	LYP	0.8326	0.0427
WYP	0.1026	0.0193	WYP	0.0896	0.0220
WSSY	0.0286	0.0079	WSSY	0.0346	0.0108
DZ	-0.0419	0.1509	DZ	-0.3268	0.1458
DPO	0.0545	0.0309	DPO	0.0368	0.0410
DUINT	9.1026	10.264	DUWYP	0.02813	0.0185
DULYP	-0.5944	0.7121	DUWSSY	-0.0199	0.0136
DUWYP	-0.1229	0.0913			
DUWSSY	-0.0281	0.0237			

DUINT=DT*INTP; DULYP=DT*LYP; DUWSSY=DT*WSSY; DT=0 if t≤1989, 1 otherwise.

Third, we have tested whether dummy variables controlling for a change in regime since 1990 prove significant in the co-integrating regression. In this case, in order to make a correct inference despite non-stationarity, we first compute the dynamic OLS estimator by including interaction terms between dummies and the variables entering the co-integrating vector. Then we re-scale standard errors by the

[27] We have replicated the test computing the estimators' long-run variances by different kernel and under (locally) changing bandwidth. (We set the central value of this parameter as low as 2 in view of the evidence of nearly "white" residuals.) The results, not reported, confirm solid evidence against parameter instability.

factor λ_v / s, with s being the usual standard error of the regression and λ_v a consistent estimate of long-run variance of residuals[28].

Evidence confirms our previous results, as both the slope and level dummies are all scarcely significant – although with signs occasionally different than expected (Table 3.7, column A). Note that the estimation sample terminates in 1996, given the two leads in first differences we include in the dynamic specification, thus eliminating potentially useful observations for a sounder appraisal of the change in regime.

In order to attenuate this problem and gain degrees of freedom in regression, we have turned to standard OLS estimators by including only the relatively more significant dummies, namely DUWSSY and DUWYP, which interact with pension and non-pension wealth respectively (Table 3.7, column B)[29]. The opposite signs of the coefficients of these variables signal that changes in the consumption function may be under way in line with our interpretation: stronger accumulation of real and financial assets would follow the reduction in expected pension benefits. As noted earlier, a sound statistical identification of the magnitude of these movements is fraught with difficulty, due to the size of our sample and the uncertainty still surrounding the final setup of social security in Italy.

3.7 Conclusions

The paper provides fresh evidence on the aggregate demand of Italian households according to the augmented life cycle model of consumption. Under the caution ordinarily urged in view of the controversial computations of social security wealth, the main findings may be summarized as follows:

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[28] A detailed description of the computation of the rescaling factor, which is required for achieving efficient estimates uniquely for coefficients of I(1) variables, is in Hayashi (2000). In this case, we found this procedure less cumbersome than a kernel.

[29] These two variables have been identified in the context of dynamic OLS, via a gradual reduction of the general specification reported in table 7.

- symmetrically with previous evidence on the effects of past expansionary reforms of social security, recent restrictive corrections have contributed significantly to depress the expenditure of Italian households;

- social security wealth proves to exert a much weaker effect on long-run consumption demand than real and financial assets, and the degree of substitutability between the two components of wealth results turns out to be far lower than in previous time series evidence;

- signs of instability in consumption demand have increased during the last decade, although they are not statistically significant, probably because of the paucity of observations subsequent to Italy's social security reforms. Recursive point estimates suggest a declining coefficient of pension wealth in the long-run consumption function and a rising coefficient of other components of wealth since the turn of the nineties;

- in the same period the difference between the observed and the desired ratio of non-pension wealth to income has turned negative, after being positive in the seventies and eighties. Presumably, in an effort to compensate for reductions in actual pension payments and to provide a financial cushion against the uncertainty over future entitlements, consumers stepped up accumulation of real and financial assets;

- demographic trends, such as changes in life expectancy at birth and in the share of the population over 65, play a significant role in affecting consumption demand, although they are not co-determined with it in the long run. The result calls for taking account of the major demographic changes of Italian society in characterizing household expenditure, even at the aggregate level we consider;

- first estimates of capital gains on net financial and real assets held by Italian households show a negligible impact on private consumption, likely due to their high volatility in level and composition.

As a final remark, the interpretation of our evidence requires some caution in view of two issues, which would make good topics for future research:

i) the size and timing of the correction in expected pension benefit of households – which, we have argue, appeared well in advance to the actual reform in 1992 - are subject to revisions of the micro-model underlying the estimates we have

adopted; these revisions which are currently under way, as a part of a separate project at the Bank of Italy;

ii) time series analysis of consumers' expenditure notoriously misses important composition effects, which in our case risk being particularly strong due to the great heterogeneity of Italian households with respect to pension entitlements and access to financial markets, in addition to individual variations in age and labor income.

APPENDIX 3.I

Statistical tables

Table A1a

UNIT ROOT TESTS FOR VARIABLE LYP
DF regressions include intercept and linear trend

43 observations used in the estimation of all ADF regressions (1956-98)

Test Statistic	LL	AIC	SBC	HQC	
DF	-.95061	99.5005	96.5005	93.8587	95.5263
ADF(1)	-.85854	99.6908	95.6908	92.1684	94.3918
ADF(2)	-.87460	99.7168	94.7168	90.3138	93.0931
ADF(3)	-.71166	99.8460	93.8460	88.5624	91.8975
ADF(4)	-.50433	99.9982	92.9982	86.8340	90.7250

95% critical value for the augmented Dickey-Fuller statistic = -3.5162
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Table A1b

UNIT ROOT TESTS FOR VARIABLE LC
DF regressions include intercept and linear trend

43 observations used in the estimation of all ADF regressions (1956-98)

	Test Statistic	LL	AIC	SBC	HQC
DF	.86343	119.1179	116.1179	113.4761	115.1437
ADF(1)	-.0076770	121.3640	117.3640	113.8416	116.0651
ADF(2)	.0081516	121.3649	116.3649	111.9619	114.7412
ADF(3)	-.29601	121.8187	115.8187	110.5351	113.8703
ADF(4)	.061977	122.2591	115.2591	109.0949	112.9859

95% critical value for the augmented Dickey-Fuller statistic = -3.5162
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Table A1c

UNIT ROOT TESTS FOR VARIABLE LWYP
DF regressions include intercept and linear trend

43 observations used in the estimation of all ADF regressions (1956-98)

Test Statistic	LL	AIC	SBC	HQC	
DF	-2.1379	13.2187	10.2187	7.5769	9.2445
ADF(1)	-2.3465	13.7644	9.7644	6.2420	8.4655
ADF(2)	-2.5244	14.2591	9.2591	4.8561	7.6354
ADF(3)	-1.9905	14.7414	8.7414	3.4578	6.7930
ADF(4)	-1.5896	15.0172	8.0172	1.8530	5.7441

95% critical value for the augmented Dickey-Fuller statistic = -3.5162
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Table A1d

UNIT ROOT TESTS FOR VARIABLE R

DFuller regressions include intercept but not trend

43 observations used in the estimation of all ADF regressions (1956-98)

	Test Statistic	LL	AIC	SBC	HQC
DF	-2.3076	107.4149	105.4149	103.6537	104.7654
ADF(1)	-2.3149	107.5419	104.5419	101.9001	103.5677
ADF(2)	-1.7361	108.4757	104.4757	100.9533	103.1767
ADF(3)	-1.5934	108.4937	103.4937	99.0907	101.8700
ADF(4)	-1.3640	108.6723	102.6723	97.3887	100.7239

95% critical value for the augmented Dickey-Fuller statistic = -2.9303

LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Table A1e

UNIT ROOT TESTS FOR VARIABLE WSSY

DF regressions include intercept and linear trend

43 observations used in the estimation of all ADF regressions (1956-98)

Test Statistic	LL	AIC	SBC	HQC	
DF	.21230	-23.7477	-26.7477	-29.3895	-27.7220
ADF(1)	-.24155	-23.0156	-27.0156	-30.5380	-28.3146
ADF(2)	.23394	-22.3527	-27.3527	-31.7557	-28.9764
ADF(3)	.077986	-22.3060	-28.3060	-33.5896	-30.2545
ADF(4)	-.17617	-22.1347	-29.1347	-35.2989	-31.4079

95% critical value for the augmented Dickey-Fuller statistic = -3.5162

LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Table A1f

FURTHER UNIT ROOT TESTS FOR VARIABLE WSSY

OLS estimation based on Newey-West adjusted S.E.'s

Dependent variable is DWSSY; 47 observations from 1956 to 1998

Regressor	Coefficient	Standard Error	T-Ratio
INTP	.41963	.17364	2.4167
WSSY (-1)	-.066453	.039350	-1.6888

Table A1g

UNIT ROOT ANALYSIS FOR WSSY

Structural break as in model C in Perron (1989)

Dependent variable is WSSY; OLS Estimation, with 43 observations from 1956 to 1998;
DU=1 if t=1990+1, 0 otherwise – DTB=1 if t>1990, 0 otherwise – DT=0 if t≤1989, t otherwise

T_B=1990, λ=0.8; 5% critical value for τ_α equal to −4.04

Regressor	Coefficient	S.E.	Regressor	Coefficient	S.E.
INTP	0.704	0.206	DWSSY(-3)	0.029	0.147
WSSY(-1)	0.511	0.196	DWSSY(-4)	0.089	0.137
TREND	0.094	0.039	DT	-0.206	0.137
DWSSY(-1)	0.191	0.207	DTB	6.742	5.615
DWSSY(-2)	-0.059	0.173	DU	-0.168	0.501

$\hat{\tau}_\alpha = -2.5503$

Table A2

UNIVARIATE COINTEGRATION ANALYSIS

Stock-Watson Approach

OLS estimation based on Newey-West adjusted S.E's

Dependent variable is LC. 43 observations used for estimation from 1954 to 1996

Regressor	Coefficient	S.E.	Regressor	Coefficient	S.E.
INTP	1.828	0.537	DWYP	-0.069	0.022
LYP	0.820	0.044	DWYP(-1)	-0.051	0.020
WSSY	0.033	0.006	DWYP(-2)	-0.032	0.024
WYP	0.088	0.020	DWYP(+1)	0.017	0.023
DZ	-0.077	0.117	DWYP(+2)	0.028	0.018
DPO	0.068	0.035	DWSSY	-0.031	0.009
DLYP	-0.701	0.250	DWSSY(-1)	-0.018	0.008
DLYP(-1)	-0.509	0.233	DWSSY(-2)	-0.013	0.007
DLYP(-2)	-0.395	0.201	DWSSY(+1)	0.001	0.008
DLYP(+1)	0.000	0.194	DWSSY(+2)	-0.002	0.008
DLYP(+2)	0.084	0.155			

****

Pesaran-Shin Approach

ARDL (1, 1, 0,0)

Engle-Granger Approach

OLS Estimation

Dependent variable is LC. 46 observations used for estimation from 1952 to 1998

Regressor	Coefficient	S. E.	Coefficient	S.E.
LYP	.902	.072	.865	.037
WYP	.067	.028	.115	.012
WSSY	.022	.010	.020	.005
INTP	.964	.812	1.148	.419
DZ	-.259	.265	-.270	.135

ERROR CORRECTION MODEL AND WU-HAUSMANN TEST FOR EXOGENEITY OF DLYP, DR, DWSSY, UNC

Dependent variable is DLC - List of variables added to the regression: RDLYP, RDR, RDWSSY, RUNC
43 observations used for estimation from 1956 to 1998

Regressor	Coefficient	S. E.	T-Ratio	Regressor	Coefficient	S. E.	T-Ratio
DLC(-1)	0.44825	0.1163	3.5435	RUNC	-0.0043	0.0027	-1.6291
DLC(-2)	-0.2091	0.10918	-1.9313	UNC	0.0014	0.0024	0.5870
DLYP	0.2415	0.21347	1.1313	DPO	0.0294	0.0118	2.4871
DZ	-0.1310	0.0558	-2.5940	DPO(-2)	0.0179	0.0121	1.4804
DZ(-1)	0.1347	0.0476	2.3294	DASP	-0.0478	0.0125	-3.8344
DR	-0.0372	0.1518	-0.2451	DASP(-2)	0.0281	0.0159	1.7659
DR(-1)	-0.0737	0.0862	-0.8554	DWSSY	0.0098	0.0038	2.5810
RDLYP	-0.0796	0.1971	-0.4040	DWSSY(-1)	0.0078	0.0041	1.9122
RDR	0.1979	0.1692	1.1694	ECM(-1)	0.0848	0.0539	1.5726
RDWSSY	-0.0171	0.0105	-1.6307				

Variables RDLYP, RDR, RDWSSY, RUNC are residuals of regressions of DLYP, DR, DWSSY, UNC, respectively, on: const, DLC(-1), DLC(-2), DLYP(-1), DLYP(-2), DR(-1), DR(-2), DWSSY(-1), DWSSY(-2), UNC(-1), UNC(-2)

Joint test of zero restrictions on the coefficients of additional variables:
LM Statistic.: CHSQ(4)= 8.3460; LR Statistic: CHSQ(4)= 9.268; F Statistic F(4,24)=1.445

APPENDIX 3.II

Data set

For most of the variables for which specific computations have been required, sources and methods are broadly the same as in Rossi-Visco (1994). With respect to the data set adopted in that paper, however, important revisions have occasionally resulted from updated evidence about some basic parameters and statistics. Here we define the main variables considered in the empirical analysis and sketch their computation procedure.

LYP stands for the logarithm of households' disposable income at constant prices, net of pension payments[30] and adjusted for the loss in purchasing power of net financial assets due to inflation. As to the former, which substitute for social transfers considered in Rossi-Visco, they are computed after taxes on the basis of the average tax rate given by the ratio of total direct taxes paid by households and their income. The Hicksian correction for monetary erosion of net financial assets is computed with respect to expected inflation, whose index has been retrieved from the results of the business survey run by *Forum-Mondo Economico*.

WYP is the ratio of net real and financial assets to our measure of disposable income. Real assets are the sum of end-of-period stock of durables, dwellings and land. Each component is estimated by projecting backward and forward the relevant value for a benchmark year, on the basis of the flow of investments and depreciation. With reference to dwellings, which accounts for more than 70 per cent of total real wealth of Italian households, major revisions have occurred with respect to the estimate adopted in Rossi-Visco. They mainly reflect a lower value for the benchmark year 1980 and a new price index adopted to turn stock into market value, which now comes from the Bank of Italy based on data provided by *Il Consulente Immobiliare*. As a consequence, on average for the first five years of the nineties the estimated stock of dwelling wealth adopted in the paper is around 10 per cent lower than in Rossi-Visco.

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[30] Their source is ISTAT and, for years before 1973, Morcaldo (1977).

R stands for the real interest rate, which is measured by $\log[(1+i)/(1+\pi)]$, with i the nominal interest rate on Treasury bonds with a residual life longer than one year and π the expected inflation rate computed as described.

CAPS is households' total capital gains on dwellings, bonds and equities. Each of the three components has been estimated separately on a yearly basis, by applying annual changes in the respective capitalization index as to the value of the stock at the end of the previous year. In the case of dwellings, revaluation has been proxied by changes in the price index of new and recently restructured buildings devised by the Bank of Italy, as noted. In the case of equities and bonds, estimates of capital gains include the capitalization of dividends or interests, that has not been transferred to the assets' holders.

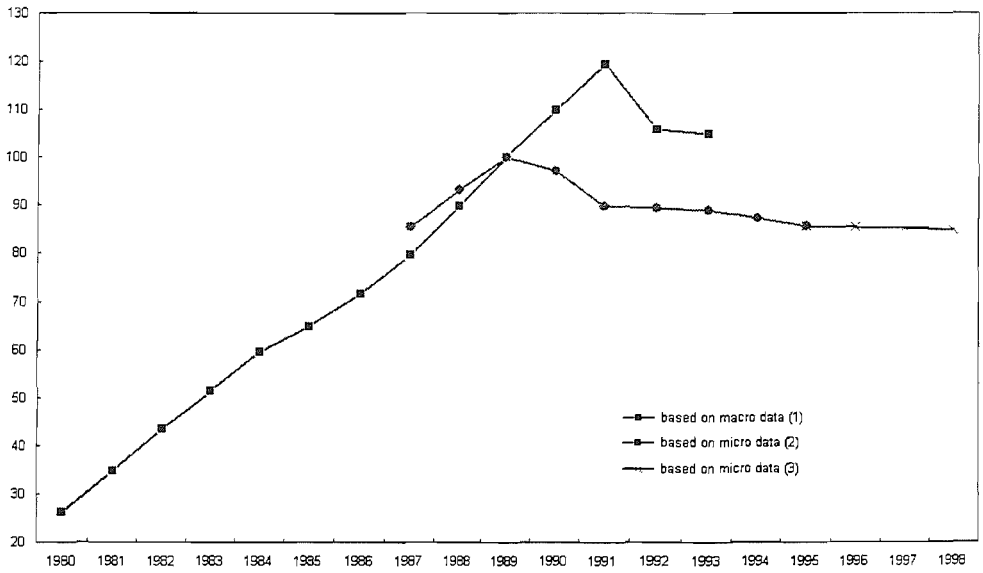
WSSY is the ratio of gross social security wealth to disposable income. In the definition we adopted, it is given by the present discounted value of the sum of benefits that current contributors expect to receive after retirement and those that current retirees will keep receiving (Feldstein, 1974). The computation of this variable is controversial, since it involves a variety of unobservable factors, such as expected age at retirement and death, future labor incomes, the discount factor. In the absence of a single time series covering the full period, the measure we used comes from a combination of different sources. They include: a) estimates made by Beltrametti for the period 1951-93 (Beltrametti, 1995); b) estimates made by Nicoletti-Altimari (1999) for any two years between 1987 and 1995; c) provisional Bank of Italy simulations for 1994-98 (Ando et al., 1999). Whereas the last two are based on the same micro-model of the Italian economy, which has been estimated with data from the Bank of Italy Survey of Household Income and Wealth, the first is obtained from the traditional, more aggregated approach. The measure we adopted is equal to the latter until 1989; for later years it is given by a projection of the same series on the basis of the growth rates of the micro estimates.

The identification of the cut point as 1989, which proves crucial for the recent development of variable WSSY, is predicated on the following argument. The "micro" measure sub b), shows a correction in social security wealth earlier than the "macro" measure sub a), suggesting adjustment in WSSY prior to the actual reform in 1992. This is presumably due to the fact that the "micro" measure allows one to estimate a key parameter like retirement time, which otherwise is restricted to be

equal to the legal requirement, and takes better account of composition effects coming from heterogeneous workers. Both factors are likely to prove especially important under recurrent institutional changes, which may induce stratification of different regimes[31]. There is in fact some indication of this in the much larger discrepancies between the two measures that we observe towards the end of the seven-year period in which they overlap (see chart).

Fig. A1

ESTIMATES OF GROSS SOCIAL SECURITY WEALTH
(Index 1989=100)



(1) Based on data from Beltrametti (1995). (2) Based on data from Nicoletti (1999). (3) Based on data from Ando et al. (1999).

The computation of the measure we adopted proceeded in several steps. First, we linearly interpolated the original biannual estimates by Nicoletti-Altimari and merged the resulting yearly series with that referred to sub c), after converting both into indexes (1995=100) to correct for discrepancies. Second, the micro

[31] In Italy, pension benefits currently conform to three different regimes, identified according to the length of the contribution period: a) the "old" one, as heavily reformed in 1992, still holds for people with at least 18 years of contributions in 1995; b) the "new" one, introduced in 1995, applies to people whose contribution period started in 1993; c) the "intermediate" one, concerning people with less than 18 years of contributions in 1995, combines the old regime for contributions until 1995 and the new regime for the subsequent years. The specific formulas and details on evolution of Italian pension system are discussed in Bank of Italy (1995) and Peracchi et al. (1995).

estimates, now running from 1987 to 1998, have been merged with the "macro" one, again after converting both into indexes (1989=100). Finally, levels have been retrieved

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