RIVISTA DI POLITICA ECONOMICA

X-XII

«ANGELO COSTA» ECONOMICS UNDERGRADUATE THESES AWARD
XVth Edition

XIIIth «ANGELO COSTA» LECTURE

Some Economics of Banking Reform

John Vickers

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Founded in 1911

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Preface

In the year 2012, the Rivista di Politica Economica (RPE) promoted the competition for the XVth edition of the «Angelo Costa» Economics Undergraduate Theses Prize consisting in the publication of the four most deserving papers taken from undergraduate theses in economics written by students who graduated in Italian universities between May 1st, 2010 and October 30th, 2012. This issue collects the four papers winning the competition.

The «Angelo Costa» Theses Prize aims at drawing attention to the most promising graduates in Economics, awarding them with the publication of their paper in order to encourage studying and improve their post-graduate chances of admission to Master and/or Ph.D. programs. We also wish this Prize to bring the authors to the attention of a wider public, preventing that their work remains a mere manuscript with a limited and random circulation as it often occurs.

The Prize is named in memory of Angelo Costa, the first President of Confindustria (the Confederation of Italian Industry) in the immediate post-war period. He was elected President in 1945 and guided the organisation throughout the reconstruction period until 1955. Angelo Costa was again elected to chair the board of Confindustria from 1966 to 1970. A free-market advocate, on several occasions Angelo Costa firmly opposed the constraints imposed by statism and stressed the key role played by small and medium-sized enterprises in Italy's economic and industrial growth.

Even for this 2012 edition the publication of the «Angelo Costa» Lecture – held on the awarding day by a member of the International Scientific Committee or by an internationally renowned economist on a topic of economic interest – enriches the issue collecting the winning papers. The XIIIth Lecture that we are here honoured to publish, is entitled: «Some Economics of Banking Reform», and was held on December 11th, 2012 by Prof. John Vickers of the All Souls College Oxford University at the "LUISS Guido Carli" University of Rome.

Eighteen graduates from twelve Italian universities submitted papers for this XVth edition. Two candidates were enrolled at "Luigi Bocconi" University of Milan, "LUISS Guido Carli" University of Rome, "Tor Vergata", University of Rome,"Ca' Foscari" University of Venezia, University of Siena and University of Bologna. One candidate was enrolled in each one of the following universities "Cattolica Sacro Cuore" University of Milan, University of Palermo,"Politecnica" University of Marche, University of Brescia, University of Florence, University of Catania.

Each paper was submitted in anonymous form – as envisaged in the first stage of the competition – to be evaluated by one of the following Italian referees: Alberto Bagnai, Marida Bertocchi, Ennio Bilancini, Luigino Bruni, Rossella Castellano, Luisa Corrado, Alessio D'Amato, Giuseppe De Arcangelis, Daniela Di Cagno, Daniele Fabbri, Antonio Guarino, Alessandro Missale, Paolo Paesani, Luca Sala, Lucio Sarno, Lucia Tajoli, Mario Tirelli, Giovanni Vecchi.

On the basis of their opinions the authors who qualified for the second stage of the contest were the following (listed in alphabetical order): Laura Bartolini, University of Florence, «Irregular Status and Migrants' Behaviours. An Empirical Description of the Skill Waste Effect»; *Barbara Biasi, "Luigi Bocconi" University of Milan, «*Healthcare and Federalism: A Political Economy Approach»; *Emilio Bisetti, "Luigi Bocconi" University of Milan,* «The Impact of Longevity Risk on the Term Structure of the Risk-Return Tradeoff»; *Monica Di Prospero, "Ca' Foscari" University of Venezia,* «Relational and Material Child Well-Being in Italian Families»*; Marco Fabbri, "Alma Mater Studiorum" University of Bologna,* «Creating and Changing Social Norms: Evolutionary Perspectives and Policy Analysis»; *Licia Ferranna, "Ca' Foscari" University of Venezia*, «Technical Change in Economic Models for Climate Change»; *Daniele Girardi, University of Siena,* «Do Financial Investors Affect Commodity Prices? The Case Of Hard Red Winter Wheat»; *Giuliano Pirrone, University of Palermo,* «The 2008 - Financial Crisis and the Effects on International Trade: New Empirical Evidence»; *Isolina Rossi "Tor Vergata" University of Rome,* «Life Satisfaction and Unemployment: An Analysis from the Eurobarometer Survey»*; Emilio Zanetti Chini, "Tor Vergata" University of Rome*, «Updating the PPP Puzzle: Should We Use Nonlinear Models?».

Each one of these papers was then submitted – again in anonymous form – to two different members of the International Scientific Committee who finally defined the winners of the 2012 competition. The Members of the International Scientific Committee for this edition were:

Prof. Kyle Bagwell (Stanford University)
Prof. Richard Blundell (University College London)
Prof. Michael Brennan (University of California in Los Angeles)
Prof. Heinz Kurz (University of Graz)
Prof. Axel Leijonhufvud (University of California, Los Angeles)
Prof. Charles F. Manski (Northwestern University)
Prof. Robert A. Mundell (Columbia University)
Prof. Lee E. Ohanian (University of California, Los Angeles)
Prof. Andrew Rose (University of California, Berkeley)
Prof. Stephen A. Ross (Massachusetts Institute of Technology)
Prof. Bertram Schefold (J.W. Goëthe Universität Frankfurt am-Main)
Prof. Jean Tirole (Université des Sciences Sociales de Toulouse)

The four authors who were awarded the 2012 "Angelo Costa" Undergraduate Theses Prize are the following (listed in alphabetical order): Barbara Biasi, "Luigi Bocconi" University of Milan, «Healthcare and Federalism: A Political Economy Approach»; *Emilio Bisetti, "Luigi Bocconi" University of Milan,* «The Impact of Longevity Risk on the Term Structure of the Risk-Return Tradeoff»; *Giuliano Pirrone, University of Palermo,* «The 2008 - Financial Crisis and the Effects on International Trade: New Empirical Evidence»; *Isolina Rossi "Tor Vergata" University of Rome,* «Life Satisfaction and Unemployment: An Analysis from the Eurobarometer Survey».

Once again our initiative has received widespread and appreciative comments in Italian and foreign academic circles and we would like to sincerely thank all those who gave their contribution to spread information on the Prize. Special thanks for their personal direct and considerable commitment goes to the Italian referees and to the members of the International Scientific Committee. The positive comments they expressed on the Prize and the notable skill of the candidates encourage us and testify that the «Angelo Costa» Economics Undergraduate Theses Prize is considered today among the important events capable of fostering and encouraging young Italian economists in their scientific studies by making them known to a broader public. The final choice of the winners, based on a criterion solely related to the quality of the manuscripts, is implemented by a doubleblind refereeing procedure made by Italian and international economists who have given important contributions to the science of Economics and have acquired a rigorous capacity to evaluate scientific work over the years. Our guidelines for this Prize can be summed up with two terms: merit and competition.

We believe these two characteristics have been and can be assured in the future by the rigour and transparency of the procedures adopted in the selection.

This issue of Rivista di Politica Economica also collects the profiles of the four winners of the XVth edition, the announcement of the 2013 competition and a biographical update of the past-editions winners. We take this opportunity to congratulate our young colleagues and wish them great success in their future studies and professional activities.

THE MANAGING EDITOR
PROF. GUSTAVO PIGA

XIIIth «ANGELO COSTA» LECTURE

Prof. John Vickers during the XIIIth «Angelo Costa» Lecture, held at "LUISS Guido Carli" University of Rome on December 11th, 2012.

Some Economics of Banking Reform

John Vickers*
All Souls College, Oxford University

Where do we stand, five years on from the start of the crisis, on progress towards banking reform? Following a stock-take of current reform initiatives, the paper reviews some economics of public policy towards banks, in particular capital requirements and the role of structural regulation in making banking systems safer. Forms of separation between retail and investment banking are compared, notably ring-fencing and complete separation. The paper concludes with reflections on the wider European policy debate following the Liikanen Report. A central theme is that banking reform needs a well-designed combination of policies towards loss-absorbency and structural reform.
[JEL Classification: G21; G28; L51].

Keywords: banking; bail-outs; capital requirements; deposit guarantees; Glass-Steagall; resolution; ring-fencing; structural reform; Volcker rule.

* <*john.vickers@economics.ox.ac.uk*>, paper prepared for the Angelo Costa Lecture in Economics in Rome on December 11th, 2012. I am grateful to Brian Coulter, Colin Mayer, Gustavo Piga, Rob Probyn, Benedict Wagner-Rundell and Sam Woods for helpful comments and discussions of the topics in this paper but I alone am responsible for what it contains.

1. - Introduction

Where do we stand, five years on from the start of the crisis, on progress towards banking reform? Major advances have been made, both internationally and in some countries – notably the UK – but given the scale of the problems revealed by the crisis, they have been modest overall, and a lot of unfinished business remains. The questions at stake are hugely important for us all, but even for many economists the policy issues can look dauntingly technical, and without clear foundation in mainstream economic principles.

Some might say that those principles should anyway be abandoned because the crisis has demonstrated that they, like many banks, have gone bust. On this view what we need is new economics. Of course new and better economics, with appropriate standards of analytical and empirical rigour, is always to be welcomed, but to jettison established economic principles would be foolish as well as unhelpful in terms of current policy guidance. It would be foolish because, while the crisis has emphatically refuted any notion that the market system always works well under *laissez-faire*, mainstream economics made no claim that it did. On the contrary, at its core is the analysis of various kinds of 'market failure' – market power, externalities, asymmetric information, distributional issues, and so on.

That said, the term 'market failure' hardly lives up to what we have seen since 2007. The whole financial and hence economic system was on the verge of collapse, much of it continues to be reliant on massive state support, which, together with the macroeconomic consequences of the crisis, is in turn imperilling the solvency of some governments. How then can mainstream economics explain what went wrong and what to do about it in terms of financial sector reform?

This lecture is a partial attempt to answer that question. It is entitled "Some" – rather than "The" – economics of banking reform because the issues are too big and complicated for a comprehensive account in a lecture of this scope. The discussion is less than comprehensive also because it focuses on banking reform, which is only part, albeit a central element, of financial sector reform. It is partial in another sense too, for I will focus on the reforms recommended by the UK's Independent Commission on Banking, which I chaired from its formation in June 2010 to the publication of its *Final Report* (ICB, 2011) fifteen months later.

The discussion will be non-technical. The crisis has taught, surely, that banking should be central to economics, not the specialism that it became. Where technicalities abound, even the best-intentioned regulatory reform will be frustrated by the manoeuvres of vested interests, which is all the more reason to promote discussion of the basic economics of banking reform.

The plan of the paper is as follows. Following a stock-take of current reform initiatives, section 3 reviews some economics of public policy towards banks, starting with the rationale for deposit guarantees and lender-of-last-resort support, and moving onto the evident compulsion governments feel to provide solvency support in crisis. Section 4 looks at the economics of capital requirements – and loss-absorbency more generally – and examines from a public economics perspective why such regulation is a better approach than taxation to address systemic risk externalities. Section 5 discusses the role of structural regulation – in particular forms of separation between retail and investment banking – in making banking systems safer. Section 6 concludes with some reflections on the wider European policy debate, especially on the structural question, in the light of the Liikanen Report (2012) published in October. A central theme of the paper is that banking reform needs a well-designed *combination* of policies towards loss-absorbency and structure.

2. - Banking Reform: Where Do We Stand?[1]

Banking reform is central to the general reform of financial services in the wake of the crisis. Among the areas of wider reform are:

- macro-prudential regulation – monitoring and addressing by policy intervention risks to the stability of the financial system as a whole (as distinct from risks to individual institutions, the focus of [micro-]prudential regulation);
- shadow banking – non-bank institutions (*e.g.* money market mutual funds) that together provide close substitutes to banks' services;
- market infrastructure – *e.g.* initiatives to shift bilateral "over-the-counter" derivatives trading onto central counterparties with standardised contracts;
- accounting standards;
- ratings and ratings agencies;
- the insurance sector.

Banking reform itself has several broad elements:

- better loss-absorbency – principally but not only through more and better capital;
- better liquidity;

[1] A comprehensive answer to this question is provided country-by-country in Table 3.8 of IMF (2012), which also has a summary at Table 3.2, from which this section draws.

- recovery and resolution;
- structural reform;
- other – including corporate governance, remuneration, and forms of bank taxation.[2]

Capital and liquidity standards have been reformed internationally in the so-called Basel III standards set by the Basel Committee on Banking Supervision. In essence, banks must maintain a minimum *ratio* of capital to risk-weighted assets (RWAs) in their funding structure. Compared with the pre-crisis capital requirements, Basel III is *(i)* tightening definitions of capital, *(ii)* raising the minimum equity capital *ratio* to 7%, and *(iii)* tightening methods of risk-weight calculation.[3] Risk-weighting performed very badly in the run-up to the crisis, so as well as the 7% minimum equity capital *ratio* relative to risk-weighted assets, there is to be a requirement that capital (including some non-equity) must be at least 3% of total (unweighted) assets; this will still allow up to 33 times leverage. Banks that are systemically important globally will need up to 2.5% additional equity relative to RWAs. The Basel III capital reforms are due to be completed by the start of 2019. In Europe they will be implemented by an EU Directive known as CRD IV.

While capital regulation aims to safeguard solvency, liquidity regulation seeks to ensure that banks have sufficient high-quality liquid assets and that their maturity transformation is not excessive. Under Basel III attention focusses accordingly on two *ratios*.[4] The Liquidity Coverage Ratio (LCR) sets a minimum *ratio* for assets that can be converted surely into cash in the short term. The Net Stable Funding Ratio (NSFR) promotes resilience to longer-term stress.

Recovery and resolution initiatives are led internationally by the Financial Stability Board (FSB), which has set out "key attributes" for effective resolution, especially in a cross-border context. These include improved recovery and resolution plans (RRPs) for banks, ensuring that national resolution authorities have adequate powers, and cross-border cooperation arrangements for crisis management. Regulatory powers to make providers of debt funding rather than taxpayers bear losses in crisis – "bail in" rather than bail-out – are an important part of the toolkit

[2] Besides the discussion in section 4 below of taxation as an approach to systemic risk externalities, these issues are beyond the scope of this lecture.

[3] In practice things are much more complex than this simplified sketch. For more, see Box 4.2 of ICB (2011).

[4] For more detail see Box A2.1 of ICB (2011).

being developed. The European Commission (2012*a*) has proposed a directive on bank recovery and resolution.

Structural reform has only recently received international attention. The main national initiatives have been the so-called Volcker Rule ban on proprietary trading in the US, and retail ring-fencing in the UK.[5] The international debate has now begun with the Liikanen Report (2012) proposal for trading ring-fencing across Europe, and the IMF has recently called for a wider international debate:

«*Despite much progress on the reform agenda, reforms in some areas still need to be further refined by policymakers. These areas include a global-level discussion on the pros and cons for direct restrictions on business models* …».[6]

Those pros and cons are the subject of section 5 below, but first let us consider liquidity, solvency and ways of improving loss-absorbency.

3. - Some Economics of Liquidity and Solvency

In stylised terms banks raise funding in terms of equity capital, deposits and other debt – the liability side of their balance sheet – and this finances their loans and trading – the asset side. The solvency of a bank depends on whether the value of its assets, if held to maturity, is sufficient to meet its obligations to depositors and holders of other bank debt (bondholders say). Not only insolvent banks can get into difficulty, because banks engage in maturity transformation insofar as they "borrow short but lend long". This brings huge efficiency benefits so long as the banking system is stable, but without proper safeguards it jeopardises that stability. It is efficient because it reconciles the freedom for depositors to meet their short-term liquidity needs with the financing of long-term lending both to households (*e.g.* residential mortgages) and for corporate investment. But such assets cannot be liquidated before they are due to mature without serious loss, so banks are vulnerable to a mass withdrawal of deposits and/or the refusal of bondholders to refinance maturing short-term debt. Even perfectly solvent banks can be vulnerable to liquidity crises of this kind.

The standard framework for exploring these issues is the Diamond-Dybvig (1983) model[7], which in essence has two kinds of equilibrium for solvent banks. (Insolvent and doubtfully solvent banks will be discussed later.) In the good equilibrium only the minority of depositors with current liquidity needs to withdraw

[5] The draft legislation on ring-fencing and other reforms is in HM TREASURY (2012*b*).

[6] IMF (2012, summary of chapter 3).

[7] See also BRYANT J. (1980) and the exposition in TIROLE J. (2006, chapter 12).

their funds from the banking system. The bulk of deposit funding remains in place, and there is no need for banks prematurely to terminate existing long-term lending or to refrain from new lending commitments. In the bad equilibrium households, fearing bank runs, do not make substantial bank deposits so banks cannot carry out economically beneficial maturity transformation. A banking "panic" occurs when things flip from the good type of equilibrium to the bad type: there is a run as depositors generally pull out their funding. Banks have to sell assets in distress, call in loans where possible, and halt new lending. Asset value gets greatly impaired in the process, so it is not irrational for depositors to run if they believe that others will, even if the banks would be perfectly solvent in the absence of panic. The same good/bad equilibrium story can be told in relation to the roll-over, or not, of short-term wholesale funding.

Public policy guards against the bad type of equilibrium in two main ways. The first is by the provision of lender-of-last resort (or "discount window") liquidity facilities by central banks. The traditional Bagehot advice on this support was to lend freely, but at a high rate and against good security, to illiquid but solvent banks. Second, governments guarantee some categories of deposit, typically retail deposits up to size limits. As with lender-of-last resort operations, deposit guarantees do not expose the public finances to risk of loss so long as the crisis is merely one of liquidity, and not one of solvency. However, the distinction between the two is not clear-cut.

The crisis of 2008 was clearly one of solvency, not just liquidity, and government support has gone massively beyond liquidity support – to asset purchases, capital provision, and other forms of bail-out. The European Commission (2012*b*) estimates that 4.5 trillion euros of taxpayers' money has been deployed to rescue banks in the EU. Governments got so drawn into supporting the banking system – even to the extent of jeopardising their own solvency in some cases – for the simple reason that the alternative of standing back was worse. In particular, governments could not allow interruption, let alone failure, of the continuous provision of core banking services for which ordinary households and small businesses have no ready alternative. Failure of those services would have meant that payment systems, the safeguarding of deposits and the provision of credit in the economy would all have seized up, with incalculable economic and social consequences. The result is effectively a large subsidy to activities that gave rise to the crisis. Objectionable though this is from the point of view of both incentives and income distribution, non-intervention was not "time-consistent", and pre-commitment not to intervene would not be credible.

One striking feature of what happened in the crisis is that, while providers of equity and holders of subordinated debt lost money, bondholders (even unsecured) as well as depositors generally came out whole, even as public funds were injected on a very large scale. This contravened the natural order of loss-bearing, in which unsecured bondholders should bear losses not absorbed by shareholders, with the taxpayer as loss-bearer of very last resort. Why then did it happen? The essential reason is that bondholders bear loss only in bankruptcy, and governments could not let bankruptcy happen because of the imperative of continuous core service provision set out above. Another reason is that debt ranked equally with deposits, many of which are government guaranteed, in terms of liability to loss. So, in effect, taxpayers were marched from the back to near the front of the queue of loss taking, with large resulting damage to the public finances in the affected countries, even before account is taken of the fiscal consequences of the associated macroeconomic recession.

In principle, the hierarchy of loss-bearing is related to the hierarchy of control rights and hence to risk-taking incentive structures. In textbook terms, equity holders bear first loss and have control rights unless there is bankruptcy, in which case control shifts to bondholders. In practice, of course, there might be various classes of equity, of debt (*e.g.* secured *versus* unsecured), of hybrids such as convertible bonds, and in the case of banks of deposits. In normal corporate settings, providers of debt finance, although they don't exercise day-to-day control, can shape corporate decision-making by way of the conditions and/or collateral attached to their debt funding. In particular, providers of debt finance normally have strong incentives to ensure that excessive risks are not run, because they lose out if risks go bad, whereas upside risk is captured by shareholders and/or employees on highly-geared incentive contracts. Despite banks being highly leveraged compared with other kinds of business, the influence of providers of debt finance to banks has been limited.[8] Depositors have neither the ability nor incentive to exert influence, and neither do bondholders if they expect to be shielded from loss in any event. If contingent liability rests with taxpayers, market incentives to discipline bank risk-taking are poor.

Another striking feature of the government rescues of banks in the crisis was its comprehensive, indeed unfocused, nature. The balance sheets of troubled banks were so broad, complex and intermingled that governments did not have

[8] Recently, however, there are signs that banks' debt financing costs are becoming more risk-reflective, which helps discipline risk-taking.

the option of saving some business lines but not others. In particular, they could not target support on the core banking services whose continuous provision is imperative. So, on top of thin loss-absorbency by the private sector, the scope of public support was much more extensive than would have been necessary if banking structures had allowed the option of targeted policy intervention.

The next two sections discuss how to remedy these shortcomings for the future by reforms to improve the ability of banks' shareholders and bondholders, rather than taxpayers, to absorb losses, and to establish more resilient structures for banking by forms of separation between retail and investment banking.

4. - Some Economics of Loss-Absorbency

Banking, including retail banking, is inherently risky. Credit risk – *i.e.* the risk of not being repaid in full – exists with all forms of lending, including to sovereign governments. The protection offered by collateral, such as with residential property mortgages, is not total because asset values can tumble. So even for well-diversified banks, substantial losses are always possible, and for market economies to work satisfactorily the banking system must be able to absorb them without jeopardy to the continuing provision of core financial services. Such resilience was woefully lacking in 2008.

The standard regulatory approach is in terms of capital *ratio* requirements. But before considering how high they should be, it is worth reflecting on whether they are the right approach. Thinking of financial crises as massive negative externalities, it might seem a more natural economic approach to tax the externality-generating activity to align private incentives better with the public interest, and perhaps to create a fund with the proceeds to deal with possible future crises. For example, Kocherlakota (2010) proposes that "just as taxes are imposed to deal with pollution externalities, taxes can also address risk externalities".[9] Moreover, taxation might seem the natural offset to the implicit subsidy to risk that arises from the prospect of direct or indirect government bail-outs. But the capital *ratio* regulation of banks that is used in practice seems on the face of it to be rather different from taxation.[10]

[9] ACHARYA V. *et* AL. (2012) likewise propose an externality tax on banks on the basis of their expected contribution to systemic risk.

[10] Some forms of taxation to address systemic risk issues are also being introduced in practice: see COULTER B. *et* AL (2012) for some discussion and references.

We examine the issues in Coulter, Mayer and Vickers (2012). First, we show that the economics of pollution externalities has limited applicability to banking risk externalities. Inherent in a banking crisis is the inability of banks to meet their financial obligations, so the "polluter pays" principle cannot be applied to banks after the event. They could nevertheless be required to *pre-pay* in some form, such as via a levy.

Our second point is that, when one compares forms of pre-payment by banks, the distinction between "taxation" and "regulation" (*i.e.* of capital *ratios*) becomes unclear. For example, compare *(i)* capital *ratio* regulation with *(ii)* a pre-paid capital levy per unit loan to create a fund to deal with future crises. Under some conditions – perfect risk correlation across banks, return on levy funds independent of who manages them, and no net transfers to or from government – options *(i)* and *(ii)* are *equivalent*. This indicates that the question is not well posed as "taxation *versus* regulation", but involves deeper issues, including the following. How correlated are risks across banks? Who owns the fund of levies while there is no crisis? How are levy proceeds invested while there is no crisis? How are they disbursed if there is a crisis? What happens to control rights in a crisis?

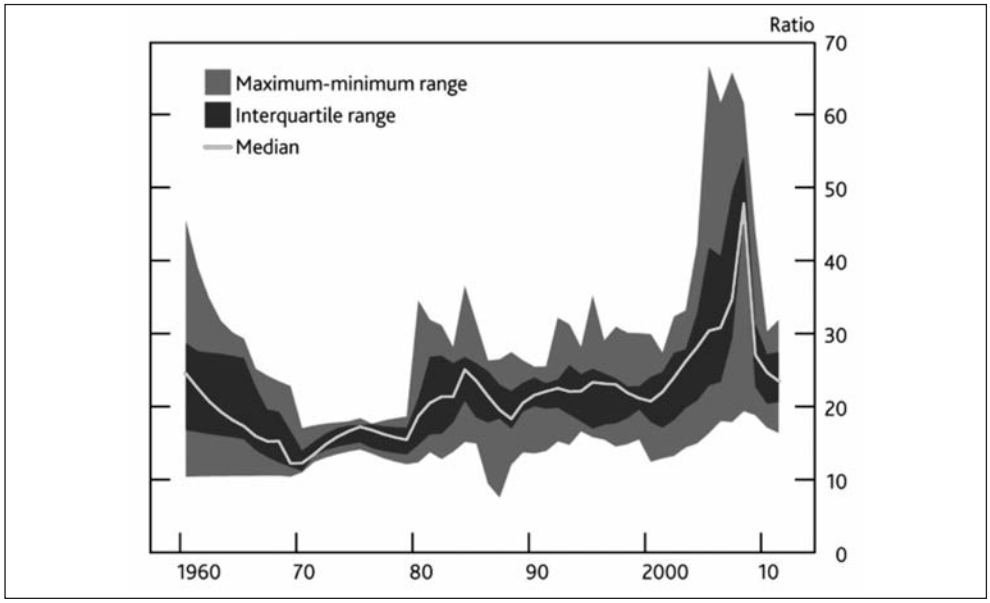
Our third and main point is that forms of taxation, unless in the form of pure capital, are a double-edged sword because while taxation curbs risky lending by raising the price of loans, it thereby increases funding needed per loan. The latter effect increases the potential negative externality from a financial crisis. So unlike pollution externalities, the potential financial crisis externality is itself directly and adversely affected by taxation, unless the taxation takes the form of pure capital. But in that case it is akin to being capital *ratio* regulation and we have come full circle.

How then to make banks better at absorbing losses? The first and best layer of loss-absorbency is equity capital.[11] What matters is capital in relation to potential losses. Leverage, which is the *ratio* of bank assets to capital, is one measure of this. Graph 1 shows for UK banks how leverage soared in the run-up to the crisis, to levels of forty and fifty, more than double the historical norm. You do not need new economics to know that leverage at such heights is an accident waiting to happen.

[11] Known as Common Equity Tier 1 (CET1) in regulatory parlance. On this and other types of regulatory capital, again see ICB (2011, Box 4.2).

GRAPH 1

UK BANKS' LEVERAGE



Source: BANK OF ENGLAND, *Financial Stability Report,* June 2012, Chart 2.15.

In principle a better measure of capital adequacy in relation to potential losses is capital in relation to *risk-weighted* assets (RWAs). Capital relative to RWAs is the centrepiece of bank regulation internationally under the Basel accords. Risk-weighting makes good sense as an approach but faces problems both in theory and practice. The theoretical issue is that the riskiness of assets, or indeed institutions, in isolation is not the key issue. Rather, it is their contribution to *systemic* risk that matters.[12] The practical problem is the plain fact that regulatory risk weights failed to measure risk in the years preceding the crisis. As risk was mounting, risk weights were falling, and it was this that allowed leverage to balloon despite requirements on banks' capital in relation to RWAs.

As was outlined in section 2, under Basel III banks must have capital of at least 7% of RWAs by the start of 2019. Global systemically important banks will be required to have more, on a sliding scale up to 9.5%. Risk weights are being revised. It is also proposed in Basel III that capital must be at least 3% of un-

[12] As stressed in BRUNNERMEIER M., ADRIAN T. (2011) CoVar approach and by ACHARYA V. *et* AL. (2012).

weighted assets, so leverage cannot exceed 33.[13] Although much better than the pre-crisis situation, this still allows a great deal of leverage in the reformed post-2018 world. The obvious, and good, question is: why not move to capital requirements much higher than Basel III?[14]

Many in the banking sector strenuously resist the idea of high capital requirements, arguing that they raise the cost of capital and hence the cost of credit, with serious damage to economic growth. This claim is wholly at odds with the basic proposition of corporate finance theory – the Modigliani-Miller (1958) theorem (MM) – that under particular assumptions the cost of capital is independent of debt-equity structure. Equity-holders require a greater return than bondholders because as first loss-bearers they face more risk. But as a firm increases its equity/debt *ratio*, the risk of both equity and debt decrease, and the firm's aggregate cost of capital is unchanged. In short, the aggregate value of the firm's paper depends on the underlying value of the firm, not on the proportions of its paper that are debt and equity. Otherwise, moreover, there would be an arbitrage opportunity. If the MM theorem applied to banks, higher equity requirements would entail no long-run cost at all.

Opponents of higher capital requirements object that MM does not apply in reality, and especially not to banks. There are two ways of responding to this. One is to make the blunt yet sound point that, whether or not MM applies, a bank that claims that it must pay its shareholders a 15% (say) annual return on equity, when the risk-free rate is close to zero, is effectively saying that it is a seriously risky bank.[15] The public interest requires that such banks have more equity. The second line of response is to recognise that of course MM does not apply precisely. Like all economic theorems it is conditional on its assumptions,

[13] This leverage cap relates to Tier 1 capital, which is CET1 plus some additional kinds of capital such as preference shares. So in relation to equity capital in the sense of CET1, the leverage cap is looser than 3%. The ICB recommended that a tighter leverage cap – allowing no more than 25 times leverage – should apply to the large UK retail banks, in line with their higher capital requirements. Alas the Government (HM TREASURY, 2012*a*) has not accepted this recommendation.

[14] ADMATI A. *et* AL. (2010) and MILES D. *et* AL. (2012) argue for capital requirements much higher than Basel III. KOTLIKOFF L. (2010) in his Limited Purpose Banking proposal goes so far as to advocate, in effect, 100% capital requirements. Financial activity would be undertaken only by mutual funds not allowed to borrow. That would end banking as we know it, with (in my view but not Kotlikoff's) huge losses of economic efficiency compared with a world of well-regulated banks (as we know them).

[15] Martin Wolf has made this point to particularly good effect.

and these are stylised. MM is still a very illuminating benchmark that provides a basis for considering the ways in which reality differs from its theoretical assumptions. The question is then whether more realistic assumptions weaken or strengthen the conclusion that higher equity requirements on banks would not significantly increase costs. In answering this it is crucial to distinguish between *(a) private* costs to current shareholders (and those with highly-geared remuneration) and *(b) social* costs to the economy as a whole.

There are several points to be made – on tax, bankruptcy, the public finances, incentives, regulatory arbitrage, and transition costs. Most corporate tax systems give debt tax advantages over equity,[16] so (perversely in the context of banks) encourage leverage. This private advantage of debt finance goes some way to explaining the private sector resistance to higher capital requirements, but it is not a social cost.

The next issue is bankruptcy costs. When bankruptcy is costly to suppliers of finance, equity has the merit over debt that it reduces the probability that those costs will materialise. In the case of banks the social costs of bankruptcy are far greater than the private costs, so again there is a wedge between private and social interests. Indeed, as discussed above, the prospective social costs may be so great as to compel governments to stave off bankruptcy by bail-outs. But that undoes the private incentive to guard against it. Prospective bail-outs cheapen the private but not social cost of debt relative to equity.

This leads to a major reason why MM is not fully applicable to banks – the fact that the public finances are to some extent exposed to bank losses, through deposit guarantees and prospective rescues should crises happen.[17] The government, and ultimately the public, are therefore (contingent) creditors of banks. Increasing equity then shifts risk back from the public finances to private investors, thereby increasing private funding costs. But the creditworthiness of the government improves as that happens, lowering government borrowing costs. So MM might hold taking the public and private sectors together, while it fails for the private sector in isolation. Again we have a reason why private and social incentives for greater bank capital may diverge.

Incentive issues are another feature absent from MM that helps explain why financial structure does matter. Principal-agent relationships vary with financial

[16] One needs also to consider how income and capital gains from equity are treated in the personal tax system, but this does not undo the tax advantages of debt.

[17] This is one of the points emphasised in Miller M. (1990).

structure, which may create a valuable incentive role for debt in addition to equity.[18] For example, bondholders may well have more incentive to monitor downside risks than equity holders, who are more focussed on upside returns when there is limited liability. But this is hardly an argument for a thin capital layer.[19] And if there is a prospect of taxpayers being on the hook for bank losses, the incentive for bondholders to exert discipline on risk-taking is diluted. Risk-taking that threatens major negative externalities, far from being discouraged, is then subsidised. Only if risk lies fully with private funders of banks will market forces properly discipline risk-taking.

A different line of argument concerns regulatory arbitrage. If banks, but not other financial institutions, had to face much higher capital requirements, then business might migrate inefficiently from banks to those institutions, possibly to the detriment of financial stability overall. Likewise, if higher requirements applied to banks in some countries but not others, then undesirable geographic arbitrage might unintentionally be encouraged. (Such considerations might also help explain private sector resistance to less-than-universal increases in capital standards.) This was an important reason why the ICB did not go further above the Basel baseline in its loss-absorbency recommendations, and why, subject to major *caveats*[20], we recommended that international standards should apply to the international business of UK banks outside their UK retail subsidiaries. If our remit had had wider geographic scope, we might well have recommended still higher capital requirements.

The final issue to mention on MM is transition costs. The MM theorem compares alternative steady states. In practice one has to proceed from the state of affairs that exists now. This gives a further reason for resistance by current shareholders to issuing more capital. Many of the benefits of greater capital are likely to flow to others than current shareholders, especially if the *status quo* has too little capital. The risks faced by bondholders and the public finances decrease,

[18] DEWATRIPONT M. and TIROLE J. (1994) provide a theoretical analysis of debt-equity complementarity. The ICB made a number of recommendations to make debt, in addition to equity, credibly loss-absorbent, as described below.

[19] Neither is the idea that it is desirable to have so much of bank funding in terms of deposits that there isn't room for more than a few percentage points of equity funding. Equity could be a significant multiple of its current level without squeezing deposits at all.

[20] In particular that large UK banks have credible resolution plans including adequate loss-absorbing debt across their overseas as well as UK operations. The Government has not fully accepted this recommendation – see HM TREASURY (2012*a*, par. 3.26) and (2012*b*, par. 2.59).

but existing shareholders do not capture those benefits. In short, increasing equity yields positive externalities, so without regulatory intervention there is insufficient incentive to do it. However, transition costs matter for public policy too. In the current macroeconomic malaise, a rapid increase in required capital/lending ratios could unduly squeeze the denominator, *i.e.* lending to the corporate and household sectors. While this gives every reason to press ahead with raising capital levels (the numerator), this is an argument to set an unrushed time schedule for capital *ratio* reform, as the ICB recommended in line with the Basel timetable, but certainly not to shy away from reform.

Higher capital requirements were not the only element of the ICB recommendations on loss-absorbency. We also made a series of recommendations to make debt more credibly loss-absorbent – by "bail-in", by depositor preference, and by requirements to have sufficient "primary loss-absorbing capacity" (PLAC) to ensure that there is a layer of bank debt, of a kind not vulnerable to runs, that would absorb loss if a bank got into serious difficulty, without bankruptcy needing to occur.

This requires the establishment of policies and procedures for a situation intermediate between business-as-usual and bankruptcy. In this *resolution* process the authorities seek to sort out the various business of a failing bank in an orderly way that ensures the continuation of core services while minimising the risk of taxpayer liability and wider damage to the financial system. Depending on the nature of the crisis and the bank(s) concerned, resolution is likely to involve different approaches for different aspects of a bank's business. Some assets and liabilities might be sold or taken over by other banks, others wound down, and others put into a "bridge bank", which might be state owned for a transitional period, so that basic service provision is not interrupted.

Credible resolution needs structural reform so that orderly resolution, rather than indiscriminate bail-out, can be conducted in crisis conditions. Structural reform is the subject of the next section. Credible resolution also requires loss absorbency much deeper than that ensured by with Basel III equity capital *minima.* In particular, unless the bank has equity funding well above those *minima*, which would be desirable but is unlikely given the private/social incentive divergences with respect to increasing equity discussed above, an adequate amount of debt with certain characteristics must be written down or converted to equity, and there needs to be a credible process for this to be done.

This process will not work well for secured debt because its holders have ownership rights over collateral. Neither can it sensibly apply to government-guaranteed deposits, because that would institutionalise taxpayer bail-out, which it is a

paramount objective to avoid as far as possible.[21] To reinforce this, the ICB recommended that guaranteed deposits rank ahead of all other unsecured creditors in insolvency. There are also potential problems with very short-term debt being at the front line of loss absorption because as signs of trouble appear it might rapidly dry up, intensifying rather than absorbing distress. This points to long-term unsecured debt as the best kind of debt for loss-absorption in resolution.

As to the processes for loss-absorption, these are automatic for equity – since its value is by definition the difference between asset value and the value of non-equity liabilities. For some kinds of non-equity, there might be market processes, well short of resolution, for loss-absorption. For example, "contingent capital" is debt that converts to equity if some trigger point, perhaps involving an equity/assets *ratio*, is reached. The trigger might be set well above the point at which a bank would be taken into resolution, and thereby provide a good prospect of a market solution without regulatory intervention. "Bail-in", by contrast, is the shorthand name for the imposition of losses (by write-down or conversion to equity) at the point of failure. This could happen by the exercise of regulatory powers in resolution, so long as they exist in law. A central ICB recommendation is that the authorities should have just such powers, and in relation to sufficient debt. They are also a key element of the European Commission's (2012*a*) proposals on recovery and resolution.

For loss-absorption to be effective there needs to be enough bail-inable debt in addition to types of equity capital. To that end the ICB recommended that, depending on their size and systemic importance, UK banks should have PLAC of at least 17% of RWAs. Equity would be most of this – at least 10 of the 17% – and could be all. The rest is however more likely to be bail-inable debt and perhaps, if a bank wished, some contingent capital too. We recommended further that up to an additional 3% of equity capital could be required of a bank about which there are regulatory concerns about resolvability. This leads naturally to the issue of structural reform.

[21] This point does not apply if there is a big enough deposit guarantee fund, but even large funds can be quickly wiped out in systemic crises.

5. - Some economics of structural reform

If the equity capital and other loss-absorbency of banks were so great as to remove all substantial divergence between the private interests of banks and the public interest, there might not be a strong case for public policy to regulate the structures of banks. But there is no realistic prospect of this condition being met, and in particular, the Basel III reforms to capital requirements are insufficient to ensure it. There are two broad, inter-related reasons why structural reform should be an element of banking reform – curtailing the implicit taxpayer subsidy, and limiting the probability and severity of negative externalities arising from banking crises.

The most important structural regulation of banks in the twentieth century was the Glass-Steagall separation between commercial and investment banking in the US introduced by the 1933 Banking Act. Sections 20 and 32 of that Act prohibited affiliation between banks and companies engaged principally in the business of underwriting securities &c. Having been eroded by regulatory permissiveness, these provisions were finally repealed in 1999. Sections 16 and 21 of Glass-Steagall remain in place. Among other things they prohibit deposit banks, but not now their affiliates, from underwriting or trading in corporate securities. These provisions, together with sections 23A and 23B of the 1933 Federal Reserve Act[22], amount to a light form of ring-fencing.

It is no coincidence that the 1933 Banking Act also established federal deposit insurance. The rationale for deposit insurance (see above) has nothing to do with investment banking activities, but without some form of separation there is nothing to stop insured deposits effectively funding them. Since banks are not riskless, and since it would be hopelessly impractical for the authorities to "price" deposit insurance according to the fluctuating riskiness of each bank's activities, the result is a potentially major incentive distortion in favour of investment banking risk-taking at the contingent expense of the public finances. This not just a point about deposit insurance: the same is true of lender-of-last-resort facilities and the prospect of government solvency support to maintain the continuous provision of core banking services.

Even if the implicit subsidy were eliminated, investment banking risks could still jeopardise core banking services in the absence of structural measures. If there is no separation between the capital that is funding trading and/or international[23]

[22] See footnote 28 below.

[23] Throughout this paper "international" should be understood to mean outside Europe.

activities on the one hand and the capital supporting core retail services on the other, then losses on the former put the latter at risk. (Qualitatively, but probably not to the same extent, the reverse is true too. But, depending on the nature of the crisis, the authorities are likely to have less, though not zero, concern about a bank's investment banking arm going down.) Separation helps stop damaging contagion spreading within banking organisations.

If and when crises nevertheless happen, separation has the further advantage of facilitating resolution (see above). Indeed it is hard to see how the authorities can apply targeted, as distinct from undiscriminating, crisis management policies unless there is ready separability between different kinds of activities within banks. Depending on the nature of the crisis they faced, the authorities might want to follow quite different approaches for retail banking, given the importance of core service continuity, and wholesale/investment banking. Further, it is hard to see how such separability can be effective, especially in a crisis, without some degree of separation already in place. As well as facilitating crisis resolution, separation can help risk monitoring by supervisors and market participants in normal times too.

There are arguments against separation. One line of objection is that it loses benefits of diversification.[24] For example, there are some situations where a separate domestic retail bank would fail – say because of a domestic property market crash – which would have survived if it had been part of a banking group with wider scope geographically and/or functionally. This is not a compelling point against separation generally, but does have relevance for the design of separation – see below.

Another objection to separation is that, while separation might help get the taxpayer off the hook for risks in international/investment banking, it increases the probability and extent of taxpayer liability for domestic retail banking. But this ignores the role of enhanced loss-absorbency for retail banking to contain that risk. Indeed only by some form of separation can one have higher-than-international capital standards for domestic retail banking while international standards apply to international business. Thus can more resilient domestic banking be combined with continued competitiveness of international banking (without which geographic regulatory arbitrage could also be detrimental to financial stability[25]).

[24] This objection is invalid to the extent that investors can achieve diversification benefits through their portfolio decisions, without corporate integration.

[25] The risk of geographic arbitrage is much greater in wholesale than retail banking but could become significant in the latter case if national reform diverged too sharply from international standards. The ICB considered that its proposed reforms do not create such a risk.

To consider further the *pros* and *cons* of separation between "retail" and "investment" banking, let us look at some leading possibilities. They vary according to *(i)* which banking activities are separated from each other, and *(ii)* the form that separation takes.

So-called "narrow banking" is the idea that the basic services of deposit-taking and payment systems should be separated from other, inherently risky, banking activities by a requirement that deposits are fully backed by safe liquid assets. This idea faces several problems. First, as the crisis has underlined, even government bonds are not necessarily safe liquid assets. Second, despite large government debts, there might not be enough government bonds to back retail deposits, especially of short- to medium-term maturity. Third, narrow banking could lead to a very inefficient misallocation of resources. Natural holders of government bonds such as pension funds would find them in short supply, while credit in the economy was deprived of a prime funding source – deposits. Narrow banking would also lose the natural synergy that exists between deposit-taking and the provision of overdraft facilities. Fourth, deposit-taking and payments systems are not the only banking services for which continuous provision is essential; the same is true of some credit supply, which would happen outside the narrow bank. So narrow banking, despite entailing large economic costs, would not address a major part of the problem.

Whereas narrow banking would isolate deposit-taking and payments from all other banking services, the Volcker Rule[26] being applied in the US prohibits proprietary trading by banks (and limits their hedge fund and private equity activity) while allowing them to combine other banking services. The spirit of the Volcker Rule has much in common with Glass-Steagall and with the ICB recommendations, which it influenced. For several reasons, however, we concluded that it would not be right to recommend the Volcker Rule for the UK instead of retail ring-fencing, nor as a supplement to it.

First, as the US experience of regulatory rule-making is showing, the rule seeks to draw a line in a very difficult place. For one thing, it is hard to distinguish – both in theory and practice – between customer-oriented market-making by banks and proprietary trading. Second, we concluded that the rule does not go far enough for the UK because there is a wide array of investment banking activ-

[26] The rule is enacted by section 619 of the Dodd–Frank Wall Street Reform and Consumer Protection Act of 2010. Chapter 7 of Acharya V. *et al*'s (2011) comprehensive economic analysis of the Act covers the Volcker Rule. Congress weakened the rule as proposed by Paul Volcker by allowing banks to engage in hedge funds and private equity to some extent.

ities beyond proprietary trading from which core retail services should have a degree of insulation. Third and on the other hand, the rule goes further than necessary by prohibiting proprietary trading anywhere in an entity that does banking.[27] Ring-fencing, by contrast, separates trading &c from retail banking but allows it elsewhere in banking groups. Fourth, the Volcker Rule must not be viewed in isolation but in its US context, which differs from the situation in the UK and elsewhere in respect of both risks – *e.g.* banks in the UK have proportionately much more international exposure – and regulation. In particular, US regulation restricts banks' dealings with affiliates, which can be seen as a degree of ring-fencing.[28]

More far-reaching than the Volcker Rule would be to separate trading, including market-making, from commercial banking. The Liikanen (2012) proposals for the EU recommend such an approach, together with measures to boost loss-absorbency, as discussed in section 6 below. Separation of trading avoids difficulties of distinguishing between types of trading and gives retail banking insulation from a wider range of trading risks than the Volcker Rule. But it does not give any protection to domestic retail banking from other banking risks. For example, separation based on trading, without more, would still allow a retail bank to buy assets (*e.g.* covered bonds issued by other financial institutions or overseas mortgage-backed securities[29]) giving rise to exposure to non-retail financial and international risks, so long as it intended to hold rather than trade those assets.

In part for these reasons, the ICB's central structural recommendation for UK financial stability is retail ring-fencing. The draft legislation to implement ring-fencing begins by giving the regulators the "continuity objective" of protecting the continuity of provision in the UK of "core services", which are taking deposits from individuals and SMEs, and related payments and overdraft services.[30] UK

[27] We therefore did not recommend the Volcker Rule *in addition* to ring-fencing. That would however be a coherent policy combination, and it is perhaps at least as worthy of debate as the "Volcker *versus* ring-fencing" question.

[28] In particular, dealings between banks and their affiliates are limited and constrained by the Fed's Regulation W, which implements sections 23A and 23B of the Federal Reserve Act of 1933, which section 608 of the Dodd-Frank Act has substantially widened and strengthened.

[29] SHIN H. (2012) shows the importance, in the run-up to the crisis, of European global banks in intermediating between US households (*e.g.* holders of money market mutual funds) and US borrowers (*e.g.* subprime mortgage borrowers) through the shadow banking system.

[30] HM TREASURY (2012*b*). The draft legislation also provides for depositor preference – *i.e.* deposits covered by the government's deposit guarantee scheme would rank senior to other debt in insolvency.

institutions with permission to carry out core services – "ring-fenced" bodies – may not carry out "excluded activities" or contravene "prohibitions". Dealing in investments as principal is the only excluded activity initially specified, albeit a very broad one (and very much wider than the Volcker Rule). The Treasury may specify others as judged necessary for the continuity objective. The draft legislation likewise empowers the Treasury to prohibit ring-fenced bodies from entering into transactions of specified kinds or with kinds of counterparty, and to make geographic and ownership prohibitions (*e.g.* on having branches outside Europe).

Depending how the Treasury exercises these powers, they enable implementation of the ICB recommendation that the following should not be permitted within the retail ring-fence: services to non-EEA customers[31], services (other than payments services) resulting in exposure to financial customers, "trading book" activities, services relating to secondary markets activity (including the purchases of loans or securities), and derivatives trading (except as necessary for the retail bank prudently to manage its own risk). These activities have in aggregate accounted for most of UK bank balance sheets in recent years. There is however a wide range of commercial banking activity that is neither required to be in the ring-fenced body nor excluded/prohibited from it. This includes taking deposits from customers other than individuals and SMEs, and lending to large non-financial businesses. It will be up to the banks and their customers whether such business is transacted within or outside the ring-fenced body. This flexibility is efficient and consistent with the continuity objective for core services.

The permitted interactions between a ring-fenced body and the rest of a group to which it belongs will be determined by regulatory rules. Among other things these will ensure that such interactions are on a third party basis, and that the ring-fenced body's independence is strongly secured.

The strongest guarantee of independence would be fully to split retail and investment banking – *i.e.* to prohibit investment banking altogether in a group that does retail banking. The Glass-Steagall legislation in the US from the 1930s to the 1990s was a form of full separation.[32] So why not adopt full separation rather

[31] However, the Government's view is that ring-fenced banks could have counterparties and hold assets outside the EEA provided that this did not create a barrier to resolution – see HM TREASURY (2012*a*, par. 2.33). This is a questionable relaxation of the ICB recommendation, though without non-EEA branches the ring-fenced banks might be unlikely to have many such exposures.

[32] But as the history of Glass-Steagall itself shows, full separation is no guarantee against erosion over time.

than ring-fencing? Part of the answer is that it is likely to entail considerably higher costs than ring-fencing, as synergy benefits are lost.

Second, depending on the form of the next crisis, financial stability might be greater with ring-fencing than with full separation. In particular, with full separation there is no availability of non-UK-retail banking resources to ameliorate a retail banking crisis resulting from, for example, a slump in UK residential and commercial property prices. This reflects a diversification benefit of universal banking – the possibility that wholesale/investment banking, or retail banking elsewhere in the world, is performing well while domestic retail banking is not. If, on the other hand, UK retail banking were conducted only by similar, undiversified, stand-alone institutions with correlated risk profiles, there would be vulnerability to some kinds of domestic shock. So if the draft UK legislation went further, and banned dealing in investments as principal, non-European business, &c, from any group doing core activities – rather than banning them from the ring-fenced body – the result might worsen, not improve, financial stability.

Third, while there are some kinds of future crisis in which full separation would give stronger insulation of retail banking than ring-fencing, such as a shock emanating from outside Europe, the design of ring-fencing can offer important protections against such shocks. For example, the enhanced buffer of capital and loss-absorbent debt, plus depositor preference, guards against an international reputational crisis hitting retail banking. This solvency protection both reduces the risk of deposits running and makes more straightforward the provision of central bank liquidity if they nevertheless did so.

The ICB judged, therefore, that its recommended reform package would achieve the main aims of full separation at less cost, and without creating the risk to financial stability that could come from having an undiversified stand-alone UK retail banking sector. It is possible that, with the implicit government guarantee curtailed, some banks might choose to split themselves. That would be desirable if the distorted incentive arising from the implicit guarantee was the reason why they combined investment banking with retail banking. But tilting incentives in favour of separation by removing a distortion is a much more proportionate policy response than mandating full separation.

6. - Reflections on the European Debate

This is a timely moment to reflect, in conclusion, on European banking reform. The European Commission (2012*b*) published its roadmap towards eurozone banking union in September, and in October the high-level expert group chaired by Erkki Liikanen, Governor of the Bank of Finland, published its proposals for reforming the structure of the EU banking sector.

The Liikanen (2012) proposals have a lot in common with the ICB proposals for the UK in respect of both economic rationale and policy prescription. On structure, banks above certain size thresholds would have to conduct their trading activities in a separate legal entity from their deposit banking activities. Both could be within the same bank holding company but each would have its own capital. The trading entity could do a range of banking activities but not take insured deposits or provide retail payment services. As with the UK reforms, this is a form of ring-fencing – with a flexibly-located fence – and a move to *structured* universal banking. In addition, the Liikanen report proposes that further separation could be required by regulation if deemed necessary to ensure resolvability and the continuity of core service provision. Despite the structural focus of its remit, the group also made recommendations to enhance loss-absorbency – notably to build up bail-inable debt and to improve the robustness of risk weights in capital regulation. Finally, there are proposals to strengthen the corporate governance of banks.

There are also some differences between the Liikanen and ICB proposals. This is hardly surprising given that the ICB was focussed on the (atypical) facts of UK banking and was making recommendations, in a way fully consistent with EU law, for UK policy, whereas the Liikanen group was asked to make recommendations for the EU as a whole taking account of the enormous diversity of banking arrangements across the Union. One difference is that Liikanen would allow the deposit bank to engage in securities underwriting.[33] But securities underwriting by its nature creates large risk exposures – considerably more so than normal market-making and typical derivatives trading, which the deposit bank may not do. Liikanen also appears at first sight to be more permissive on the range of assets that the deposit bank could hold for non-trading purposes, although private eq-

[33] The contrast with Glass-Steagall, which completely prohibited securities underwriting by banks, is striking. The Liikanen report does however appear to create scope for securities underwriting to be excluded from some deposit banks under its proposal that further separation can be required if necessary for their resolvability.

uity investments, and loans and unsecured credit exposures to hedge funds, SIVs, &c would have to be held in the trading entity.[34] This still leaves open the possibility of a wide range of deposit bank exposures to other kinds of financial institution, and to non-European entities, which on the ICB's recommended approach the ring-fenced body could not take on. As the debate on the Liikanen proposals unfolds, these issues will doubtless be clarified.

The debate on European banking reform is entering a new phase now that structural reform is explicitly on the agenda. It is also fundamental to the moves towards eurozone banking union – with common supervision, joint resolution, deposit guarantees and measures of recapitalisation. A banking union with well-capitalised and safely structured banks has much more prospect of economic and political success than one without. In the latter case, banking union could mutualise, and thereby risk enlarging, the implicit government guarantee to banks, contrary to the shared European and international objective of curtailing it. Banking reform is needed whether or not there is banking union, but banking union needs banking reform.

[35] See LIIKANEN E. (2012) paragraph 5.5.1, which indicates that, unless resolution plans require otherwise, interbank lending, participation in loan syndications, plain vanilla securitisation for funding purposes, private wealth management and asset management, and exposures to regulated money market funds would be permitted in the deposit bank.

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WINNING PAPERS

Healthcare and Federalism: A Political Economy Approach

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Decisions over public healthcare are very intertwined with national political debates. The aim of this work is to analyze the features of public healthcare with the tools of political economy. When the provision is not redistributive, a coalition of middle income voters will be opposed by poorer and richer individuals. When taxation and healthcare provision are decentralized to regions, which differ among themselves in terms of income distribution, two effects are in action on the equilibrium level of healthcare spending: an income effect and an inequality effect. The latter effect will be the strongest if the system is not redistributive.
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1. - Introduction

Health is one of the most important aspects of the life of every single human being: a state of illness is able to impede basically all the activities of everyday's life. For this reason, health plays a major role in economics as well. From a micro perspective, health influences every individual's preferences and decisions in terms of allocation of resources, together with his productivity; from a macro perspective, the medical status of a population as a whole has an immediate impact on the accumulation of human capital, a fundamental component of economic development. Today, more than ever, the decisions about the optimal way in which this type of service should be provided are at the top of the political *agenda* in every country: a clear example of this is given by the intense debate over Obama's healthcare reform. From a strictly theoretical point of view, healthcare is not a public good, as it does not come with non-rivalry and non-excludibility in consumption. Nonetheless, over time and space, governments in all forms have engaged themselves in providing, in different ways and extents, the population with a minimum level of medical assistance, for reasons of equity but also to compensate for the great number of market failures which are inevitably involved with its provision (Di Matteo, 2000). Being not a public good, nonetheless, healthcare services are tradable on private markets, which − given the features of the service and the large role of individual risk − take the form of insurance markets (Hirschleifer and Riley, 1992).

Given the relevance of the political component in shaping each country's equilibrium features of the public healthcare sector, it seems meaningful to analyze them with a political economy framework: the task is interesting, in that it is something more than a simple political economics exercise. The presence of a private alternative to the public service changes voters' preferences in a direction that may prevent the simple application of the median voter theorem (Epple and Romano, 1994). In addition to this, in the attempt of performing a rigorous theoretical analysis, one should be careful in clearly stating whether the choice between private and public services is a binary one or whether it is possible, for each voter/user, to combine the two, as these two scenarios may lead to different equilibrium outcomes (Gouveia, 1996).

Last, but not least, the *locus* of the political decision over healthcare provision also plays an important role in the analysis: the determination of a majority voting equilibrium becomes in fact more complex in a fiscal federalism, where taxes are chosen and collected at the local level.

Starting from this literature on health and public good provision under a federal or centralized system, the object of the present work is hence to develop an analytical framework to understand the equilibrium features of a public healthcare system and its determinants, in a political context of democracy, in which healthcare is produced both by the government and by private providers. In this paper, and differently from the past literature (Gouveia, 1996), we focus our attention on healthcare quality; as a consequence, public and private are two alternative and mutually exclusive roads to obtain the service. The presence of a private alternative modifies individuals' preferences over the tax rate, which become non-single peaked: this introduces a layer of complexity in the analysis, which we are able to overcome using the approach of Epple and Romano. As will be clear from what follows, the results we obtain, coherently with these two previous works, are different according to a particular feature of the public provision system, *i.e.* its ability of redistributing resources across individuals, from the richest to the poorest. This characteristic proves to be peculiar in the analysis, as it drives individual preferences over tax rates. In a redistributive system of public good provision, in fact, where the good is financed with resources collected via a proportional income tax, poorer individuals will typically prefer a higher tax rate, as they understand they will receive more than they pay; richer individuals, on the other hand, will prefer a lower rate. Each individual's preferred taxation level will be therefore decreasing in his income. The opposite is true when the system of public provision does not involve redistribution of resources: poorer voters want lower taxes and the preferred tax rate will be increasing in income. Since the redistributive power of a system of public good provision depends on a multiplicity of factors and is not easy to assess or test, in this work we perform our theoretical analysis on two parallel roads, one considering a non-redistributive system and the other a redistributive one. As we will be showing, the presence of a private alternative to the publicly provided good is particularly relevant and interesting in the case of a non-redistributive system.

Having outlined the main features of the model and derived its main implications, we use the same framework to understand how the situation changes, and in which direction, when the system of tax collection and public provision is decentralized. Again, the analysis is performed along the two parallel roads of redistributive and non-redistributive public good provision. We consider here a situation in which local constituencies are not homogeneous between themselves in terms of income distribution, with a particular focus on income levels and inequality. As shown below, with such a starting *scenario*, different regions end up

with different equilibria in terms of public healthcare; these disparities depend more or less strongly on each of the two features of the income distribution, according to whether the public provision system entails or not redistribution of resources across citizens.

The main contribution of the paper is twofold; first, it is novel in focusing on healthcare quality, instead of quantity, as the key variable which is directly related to the amount of resources fueled into the public sector. Secondly, it includes in the analysis an alternative private market which, due to the peculiar public good under analysis, takes the form of an insurance market, in which the cost of healthcare depends on each individual's health risk level. In addition to this, the theoretical framework has been designed to fit the current italian situation, in which fiscal federalism is gradually being implemented, but the debate is still open on the desirability of such scheme from the point of view of poorer regions.

The main implication of our model is that, when the public healthcare system of provision is non-redistributive, the equilibrium policy outcome in terms of overall quality depends on income inequality, and on the size of the middle class: when this is very large, *i.e.* when wealth is distributed more equally within the community, the tax rate and the level of quality of healthcare is higher than in the case of a more unequal country. Hence, the effects and benefits of fiscal federalism depend on the internal income distribution of each region: in a country in which districts differ in terms of wealth and inequality, richer and more equal countries end up with a greater level of services quality, with the equality effect being stronger than the income level effect.

Last, but not least, we acknowledge that the literature on fiscal federalism has been lately focusing on issues of vertical and horizontal transfers, the possibility of opting out at the local level, and other instruments with which the usual problems associated with federalism can be partially smoothed. We omit these aspects here for two reasons. The first one is simplicity. The second one lies a bit in the focus and scope of the paper: the intent of the work is in fact to shed light on how a political equilibrium over spending on a peculiar good such as healthcare might change quite a lot from the case of a centralized system of taxation, to the case of a decentralized one. Moreover, the emphasis is put on the role played by income inequality in this process. The main message of this work is that, when different regions are left to "run alone" in public service provision and resource collection, it is not only the poor ones that fare badly, but especially the ones in which income inequality is greater. Nonetheless, the introduction of transfers and opt-out possibilities represents an interesting direction for further research.

2. - Literature

As already mentioned, healthcare and federalism have always been two heavily debated upon subjects. Fiscal federalism as a governmental organizative structure is indeed very popular among developed, but also less developed countries (Oates, 1999). Devolution of powers to local districts is often seen as a good way to improve public sectors' efficiency; moreover, these entities are also closer to the people, finding it easier to adapt the provision of goods to their needs. From a theoretical point of view, this is particularly true when such districts are non-homogeneous between and within themselves, in terms of income but also culture and ethnicity (Alesina, Baqir and Easterly, 1999). Furthermore, in a fiscal federation, risks are shared among constituencies, and eventually bring less harm on each of them (Persson and Tabellini, 1996). Decentralization, however, is not always an easy story. If local districts are required, for some reasons, to cooperate among themselves, there might be incentives to moral hazard (Persson and Tabellini, 1996): this is particularly true in countries like Italy, where cooperation between regions is needed to redistribute resources from richer to poorer regions, but how to maintain economic incentives to do well for the latter is still an open question. In addition, in a context of local public good provision, there might be a role for spillovers as well; in this case, decentralization will be economically preferable to a centralized system only under some conditions on tastes for public spending, and spillovers (Besley and Coate, 2002).

Several and different strands of economic literature have analyzed and discussed the various issues connected with the provision of public goods, in general, and healthcare in particular. Here, we focus on, and start our discussion from, the particular area of research that concentrates on understanding the dynamics of provision when a public alternative is available. The idea has his roots in a seminal paper by Epple and Romano (1996*a*), who build a model to characterize the majority voting equilibrium over a tax rate aimed at financing a particular good, provided both publicly and privately. In this first work, the good under analysis is education; in Epple and Romano (1996*b*), instead, healthcare is taken into account, and a mixture of public and private is allowed and proved to be Pareto-superior to any other alternative. A very similar work was conducted by Gouveia (1996). In our paper, we consider healthcare quality as the key variable of interest; as a consequence, public and private constitute two alternative and mutually exclusive roads. The presence of a private alternative modifies individuals' preferences over the tax rate, which become non-single peaked: this introduces a layer of complexity in the analysis, which we will try to disentangle.

3. - The Model

In this section we present a very simple static model used to analyze the characteristics of the equilibrium outcome of a majority voting in terms of fiscal policy, when taxes finance public spending on healthcare services provision, for which a private alternative is available. Our model follows the line of reasoning of Epple and Romano (1996*a*) (ER in what follows) and Gouveia (1996).

4. - Epple and Romano's Framework

The present paper departs and heavily relies on the framework presented, and results proven, by Epple and Romano (1996*a*); we believe it is useful to briefly discuss their findings here. In their works, the authors analyze a *scenario* in which public provision of a service coexists with a private market; the quality of the public good is determined by majority voting. As pointed out by Atkinson and Stiglitz (1980), the presence of a private alternative results in non-single peaked preferences over the public good. Since majority rule is typically the point of departure for the analysis of the formation of political decisions over public good provision, this gives rise to difficulties in finding a political economy equilibrium, in terms of public goods. The authors' main contribution is their ability to characterize such equilibrium. In fact, they recognize that, in such a *scenario*, a majority voting equilibrium exists if preferences feature the single-crossing property, without any restriction on the utility function: when this property holds, the median voter is pivotal for the public choice. On the other hand, when the property is violated, an equilibrium can still be characterized, but the pivotal voter will be, on average, poorer than the median: the equilibrium in this case will be such that voters with very low and very high income levels will prefer lower tax levels, contrasting a middle-income class with opposite preferences. In addition to this, the contribution of their work lies on having recognized how this fundamental single-crossing property depends on the attributes of demand over the good itself, and might hence be better suited for some types of public goods than for others. When discussing their results, the authors focus on public education as an example of public good with a private alternative, over which preferences leads to a political equilibrium of the "Ends Against the Middle" type.

5. - Theoretical Framework

For the purpose of our analysis, we consider a country in which the population of voters is modelled as a continuum of rational (utility-maximizer) individuals, indexed by i, who differ in income, y_i and in a health risk factor p_i. The latter represents individuals' probability of getting sick and being in need of healthcare services. Income is distributed as follows:

$$y_i \sim F(y_i) \text{ such that } \forall i, y_i \in \left[\underline{y}, \bar{y}\right] and \int_{\underline{y}}^{\bar{y}} y_i \, dF(y_i) = \hat{y} = E(y_i)$$

Income distribution is skewed to the right: $y^m < \hat{y}$, where y^m is such that by $F(y^m)=0.5$. The health risk factor p_i is distributed as follows:

$$p_i \sim S(p_i) \quad \text{such that } \forall i, \int_0^1 p_i \, dS(p_i) = \hat{p} \text{ and } = \forall i, y_i, p_i \sim \Theta(y_i, p_i)$$

Individuals have preferences over two types of goods: a consumption good, c_i and healthcare services, qh, where h denotes the amount of services, which we take as exogenous and normalize to 1, and q is the level of quality of the service, *i.e.* our variable of interest. One may wonder why we decide to let quality, instead of quantity, be endogenous here. A reason for this is that we want to highlight how decisions over public spending in healthcare services are taken, via a majority voting mechanism. Given this, in most countries, such as Italy, the public sector offers a "fixed" array of services, one may think that variation in spending, hence, translate in variations in quality of the service that is provided. On the other hand, quality is likely to affect each user's utility in a direct way, *i.e.* to enter her utility function. The utility of individual i is hence:

$$U(c_i, qh) \text{ such that } U_1 > 0,\ U_2 > 0,\ U_{11} < 0,\ U_{22} < 0,\ U_{12} > 0,\ U_{21} > 0$$

where U_1 denotes the first derivative with respect to c_i, U_2 the first derivative with respect to q, U_{11} the second derivative with respect to c_i, U_{22} the second derivative with respect to q; U_{12} and U_{21} are cross-derivatives[1]. In this model, a central government intervenes in the economy producing healthcare services. This public

[1] The assumption $U_{12} \geq 0$ is quite realistic: marginal utility of the consumption good is greater if the individual is more healthy, which is more likely to happen if better healthcare is available.

sector provides the fixed *per-capita* amount h of services, with a quality level equal to g, using revenues from a proportional income tax. We define g as follows:

$$\int_0^1 \gamma g p_i \, dS(p_i) \leq \int_{\underline{y}}^{\bar{y}} t y_i \, dF(y_i) \tag{1}$$

where t is the tax rate, and γ is a unitary production cost. For the moment, we assume that the public sector provides healthcare to the whole population.

Public health provision, however, is not the only channel for individuals to obtain care: there exists, in fact, a private insurance market, where individuals can subscribe an insurance contract to cover all expenses related to healthcare. The quality level produced by the private sector is equal to m, which we take as exogenous, and which is defined as follows:

$$\hat{p}I = \hat{p}\lambda m$$

where I is the value of the insurance, *i.e.* the amount of services received by every subscriber in case of sickness; assuming actuarially fair premiums and, for the moment, that every individual faces the same risk factor $\hat{p}$, $\hat{p}I$ is the premium related to the insurance contract. We denote the unitary production cost of the private sector by λ.

In this model, individuals form preferences and vote over the tax rate t; differently from Gouveia and ER, however, we assume the amount of *per-capita* healthcare services, h, to be fixed both in the public and in the private sector. Our endogenous parameter, which will drive both the political and the economic decisions, is therefore the level of quality of the public sector, g, as defined by the government budget constraint (GBC in what follows) in *(1)*.

6. - Individual Decisions

Given the features of our model and the assumptions we just made, the political equilibrium in the representative country we are considering is the result of the following individual decisions, in chronological order:

1. political decision, *i.e.* vote over $t(g)$;
2. economic decision, *i.e.* the choice between the private alternative ("going private") and the publicly provided service ("staying public"): this boils down in having, in each individual's utility function, either $q=g$ (publicly provided good) or $q=m$ (private insurance).

In the present model, as opposed to past literature, it is meaningful to consider the two provision channels as mutually exclusive. Indeed, the choice between public and private depends on the relative level of quality of one sector with respect to the other; if an individual decides to buy a private insurance, he automatically discards the public healthcare system and satisfies his needs only with the insurance coverage, as the driver of the choice is the service's level of quality, which obviously cannot be "mixed" across suppliers.

We analyze the problem using backwards induction, *i.e.* starting from the last decision in chronological order.

Economic decision. At this stage, each individual has to choose a provision channel to obtain healthcare services; assuming rationality of every individual, the driver of this choice is utility maximization. To make the decision, therefore, a generic individual i compares the utilities he will obtain in the two cases:

- $U\left(y_i(1-t), g\right)$ such that $g = \frac{t\hat{y}}{p\gamma}$, if he chooses the publicly provided good;
- $U\left(y_i(1-t) - \pi_i \lambda m, m\right)$ where $\pi_i = p_i$, if he chooses the private insurance.

The presence of a double heterogeneity (y_i and p_i) complicates our analysis. For the moment we concentrate on income heterogeneity, assuming that every individual faces the same health risk $\hat{p}$; moreover, we assume that $\hat{p}$ is orthogonal, *i.e.* independent, on individual income. We are going to relax this assumption later on.

An individual i is indifferent between public and private when the following holds:

$$U\left(y_i(1-t), g\right) = U\left(y_i(1-t) - p_i \lambda m, m\right) \tag{2}$$

From the above equation we are able to find a threshold tax level $\tilde{t}(y_i)$, such that, for every tax rate t exceeding $\tilde{t}(y_i)$, then $U(y_i(1-t),g) > U(y_i(1-t)-\pi_i\lambda m,m)$: individual i would receive greater utility by consuming the public good as compared to the private one, given his income, and he will hence prefer the public alternative. In this simple configuration of the model, $\tilde{t}(y_i)$ uniquely defines the public sector's quality level. As we can see from *(2)*, this threshold is individual-specific, being a function of the level of income. The following Lemma clarifies this relationship:

LEMMA 1 $\tilde{t}(y_i)$ is increased in income[2].

The implication of Lemma 1 is pretty intuitive. $\tilde{t}(y_i)$ is the level of taxation, and hence of public spending over healthcare quality, which makes individual i indifferent between consuming the public good as opposed to subscribing a private insurance. As we can see, this threshold tax rate is increasing in income. This is quite reasonable: since healthcare quality is a normal good, richer individuals will, on average, maximize their preferences for higher levels of such good compared to poorer agents. In this sense, a higher level of public healthcare quality (and hence of $\tilde{t}(y_i)$ will be needed in order for the higher income voters to prefer to consume this good, instead of the private alternative. On the other hand, agents with lower income (and a tighter budget constraint) will be satisfied with lower levels of healthcare quality: as a result, they will tend to use the public sector even when this features poorer quality, because they cannot afford access to the private sector. This result will be key in what follows.

POLITICAL DECISION. Before deciding whether to choose private or public provision channel, individuals have to vote on fiscal policy, *i.e.* on the level of the tax rate that finances the public sector. This choice is, again, done in a utility-maximization perspective. The presence of the public alternative, however, may lead individuals' preferences over the tax rate to violate the single peakedness assumption.[3] In fact, the problem individuals face is the following:

$$max_t \, Max \, \{U(y_i(1-t), g), U(y_i(1-t) - \pi_t \lambda m, m)\}$$

$$s.t. t\hat{y} \geq g\gamma\hat{p}$$

Note how, if there were no private alternative to the publicly provided service, the problem would have been:

$$max_t U(y_i(1-t), g)$$

$$s.t. t\hat{y} \geq g\gamma\hat{p}$$

[2] Under the assumption that $U_{12}>0$, the Lemma is true if m is high relative to g. The former variable is exogenous whereas the latter is endogenous in the model; nonetheless, it seems intuitive to assume $m>g$. If this were not the case, the private sector would not be chosen in any economic decision, and we would not have the dual markets provision problem here.

[3] The Single-Peakedness assumption is crucial in the characterization of a majority voting political equilibrium, as it allows Black's Theorem to be applied (BLACK D., 1948).

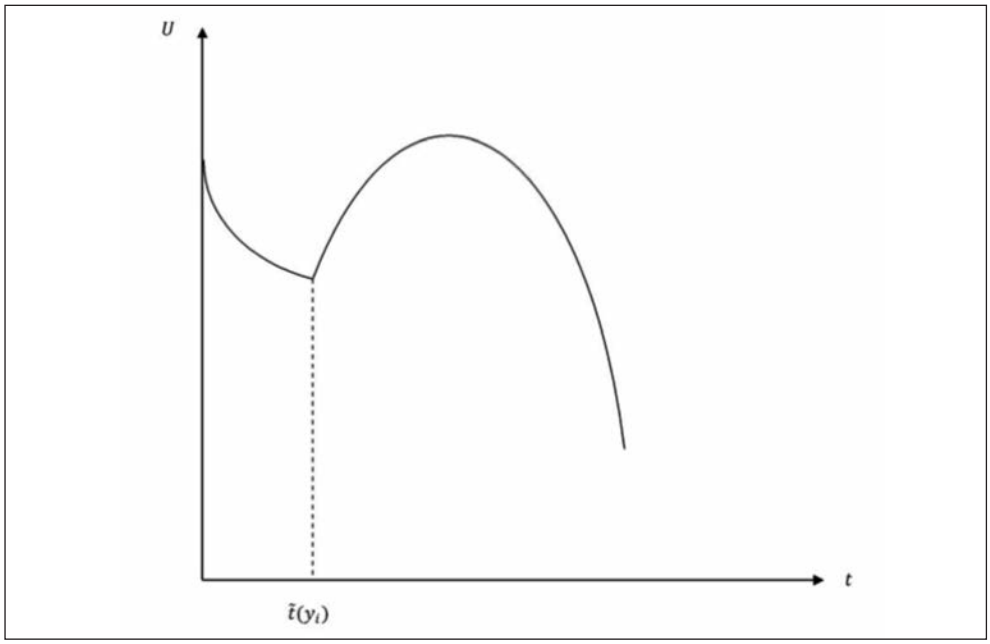
which would lead to the following first order condition:

$$-y_i U_1\left(y_i(1-t), \frac{t\hat{y}}{\gamma\hat{p}}\right) + \frac{\hat{y}}{\gamma\hat{p}} U_2\left(y_i(1-t), \frac{t\hat{y}}{\gamma\hat{p}}\right) = 0 \qquad (3)$$

As we can see, this FOC is non-monotone in t; the problem would hence have an internal solution for t^* (Laffer curve). Taking into account the presence of the private alternative, however, leads utility to depend on the tax rate as in Graph 1.

Graph 1

LAFFER CURVE



From this analysis, it follows that when the tax rate is lower than the threshold $\tilde{t}$, individual i strictly prefers to go private: his preferred tax rate would be t=0, as shown in Lemma 1. On the other hand, when $t > \tilde{t}$, preferences form a Laffer curve. The Graph clearly explains how the presence of the private alternative leads preferences over t to violate the single-peakedness condition; a Condorcet winner may fail to exist, as we cannot rely on this condition to legitimately apply the Median Voter theorem to find the majority voting political equilibrium.

7. - Equilibrium

In order to analyze the problem and find the policy outcome of the majority voting, it is useful to focus our attention to $t^*(y_i)$, *i.e.* the tax rate that maximizes utility of individual *i*, trying to understand its behavior as income varies. Notice that, from *(2)* if individual *i* prefers the public alternative,

$$\frac{\partial t^*(y_i)}{\partial y_i} = \frac{-U_1(.) - y_i(1-t)U_{11}(.) + (1-t)\frac{\hat{y}}{\gamma \hat{p}}U_{21}(.)}{y_i^2 U_{11}(.) - \frac{y_i \hat{y}}{\gamma \hat{p}}U_{12}(.) - \frac{y_i \hat{y}}{\gamma \hat{p}}U_{21}(.) + \left(\frac{y_i \hat{y}}{\gamma \hat{p}}\right)^2 U_{22}(.)}$$

As we can see, the relationship between $t^*(y_i)$ and y_i is not monotone, and its sign is unclear: it therefore depends on preferences and of technology of the private and public provision systems. A utility-maximizing tax rate t^* is increasing in income when healthcare services are a normal good, and the tax is analogous to a "tariff" each user has to pay to consume it. If, nonetheless, the system of public healthcare is structured in such a way that the provision of such good involves redistribution of resources from rich individuals to poor ones, despite normality of the good healthcare, t^* *might* actually become decreasing in income.[4] Quite intuitively, these two scenarios yields different results in terms of political equilibrium.

We now introduce and prove the main results of majority voting.

PROPOSITION 2. If $\frac{\partial t^*(y_i)}{\partial y_i} < 0$, a majority voting equilibrium tax rate t^* exists, and it coincides with the median income voter's preferred outcome.

This result is identical to the one we obtain in case of no private alternative; as said, this happens because, under the assumption of diminishing-in-income utility-maximizer tax rates, the introduction of a private alternative is not able to

[4] In the discussion that follows, we call "redistributive" a system in which $\frac{\partial t^*(y_i)}{\partial y_i} < 0$, and "non-redistributive" one in which the opposite happens. This is partially incorrect: the public system would entail some redistribution even if $p_i = \hat{p}\ \forall_i$, as the tax is proportional on income, but this is not enough to say something on the relationship between $t^*(y_i)$ and y_i, as the latter is the result of the interaction of many factors. We are aware of this, but maintain such labels for the sake of semplicity.

change the voting equilibrium. The above proposition clarifies how the equilibrium outcome is shaped in the case in which public production of healthcare services entails some sort of redistribution, which leads poorer individuals to prefer a higher tax rate, and *viceversa*. When the system is redistributive, the presence or absence of a public alternative is not able to modify the voting equilibrium that would have been reached if there was no private market for the good: in fact, the availability of the alternative has the effect of leading a share of the population not to use the public service but rather to go private. As we saw, this decision is based solely on utility; Lemma 1, moreover, shows how this share of voters is composed by richer individuals, as their requirement on the tax rate in order to be convinced to stay public is more stringent. When the poorer individual among those going private is richer than the median voter, we are in a situation in which poorer individuals favor a tax increase, and are contrasted by richer voters who instead would prefer a tax decrease, either because of the redistributive flavor of the public provision, or because they know they will not be the users of the service they are financing via taxation. This situation, in terms of voting, is not different from that we would have had if the publicly provided service were the only available option, and the median voter's preferred policy outcome is still able to win over alternatives in a majority voting context.
The following propositions draw the equilibrium in the alternative case of a non-redistributive public provision system.

Proposition 3. If $\frac{\partial t^*(y_i)}{\partial y_i} > 0$ the median income voter's preferred policy outcome is not a majority voting equilibrium.

The fact that, if $\frac{\partial t^*(y_i)}{\partial y_i} > 0$, more than half of the population favors a tax reduction when $t=t^m$ gives the proof of the following:

Corollary 4. When $\frac{\partial t^*(y_i)}{\partial y_i} > 0$, a majority voting equilibrium, if it exists, entails less public expenditure than the median voter's preferred choice.

Proposition 5. When $\frac{\partial t^*(y_i)}{\partial y_i} > 0$, a majority voting equilibrium tax rate t^* exists, and it is such that:

1. $\exists y_h \in \left[\underline{y}, \overline{y}\right]$ such that $U\left(y_h(1-t^*), \frac{t^* \hat{y}}{\hat{y}\hat{p}}\right) = U\left(y_h(1-t^*) - \hat{p}\lambda m, m\right)$,

i.e. individual with income y_h is indifferent between public and private healthcare;

2. $\exists y_l \in \left[\underline{y}, \bar{y}\right]$ such that $t^* \in arg\,max_t\, U\left(y_l\left(1-t^*\right), \frac{t^*\hat{y}}{y\hat{p}}\right)$;
3. $y_h > y_l$;
4. $\rho = \int_{y_l}^{y_h} dF\left(y_i\right) = 0.5$.

As we can see from the above proven results, matters are different when the public provision of the healthcare service is not redistributive: in this case, in fact, in the absence of a private alternative the median income voter's preferred policy outcome would be the majority voting winning option, as exactly half of the population (the richest one) would favor a tax increase, while exactly the other half would instead prefer a tax decrease. When we introduce a private alternative, we drive the situation out of equilibrium: a share of the richer individuals that would have preferred an increase now chooses to buy the insurance, not consuming the publicly provided good and therefore voting for the lowest possible tax rate. In this situation, the equilibrium tax rate has therefore to be lower than the maximizer of the median voter's utility function. In particular, it has to be such that a coalition of middle-income individuals favors a tax increase, as they are rich enough to pay for the public system but poor enough not to switch to the private insurance, and it is contrasted by a coalition of very poor and very rich people favoring instead a decrease in *t*, the former because of a tight budget constraint and the latter because they do not want to pay for a service they will not use, as that prefer to go private.[5] It particular, each of these coalition has to contain 50% of the population for the tax rate to be an equilibrium policy outcome. The presence of the private alternative, as we see, draws a situation in which a middle class is in favor of higher spending in healthcare quality. Clearly, the performance of the public healthcare sector, directly depending on the amount of resources collected via general taxation and spent on it, will depend on the characteristics of such group of voters: the richer, on average, is the middle class, the better will be the public health services.

Last, but not least, the framework allows us to introduce and analyze the concrete, and heavily debated upon, possibility of introducing vouchers, *i.e.* monetary

[5] This finding is analogous to the one by Epple D. and Romano R.E. (1996*a*) and Gouveia M. (1996).

subsidies for the consumption of the privately provided good. Let us assume that everybody who subscribes a private healthcare insurance contract receives a lump-sum transfer . Individuals who choose to go private, therefore, will receive utility equal to $U(y_i(1-t) - \hat{p}\lambda m+s,m)$, whereas the GBC becomes:

$$t\hat{y} = ygp\hat{p} + s$$

Note that, here as above, we have been exploiting a rather strong assumption: the government, allocating resources collected via general taxation to the production of healthcare services, does not internalize the fact that not *all* the population is actually going to use them, given that a part of it will buy the insurance. As a result, on the one hand healthcare quality is produced as if every individual were to use the public sector; on the other hand, resources are allocated to vouchers as if all individuals could potentially go private. As Epple and Romano suggest in their more generic discussion, this assumption can be relaxed and results will hold. Here, we stick to it for the sake of simplicity.

In order to understand how and if the introduction of the vouchers affects our equilibrium variables, let us define the new problem each individual would face if only the public alternative were available:

$$\begin{gathered} max_t U(y_i(1-t),g) \\ s.t. t\hat{y} \geq gyp\hat{p} + s \end{gathered}$$

which leads to the following FOC:

$$-y_i U_1\left(y_i\left(1-t\right), \frac{t\hat{y}-s}{\gamma\hat{p}}\right) + \frac{\hat{y}}{y\hat{p}} U_2\left(y_i\left(1-t\right), \frac{t\hat{y}-s}{y\hat{p}}\right) = 0$$

Differentiating this expression, we can obtain the partial derivative of t^* with respect to the transfer, s:

$$\frac{\partial t^*\left(y_i\right)}{\partial s} = -\frac{-\frac{y_i}{\gamma\hat{p}} U_{12}\left(.\right) - \frac{\hat{y}}{\left(\gamma\hat{p}\right)^2} U_{22}\left(.\right)}{y_i^2 U_{11}\left(.\right) - \frac{y_i\hat{y}}{\gamma\hat{p}} U_{12}\left(.\right) - \frac{y_i\hat{y}}{\gamma\hat{p}} U_{21}\left(.\right) + \left(\frac{y_i\hat{y}}{\gamma\hat{p}}\right)^2 U^{22}\left(.\right)}$$

The above expression displays a non-monotone relationship between the tax rate preferred by each individual and the amount of subsidy provided by the government through vouchers, which prevents us from the possibility of saying more on this relationship and might be due to the strong assumption of non-endogenous share of public/private sector users. Nonetheless, we can re-define the indifference-tax rate as:

$$U(y_i(1-t),g) = U(y_i(1-t) - p\lambda m+s,m)$$

Differentiation of this expression leads to:

$$\frac{\partial \tilde{t}\left(y_i\right)}{\partial s} = -\frac{-\frac{y_i}{\gamma \hat{p}}\left[U_1\left(y_i\left(1-t\right)-\lambda \hat{p}m-s,m\right)-U_1\left(y_i\left(1-t\right),\frac{t\hat{y}-s}{\gamma \hat{p}}\right)\right]}{y_i\left[U_1\left(y_i\left(1-t\right)-\lambda \hat{p}m,m\right)-U_1\left(y_i\left(1-t\right),\frac{t\hat{y}}{\gamma \hat{p}}\right)\right]-\frac{\hat{y}}{\gamma \hat{p}}U_2}$$

As we can see, the tax rate that makes individuals indifferent between public and private decreases with the introduction of vouchers.[6] We can think this instrument, hence, as a good way to manage public sector demand, in that it seems to be able to "convince" people to use the private sector over the public one. On the other hand, it does not seem to be able to contain public expenditure over public healthcare quality, since – as we saw – the relationship between a majority voting equilibrium tax rate and the level of subsidy is not monotone.

8. - Relaxing the Assumption on the GBC

As mentioned above, the results of the analysis come at the cost of a rather strong assumption of non-endogenous number of public-sector users. Here, we try to extend our analysis to a more general case in which the utility function of individual is unchanged from above, but the government budget constraint becomes

$$\int_0^1 \gamma n g p_i \, dS\left(p_i\right) \leq \int_{\underline{y}}^{\bar{y}} t y_i \, dF\left(y_i\right) \tag{4}$$

[6] For a clarification on the math behind this result, see the proof to LEMMA 1.

where n represents the share of public sector users, and can be defined as $\int_0^1 \mu_i \, dS(p_i)$, where

$$\mu_i = \begin{cases} 1 \text{ if } i \text{ uses public service} \\ 0 \text{ otherwise} \end{cases}$$

In this section, again, we stick to our previous assumption: $p_i = \hat{p}$ for every individual. Notice that, if we fix a pair (g', t'), we have that

$$n(g', t') = F(y')$$

where $F(.)$ is the c.d.f. of income and y' is such that

$$U(y'(1-t), g') = U(y'(1-t) - p\lambda m, m)$$

As a result, $n(g', t')$ includes all those individuals with income lower or equal than that of the individual indifferent between public and private at (g', t'). As a consequence, under this less restrictive assumption, t and g are not one the "linear" consequence of the other anymore: being $n(g', t')$ endogenous, a higher t does not necessarily lead to a higher *per capita* quality level g, as the increase in the tax rate may come together with an increase in the number of public services users. Calling $g^*(t)$ the *per-capita* quality level of the publicly provided service, from we have that $g^*(t) = \dfrac{t\hat{y}}{n(g^*, t)}$ and

$$\begin{aligned} \frac{\partial g^*}{\partial t} &= \frac{\hat{y}}{n(g^*, t)} - \frac{ty}{\left[n(g^*, t)\right]^2} \frac{\partial n(g^*, t)}{\partial t} \\ &= \frac{\hat{y}}{n(g^*, t)} \left[1 - \frac{t}{n(g^*, t)} \frac{\partial n(g^*, t)}{\partial t} \right]. \end{aligned}$$

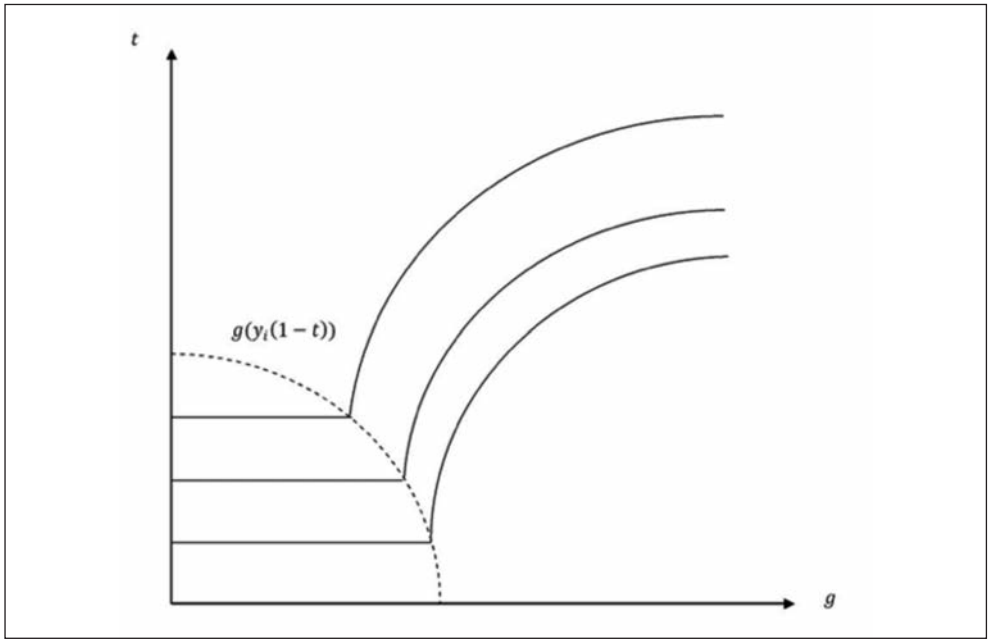
Clearly, it may well be the case that, for some (g, t), $\dfrac{\partial n(g^*, t)}{\partial t} > \dfrac{n(g^*, t)}{t}$. We therefore face an irregular budget constraint, as the one provided in ER.

In order to analyze the problem more in depth, it is useful to sketch the map of the indifference curves for individual *i* in the plane (*g*,*t*) (Graph 2). Clearly, now the relationship between *g* and *t* is slightly more complex, because of the endogeneity of . We call $\tilde{g}(y_i)$ the level of quality of the publicly provided sector at which individual *y*, with income y_i, is indifferent between the public and the private alternative. As $g<\tilde{g}(y_i)$, the individual is not going to use the publicly provided service and the indifference curves will be flat for a given *t*. We then have a kink at $\tilde{g}(y_i)$, where the indifference curve starts to be increasing in the plane; in fact, calling $M(g,y_i,g)$ the slope of the indifference curve when $g>\tilde{g}(y_i)$, we get:

$$M(g, y_i, g) = \frac{\frac{dU}{dg}}{\frac{dU}{dt}} = \frac{hU_2(.)}{y_i U_1(.)} > 0$$

GRAPH 2

INDIFFERENCE CURVES



Intuitively, when individual i is a public services user, as he pays more taxes he now also gets higher quality (and *viceversa*). The *locus* of the points (g,t) that make an individual indifferent between public and private, again, satisfies:

$$U\left(y_i(1-t),g\right)=U\left(y_i(1-t)-p\lambda m,m\right) \tag{5}$$

Differentiating this expression, we get:

$$\frac{\partial t}{\partial g}=\frac{hU_2\left(y_i(1-t),g\right)}{y_i\left[U_1\left(y_i(1-t),g\right)-U_1\left(y_i(1-t)-p\lambda m,m\right)\right]}<0 \tag{6}$$

The following Lemma, containing a result by ER, is analogous to Lemma 1 in the case of non-endogenous n, and will be helpful in deriving some of our results.

Lemma 6. $\tilde{g}(y_i)$ is increasing in y_i; therefore, richer individuals will require a higher quality level in order to choose the public alternative.

Elaboration of Lemma 6 leads to the following:

Corollary 7. If at any (g',t') an individual with income y' prefers private to public, so will do all those with incomes $y>y'$; if y' weakly prefers public, so will all $y<y'$.

9. - Equilibrium

As in the previous, simpler case, preferences fail to satisfy the single-peakedness condition in presence of a private alternative. In order to characterize the voting equilibrium, as explained in ER, we need to uncover the conditions that lead preferences to satisfy the single crossing property, a necessary condition for the Median Voter theorem to apply. Under the less restrictive assumption of endogenous n, as before, we distinguish the case in which public provision entails redistribution from the alternative one. To do this, we analyze the behavior of the slope of the indifference curve when $g>\tilde{g}(y_i)$ with respect to income.

Calling $M(g,y_i,t)$ the slope of the indifference curve of individual with income i associated to the point (g,t) in the relative plane, differentiation of it with respect to y_i yields:

$$\frac{\partial M\left(g, y_i, t\right)}{\partial y_i} = -\frac{1}{y_i^2}\frac{U_2(.)}{U_1(.)} + \frac{(1-t)U_{21}(.)}{y_i U_1(.)} - \frac{(1-t)U_2 U_{11}(.)}{y_i\left[U_1(.)\right]^2}$$

$$= \frac{1}{y_i U_i(.)}\left[-\frac{U_2(.)}{y_i} + (1-t)U_{21}(.) - \frac{(1-t)U_2 U_{11}(.)}{U_1(.)}\right]$$

Given that $U_{11}(.)<0$ by assumption, the sign of the expression is unclear. ER provide a thorough discussion on this issue, dividing the case in which $\frac{\partial M\left(g, y_i, t\right)}{\partial y_i} < 0$ (SDI, Slope Decreasing in Income) and the one in which $\frac{\partial M\left(g, y_i, t\right)}{\partial y_i} > 0$ (SRI, Slope Rising in Income).

Intuitively, when SDI holds, the system is redistributive and *viceversa.* As before, the two situations lead to different majority voting equilibria, as defined in the following propositions.

Let us first consider the case in which SDI holds. Under this assumption, and following ER, the Median Voter theorem can be applied: the utility function $U(.)$ and its indifference curves in the plane (t,g) satisfy single-crossing. As a result, under this assumption a majority voting equilibrium over (t,g) exists, and it coincides with the median voter's preferred policy outcome.

As we can see, this result is similar to the one obtained under the more restrictive assumption of non-endogenous number of public sector users. The above discussion, in fact, still applies: if richer individuals would normally prefer a lower taxation, the introduction of a private alternative attracting the richer share of the population does not "disturb" the majority voting equilibrium that would be reached if this alternative were not available.

As before, we now move to the case in which the system is not redistributive. Again, ER suggest that, when SRI holds, the median income voter's preferred policy outcome is not a majority voting equilibrium. In particular, a majority voting equilibrium, if it exists, entails a tax rate lower than that preferred by the median voter and, consequently, less public expenditure on healthcare quality.

In order to characterize the equilibrium in the case of non-redistributive public sector, we state the following:

Proposition 8. If preferences satisfy $\frac{\partial M\left(g,y_i,t\right)}{\left(\partial y_i\right)} > 0$ (SRI), a majority equilibrium (t^*,g^*) exists if the following conditions are met:

1. There exists an individual with income y_h who is indifferent between the public and the private alternative, *i.e.* for which $U(y_h(1-t^*),g^*) = U(y_h(1-t^*)-\hat{p}\lambda m,m)$;
2. There exists an individual with income y_l who weakly prefers public consumption at (t^*,g^*) to public consumption at any other point of the GBC, *i.e.* for which $U(y_l(1-t^*),g^*) \geq U(y_l(1-t^*)-\hat{p}\lambda m,m)$;
3. $y_h > y_l$;
4. $\rho = \int_{y_l}^{y_h} dF\left(y_i\right) = 0.5$.

Again, when we allow the government's supply of healthcare services to be able to adapt to demand when a private alternative is available, the results perfectly match those of the more simple case; when the system does not entail redistribution, the equilibrium level of quality of the public service depends on the characteristics of the middle class, the one favoring higher investments in it.

10. - Endogeneity of the Risk Factor

As we explained above, in this model the private provision of healthcare services takes the form of an insurance coverage, namely a contract under which individuals pay a premium to receive, in case of need, the resources needed to pay the care offered by a private provider, facing a unitary production cost equal to λ to produce a unit level of quality m. The unitary premium, *i.e.* the expected share of the insured amount each individual consumes, is denoted by π. Premiums are said to be actuarially fair when π coincides with the probability, for each individual, of using the insurance coverage; in this framework, therefore, an actuarially fair premium would be one in which $\pi_i = p_i$ for every i, where p_i is individual i's probability of being sick. Up to now, however, in order to simplify the analysis, we have assumed that every individual faces the same health risk: this is a pretty strong requirement, because it drives an important element of heterogeneity out of the analysis. The health risk factor, instead, might play a significant role in shaping the economic and political decisions and, thus, the majority voting

outcome over fiscal policy. In this section, therefore, we want to relax this restrictive assumption and consider p_i as endogenous.

In literature there is widespread agreement (Winkleby *et* al., 1992; Deaton, 1999 and 2000) on a strong relationship between per-capita income and health risk status: factors often considered as positively correlated with income, such as education, family background and culture, might influence a person's behavior by leading her to undertake less risky or harmful-to-health actions and behaviors. In addition to this, health risk may be endogenous, as it is meaningful to think that richer people invest more in healthcare services: this obviously has a positive impact on current health status. Further from these discussions, hence, we introduce p_i in the analysis by modeling it as a very simple function of income:

$$\forall i,\ p_i = \hat{p} + \alpha \frac{\hat{y} - y_i}{\hat{y}} \tag{7}$$

The distribution functions of y_i and p_i trivially coincide now: integration over $F(y_i)$ yields:

$$\int_0^1 p_i \, dF(y_i) = \int_0^1 \left(p + \alpha \frac{\hat{y} - y_i}{\hat{y}} \right) dF(y_i) = \hat{p}$$

We now proceed to solve the model again to understand if, and how, p_i modifies our results. Preferences of an individual who uses the publicly provided healthcare services are given by:

$$U(y_i\,(1-t), g)$$

where the GBC is, again, $g\gamma\hat{p}=ty$. As we see, nothing changes in this case from the previous framework. Nonetheless, preferences of an individual who decides to underwrite the insurance contract on healthcare expenditure are as follows:

$$U\left(y_i(1-t) - \lambda\left(\hat{p} + 1 - \frac{y_i}{\hat{y}} \right) m, m \right)$$

As compared to the simpler case in which p_i is constant across individuals, here income enters twice in the utility function. How does this change the polit-

ical equilibrium? As we just pointed out, $t^*(y_i)$, *locus* of the bliss points of all individuals as income varies, when they choose the public good, does not change when we make p_i as endogenous. The same is not true, however, for the tax rate that makes individual i indifferent between public and private care, which we denote as $\bar{\bar{t}}(y_i)$, defined as:

$$U\left(y_i(1-t), g\right) = U\left(y_i(1-t) - \lambda\left(\hat{p} + 1 - \frac{y_i}{\hat{y}}\right)m, m\right) \tag{8}$$

Proposition 9. Modeling p_i as in *(7)*, $\bar{\bar{t}}(y_i)$ increases at a higher speed.

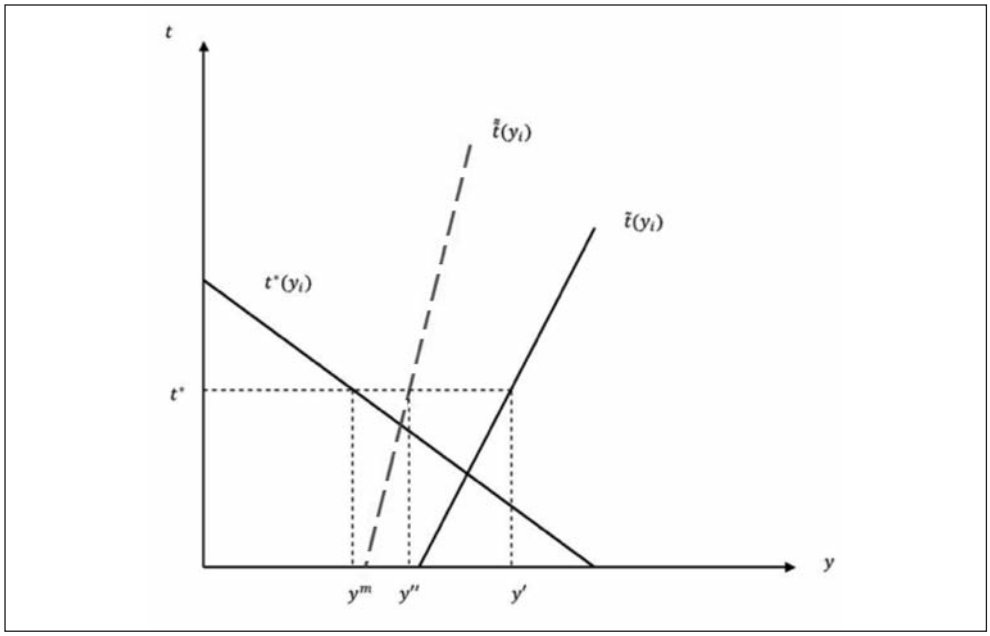
This proposition shows how, considering p_i as endogenous, richer individuals have, *ceteris paribus*, a double incentive in going private: their income is, by definition, higher, and the private insurance is cheaper to them, as they have a low p_i. As a result, they will demand a better service in order to stay public, as compared to the previous case; in equilibrium, therefore, we end up with a larger share of the population choosing private insurance.

To understand how equilibrium features change when p_i is individual-specific, let us analyze first the framework in the case $\frac{\partial t^*(y_i)}{\partial y_i} > 0$; we do it with the graphical representation in Graph 3.

As we see, the curve of threshold tax rates $\bar{\bar{t}}(y_i)$ now rotates counter-clockwise: as a result, if in equilibrium the median voter's income is such that $t^*(y^m) > \bar{\bar{t}}(y_i)$, the equilibrium tax rate is again $t^* = \tilde{t}^*(y_i)$, but, as mentioned before, a larger share of the population now chooses the private sector (individuals with $y \in (y'', \bar{y})$, as compared to the smaller interval $(y', \bar{y})$ of the simpler framework, dashed line). However, it may well be the case that $t^*(y^m) > \tilde{t}(y^m)$, but $t^*(y^m) < \bar{\bar{t}}(y^m)$; in this case, the median income voter is a private insurance user, and the equilibrium tax rate is clearly zero. Obviously, if $t^*(y^m) < \tilde{t}(y^m)$, then $t^*(y^m) < \bar{\bar{t}}(y^m)$ and the equilibrium tax rate is, again, zero. As we can see, therefore, the assumption that richer people are also less risky, in a framework in which public provision of healthcare services entails redistribution, leads to an increase in the number of private insurance subscribers and a decrease in the share of public healthcare users; depending on the parameters of the model, this effect might be so strong as to convince the median voter to choose private as well, which would obviously cause a collapse of the level of quality of the public sector.

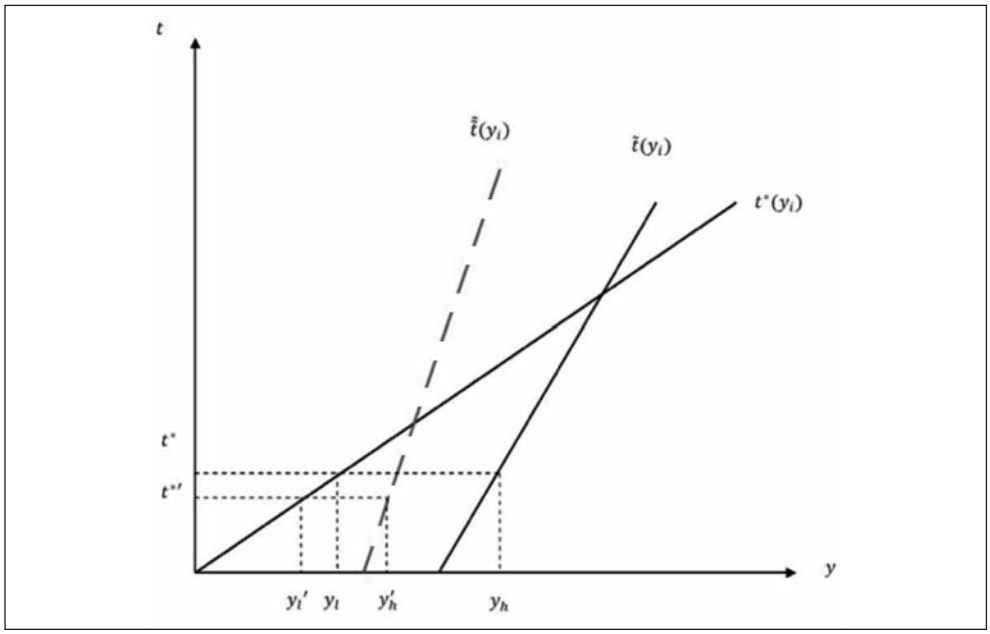
GRAPH 3

EQUILIBRIUM IN REDISTRIBUTIVE PUBLIC SECTOR



GRAPH 4

EQUILIBRIUM IN NON-REDISTRIBUTIVE PUBLIC SECTOR



The alternative situation in which $\frac{\partial t^*(y_i)}{\partial y_i} > 0$, instead, is described in Graph 4: $\tilde{t}(y_i)$ represents the *locus* of threshold tax rates when p_i for every *i*. As we can see, making p_i endogenous and modeling it as in *(7)* has, again, the effect of increasing the share of people who prefer to obtain healthcare via private insurance. However, in a situation in which an equilibrium of the "ends against the middle" type arises from a majority voting, the middle class who favors a tax increase is now poorer than before: as we can observe from the Graph, when $t^*=t^*(y_l)$ the individual with income y_l now strictly prefers the private alternative; the indifferent individual for this level of equilibrium tax rate has income $y'_h<y_h$, therefore $\rho = \int_{y_l}^{y'_h} dF(y_i) < 0.5$ and $t^*=t^*(y_l)$ is not a majority voting equilibrium policy outcome anymore. The new equilibrium is instead given by $t^{*\prime}=t^{*\prime}(\tilde{y}_l)$, defined (consistently with Proposition (5) as $\int_{\tilde{y}_l}^{\tilde{y}_n} dF(y_i) = 0.$, where $\tilde{y}_h$ is such that $t^{*\prime} = t^{*\prime}(\tilde{y}_l)$ and both $\tilde{y}_h$ and $\tilde{y}_l$ are smaller than their respective counterparts in the case of exogenous p_i, so that $t^{*\prime}<t^*$. In equilibrium, therefore, we end up with a smaller amount of resources to finance public healthcare quality, which will therefore be poorer; this is again a consequence of the fact that more people find it convenient to go private, so that the middle class, who favors a tax increase, is now poorer than in the baseline case. We can conclude by saying that, also in the case in which public provision of healthcare services does not entail redistribution, modeling p_i as a negative function of income and the private alternative as an insurance contract makes our previous results, *i.e.* an equilibrium tax rate lower than the one prevailing with no private alternative, more "extreme" and strong, as the voting policy outcome becomes even smaller. As an overall result, it is possible to claim that the assumption of health risk negatively correlated to income leads to a *scenario* in which a higher share of the (richer) population chooses private healthcare; as a consequence, the public service ends up with a lower level of quality.

11. - Federalism

Up to this point, our aim has been that of understanding the equilibrium features of public healthcare provision. As we saw, the majority voting political equilibrium over a tax rate, whose revenues finance the production of a public good for which an alternative is available on private markets, can be characterized in

two ways, depending on the particular assumptions on the redistributive power and aims of the public sector. In fact, we can have a situation in which, due to particular features of the utility function, the public provision of healthcare entails redistribution of resources: poorer individuals prefer a higher tax rate, and *vice-versa*. As shown in the previous discussion, in this case, the median income voter's preferred policy outcome is the political equilibrium one: the presence of the private alternative to such public good does not lead preferences to violate single-peakedness. However, if preferences are such that poorer individuals prefer instead a lower tax rate (*i.e.* the public provision system is not redistributive), we have a different situation: individuals' most preferred tax rate is increasing in income, and at the same time, for a given level of the tax rate, a certain portion of richer individuals will prefer the private alternative and a zero tax rate. The private alternative hence introduces a kink in preferences over the tax rate, which leads them to violate single peakedness, and the median voter theorem does not apply anymore. As we saw, however, even in this case is it possible to explicitly characterize the political equilibrium, one in which a coalition of middle income voters, who are willing to pay more in taxes because of income effects and because they will actually use the public good, is opposed to a coalition of poor and rich voters instead favoring a tax decrease, the former because of a strict budget constraint, and the latter because they will prefer to consume the private alternative.

It is clear, from the analysis we have conducted, that both types of *equilibria* depend on some features of the population of voters we are considering: in particular, what seems to matter is the type and characteristics of the income distribution. This is particularly relevant, not only in a cross-country perspective of analysis, *i.e.* when we compare different countries with similar systems for public healthcare provision, but also if we use a within-country approach, for example because the system of tax collection and public good provision is decentralized to local agencies, administering regions which differ in terms of income distribution. In this sense, in countries with a federal fiscal system, we can expect to observe different levels of public healthcare quality across regions, if these are not homogeneous. The aim of this section is therefore to understand whether, and to what extent, this can be true. In particular, how does the equilibrium, and the political outcome in terms of healthcare quality, change when we move from a centralized to a decentralized (federal) fiscal system?

For the purpose of this analysis, in this section we assume the country to be made of 3 geographic regions: region A, region B and region C. These regions are not identical among themselves: we assume in fact different income distribu-

tions in each of them (from now on, the subscript $j \in \{A,B,C\}$ will denote regions). In particular, we want to allow them to differ both in terms of income levels (average and total) and of income inequality. Consistently with the literature, we assume income in region j to be distributed as a Pareto:

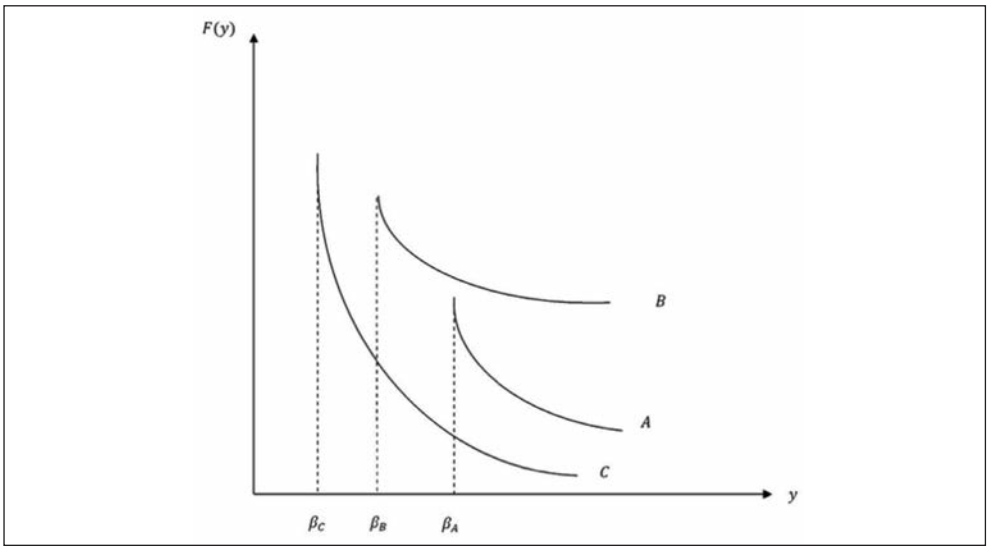
$$F\left(y_{i,j} \;\; \alpha_j, \beta_j\right) = \begin{cases} 1 - \left(\dfrac{\beta_j}{y_{i,j}}\right)^{\alpha_j} & \text{if } \; y_{i,j} \geq \beta_j \\ 0 & \text{otherwise} \end{cases}$$

$$f\left(y_{i,j} \;\; \alpha_j, \beta_j\right) = \begin{cases} \alpha_j \dfrac{\beta_j^{\alpha_j}}{y_{i,j}^{\alpha_{j+1}}} & \text{if } \; y_{i,j} \geq \beta_j \\ 0 & \text{otherwise} \end{cases}$$

where α_j is a *scale* parameter (Pareto Index, Pareto, 1896), which drives the degree of "dispersion" of the observations around the mean, and β_j is a location parameter, in particular representing the minimum value of income in the distribution; we can therefore consider β_j as a proxy for the overall level of income, and α_j as a proxy for income inequality. The density functions of the three distributions are displayed in Graph 5.

Graph 5

DISTRIBUTION OF INCOMES IN THE 3 REGIONS



We assume the 3 regions to be different in the following way: $\beta_A>\beta_B>\beta_C, \alpha_A=\alpha_C>\alpha_B$; in words, A is the richer region and C is the poorer, and in these two regions inequality is higher than in B. Given these assumptions on the distribution, denoting with $\hat{y}_i$ the average income in region j, and with y_j^m the median, the following hold:

$$\hat{y}_A = \frac{\alpha_A \beta_A}{\alpha_A - 1} > \hat{y}_A = \frac{\alpha_B \beta_B}{\alpha_B - 1} > \hat{y}_A = \frac{\alpha_C \beta_C}{\alpha_C - 1}$$

$$y_B^m = 2^{\frac{1}{\alpha_B}} > y_C^m = 2^{\frac{1}{\alpha_C}}$$

Moreover, if we assume $\frac{\beta_A}{\beta_B} > 2^{\frac{1}{\alpha_B}-\frac{1}{\alpha_A}}$

$$y_A^m > y_B^m$$

In our analysis, we assume that each region collects its proportional income tax t_j and autonomously provides its citizens with a system of healthcare services. Again, we consider the amount of *per-capita* services to be fixed at h=1; the quality of the service, g, is instead dependent on the quantity of resources that each region's public sector is able to collect via taxation. For the moment, we consider the three regions as acting independently, *i.e.* with no transfers between them or from the central government; we will remove this assumption in what follows.

12 - Non-Redistributive Public Sector

In order to characterize and compare the levels of quality reachable by the regions when they "run alone" in a federal system, we have to make a fundamental assumption on the relationship between individuals' preferences over the tax rate, and personal income. In this context, it is meaningful to start from the case in which $\frac{\partial t_j}{\partial y_j} > 0$, *i.e.* when public provision is not redistributive. As we saw in the previous sections, in this case the pivotal voter, *i.e.* the one whose preferred policy outcome is able to defeat all the alternatives in a majority voting, is not the individual with income y^m, but the one with income y_l as defined in Proposition *(5)*.

In such a situation, a coalition of middle-income voters favors a tax/quality increase, while all the others, poorer and richer, would prefer a tax decrease, the former because of a stricter budget constraint, the latter because they are not going to use the public service but rather to buy the private insurance. Having explained the equilibrium features in the case in which taxes are collected and voted upon, and public healthcare is produced at the country level, we now want to investigate on the region-specific equilibrium levels of healthcare quality in the case of a federal taxation and provision system. We consider the same regions as above, A, B and C. When fiscal federalism hold, we have that:

(9) $$t_j \hat{y}_j = \hat{p}\gamma g_j$$

By writing *(10)* in this way, we are implicitly assuming an identical distribution of health risk across regions, normalizing $p_i = \hat{p} \forall i$, and an identical level of efficiency of production between them.

In order to understand how the equilibrium varies with different values for the distribution parameters α_j and β_j, it is useful to re-write the equations characterizing the political equilibrium in region *j*:

$$\begin{cases} -y_{j,l} U_1\left(y_{j,l}\left(1-t_l\right), \dfrac{t\widehat{y_l}}{\hat{p}\gamma}\right) + \dfrac{\widehat{y_l}}{\hat{p}\gamma} U_2\left(y_{j,l} U_2\left(1-t_l\right), \dfrac{t\widehat{y_l}}{\hat{p}\gamma}\right) = 0 \\ U\left(y_{j,h}\left(1-t_j\right), \dfrac{t\widehat{y_l}}{\hat{p}\gamma}\right) = U\left(y_{j,h}\left(1-t_j\right) - \lambda \hat{p} m, m\right) \\ \int_{y_{j,l}}^{y_{j,h}} dF\left(y_{i,j}\right) = 0.5 \end{cases}$$

The third of the above equation can be rewritten as:

(10) $$\left(\frac{\beta_j}{y_{j,l}}\right)^{\alpha_j} - \left(\frac{\beta_j}{y_{j,h}}\right)^{\alpha_j} = \frac{1}{2}$$

Equation *(10)* will be fundamental in the determination of the dynamics involving the parameters together with y_h, y_j.

To understand how the level of public health expenditure varies across regions, recall again that $g_j = \frac{t_j \hat{y}_j}{\hat{p}\gamma}$ and, by assumption, $\hat{y}_A > \hat{y}_B > \hat{y}_C$. In order to understand how g_j varies across regions, we therefore need to understand the behavior of t_j. Using, again, the total differentiation expression, we have:

$$\frac{\partial g_j}{\partial \alpha_j} = \frac{\partial g_j}{\partial y_{j,l}} \frac{\partial y_{j,l}}{\partial \alpha_j} + \frac{\partial g_j}{\partial \hat{y}_j} \frac{\partial \hat{y}_j}{\partial \alpha_j} \tag{11}$$

$$\frac{\partial g_j}{\partial \beta_j} = \frac{\partial g_j}{\partial y_{j,l}} \frac{\partial y_{j,l}}{\partial \beta_j} + \frac{\partial g_j}{\partial \hat{y}_j} \frac{\partial \hat{y}_j}{\partial \beta_j} \tag{12}$$

We need to study the sign of $\frac{\partial y_{j,l}}{\partial \alpha_j}$ and $\frac{\partial y_{j,l}}{\partial \beta_j}$. From equation *(10)*, we can see that an increase in α_j leads to a decrease in the left-hand side of the equation: in fact, as α_j goes up, both $y_{j,l}$ and $y_{j,h}$ go up, but since the latter is larger than the former, the effect of an increase in the exponent leads to an overall contraction of the expression $\left(\frac{\beta_j}{y_{j,l}}\right)^{\alpha_j} - \left(\frac{\beta_j}{y_{j,h}}\right)^{\alpha_j}$. To maintain the political equilibrium, such expression has however to be equal to $\frac{1}{2}$; therefore, an increase in α_j is followed by a decrease in $y_{j,l}$ and an increase in $y_{j,h}$. We can therefore conclude that $\frac{\partial y_{j,l}}{\partial \alpha_j} < 0$. In order to study the sign of $\frac{\partial y_{j,l}}{\partial \beta_j}$, we can conduct a similar reasoning: as β_j goes up, the left-hand side of *(10)* goes up, as the effect of the increase is stronger on $\left(\frac{\beta_j}{y_{j,l}}\right)^{\alpha_j}$ than on $\left(\frac{\beta_j}{y_{j,h}}\right)^{\alpha_j}$; to maintain the equality, both $y_{j,l}$ and $y_{j,h}$ have to increase, therefore $\frac{\partial y_{j,l}}{\partial \beta_j} > 0$. These results appear quite intuitive: as the distribution becomes more dispersed across the mean, we need a larger range of incomes in order to "capture" exactly half of the population in the middle; by the same token, when the overall level of income is higher, also the two pivotal voters, with incomes $y_{j,l}$ and $y_{j,h}$, will be richer.

Having studied the signs of the partial differentials, we have all the elements to understand how g_j changes with the parameters of the distribution. As $\frac{\partial g_j}{\partial y_{j,l}} > 0$ and $\frac{\partial g_j}{\partial \hat{y}_j} > 0$, since $\frac{\partial y_{j,l}}{\partial \alpha_j} < 0$ and $\frac{\partial \hat{y}_j}{\partial \alpha_j} < 0$, from equation *(11)* we can conclude that $\frac{\partial g_j}{\partial \alpha_j} < 0$; analogously, from equation *(12)* we see that, since $\frac{\partial y_{j,l}}{\partial \beta_j} > 0$ and $\frac{\partial y_j}{\partial \beta_j} > 0$, $\frac{\partial g_j}{\partial \beta_j} > 0$. We therefore see how, in case of a federal non-redistributive system of public healthcare, both the income level and the inequality effects are present and active on the determination of *g*. This discussion enables us to summarize our results in the following proposition.

Proposition 10. In equilibrium, either $g_B > g_A > g_C$ or $g_A > g_B > g_C$

In a system in which the equilibrium is of the "ends against the middle" type, therefore, region C, poorer and unequal, will end up with the lowest level of public health spending; the total amount of taxable incomes is lower than in the other regions, moreover the "middle class" relevant for the determination of the equilibrium tax rate, due to the features of the income distribution, has to be poorer.

On the other side, the best-performing region could be either A or B: this depends on the relative magnitude of two effects. The first is the one we can call "income level effect", driven by differences in the parameter β across regions, which determines the amount of resources that can be spent on public production in each district; the second is an "inequality effect", and is driven by differences in α. If the inequality effect is the strongest, $g_B > g_A$. This is a result of the fact that, being more homogeneous in terms of individual wealth, the middle class favoring a high public spending on healthcare services is on average richer than in the other, more unequal, regions.

As we can see from this result, in a context of fiscal federalism in which the public system of healthcare provision does not include a sharp redistributive component, such provision system is likely to reward, in terms of public good quality, regions in which income is more evenly distributed: this goes partially against the widely diffused opinion that federalism is only good for richer constituencies. On the other hand, this system might eventually be detrimental for the outcome, in terms of healthcare performance, of the worse-off regions, *i.e.* those in which income is on average lower and more unequally distributed. Table 1 presents some

aggregate statistics on GDP levels and inequality and healthcare sector performance, concerning Italy at the regional level: as we can see, the predictions of the model seem to affect most of the regions in the south of the country.

TABLE 1

ITALIAN REGIONS' CHARACTERISTICS

Region	Avg. Income *per Capita*	Gini Coefficient	Share of People over 65	Public Healthcare Expenditure	Working Activity Rate	Unemployment rate
Piemonte	30,615	0.291	22.7	1,709	51.39	4.23
Valle d'Aosta	33,663	0.310	20.6	1,914	54.58	3.18
Lombardia	33,007	0.295	19.9	1,633	54.44	3.43
Trentino-Alto Adige	34,927	0.289	18.1	1,904	56.43	2.74
Veneto	31,939	0.266	19.5	1,638	53.83	3.34
Friuli-Venezia Giulia	30,224	0.265	23.1	1,714	51.25	3.41
Liguria	28,883	0.290	26.8	1,881	48.09	4.82
Emilia-Romagna	33,611	0.297	22.6	1,697	54.84	2.86
Toscana	32,150	0.283	23.3	1,687	50.94	4.30
Umbria	30,337	0.280	23.2	1,657	50.62	4.56
Marche	31,902	0.289	22.5	1,601	51.29	4.17
Lazio	30,911	0.324	19.6	1,925	50.49	6.38
Abruzzo	26,494	0.263	21.3	1,73	47.22	6.22
Molise	25,494	0.319	21.9	1,947	44.14	8.10
Campania	24,939	0.327	15.7	1,663	40.47	11.23
Puglia	25,950	0.310	17.8	1,641	42.09	11.17
Basilicata	23,507	0.289	20.0	1,643	42.65	9.55
Calabria	23,849	0.314	18.5	1,808	40.00	11.24
Sicilia	22,044	0.335	18.2	1,666	40.66	12.96
Sardegna	26,770	0.292	18.4	1,634	47.13	9.58
Italia	**29,606**	**0.314**	**20**	**1,703**	**49**	**6**

Source: ISTAT, *Indicatori socio-sanitari regionali*.

13. - Redistributive Public Sector

Having analyzed what happens in the case in which $\frac{\partial t^*(y_i)}{\partial y_i} > 0$, in this section we assume $\frac{\partial t^*(y_i)}{\partial y_i} < 0$: the bliss point tax rate of each individual is decreasing in her own income, therefore the system of public provision entails redistribution. As we saw in the case of a centralized system of taxation, under this assumption a majority voting equilibrium exists and the chosen tax rate coincides with that preferred by the median voter. In order to understand the properties of the majority voting political equilibrium, we should assess the impact of the income dis-

tribution features on the GBC. Given equation *(9)*, and since, in a redistributive context, $t^*_j=t_j(y^m_j)\forall j\in\{A,B,C\}$, the equilibrium level of healthcare quality depends on y^m_j and on $\hat{y}_j$. The first of these two components has a negative effect on g, as $\frac{\partial t^*}{\partial y_i}<0$, while the second clearly has a positive effect. In order to compare, g^*_A,g^*_B and g^*_C we should therefore assess which of the two effects is stronger.

To this purpose, it is useful to write g_j as:

$$g_j=g(\hat{y}_j, y^m_j)$$

Being g_j a function of average and median income, it directly depends on the parameters of the income distribution, α_j and β_j. In order to understand the effects of these on the function, we use the method of total differentiation to study the determinants of such relationship. We start with α_j:

$$\frac{\partial g_j}{\partial \alpha_j}=\frac{\partial g_j}{\partial y^m_j}\frac{\partial y^m_j}{\partial \alpha_j}+\frac{\partial g_j}{\partial \hat{y}_j}\frac{\partial \hat{y}_j}{\partial \alpha_j}$$

Note that:

$$\frac{\partial g_j}{\partial y^m_j}=\frac{\partial g_j}{\partial t_j}\frac{\partial t_j}{\partial y^m_j}$$

Since $\frac{\partial g_j}{\partial t_j}=\frac{\hat{y}_j}{\hat{p}\gamma}>0$, $\frac{\partial t_j}{\partial y^m_j}<0$ by assumption and $\frac{\partial y^m_j}{\partial \alpha_j}=-\frac{2^{\frac{1}{\alpha_j}}\,log^2}{\alpha_j^2}<0$, the first addend of the total differential expression of g_j is positive. To study the sign of the second addend, we look for the sign of the following expression:

$$\frac{\partial g_j}{\partial \hat{y}_j}=\frac{\partial g_j}{\partial t_j}\frac{\partial t_j}{\partial \hat{y}_j}$$

$$=\frac{\hat{y}_j}{\hat{p}\gamma}\left[\frac{\frac{y^m_j t_j}{\hat{p}\gamma}U_{12}(.)-\frac{1}{\hat{p}\gamma}U_2(.)-\frac{t_j y_j}{(\hat{p}\gamma)^2}U_{22}(.)}{(y^m_j)^2U_{11}(.)-\frac{y^m_j\hat{y}_j}{\hat{p}\gamma}U_{12}(.)-\frac{y^m_j\hat{y}_j}{\hat{p}\gamma}U_{21}(.)+\left(\frac{\hat{y}_j}{\hat{p}\gamma}\right)U_{22}(.)}\right]+\frac{t_j}{\hat{p}\gamma}$$

As we can see, the sign of the expression in square brackets is unclear. In fact, if the numerator is positive, being the denominator negative and given that $\frac{\partial y_j}{\partial \alpha_j} = -\frac{\beta_j}{\left(\alpha_j - 1\right)} < 0$, the second addend of the total differentiation is positive and we can conclude that $\frac{\partial g_j}{\partial \alpha_j} > 0$; otherwise, the second addend is negative, and in order to establish the sign of the variation of g_j with respect to α_j we have to study the magnitudes of the partial differentials.

Let us now study the variation of g_j with respect to β_j:

$$\frac{\partial g_j}{\partial \beta_j} = \frac{\partial g_j}{\partial y_j^m}\frac{\partial y_j^m}{\partial \beta_j} + \frac{\partial g_j}{\partial \hat{y}_j}\frac{\partial \hat{y}_j}{\partial \beta_j}$$

Since $\frac{\partial \hat{y}_j}{\partial \beta_j} = \frac{\alpha_j}{\alpha_j - 1} > 0$ and $\frac{\partial y_j^m}{\partial \beta_j} = 2^{\frac{1}{\alpha_j}}$, the first addend of the total differentiation is negative; the second addend is now negative when the numerator of the expression $\frac{\partial t_j}{\partial \hat{y}_j}$ is positive, otherwise we again have to study the magnitude of the differentials. The lack of certainty about the sign of the partial differentials therefore allows many situations to be possible in a federal taxation and provision system with redistributive features:

1. If $\frac{\partial g_j}{\partial \hat{y}_j} > 0$, then $\frac{\partial g_j}{\partial \alpha_j} > 0$, $\frac{\partial g_j}{\partial \beta_j} < 0$; given that $\alpha_A = \alpha_C > \alpha_B$ and $\beta_A > \beta_B > \beta_C$, we have $g_A < g_C, g_B < g_C$, and the relationship between g_A and g_B is unclear;
2. If $\frac{\partial g_j}{\partial \hat{y}_j} > 0$, two alternative cases are possible:
   1. $\frac{\partial g_j}{\partial \alpha_j} < 0$, $\frac{\partial g_j}{\partial \beta_j} < 0$; we have $g_A > g_C$, $g_B > g_C$, and the relationship between g_A and g_B is unclear;
   2. $\frac{\partial g_j}{\partial \alpha_j} > 0$, $\frac{\partial g_j}{\partial \beta_j} > 0$; we have $g_A > g_B$, $g_A > g_C$, and the relationship between g_B and g_C is unclear.

Point 1. above shows the outcomes in terms of healthcare quality in a situation in which the system has a very strong redistributive component. As we can see, the result is the exact opposite of what we got in the no-redistribution case: the low-income, high-inequality region, due to redistribution, reaches the highest level of *g*; if the inequality effect is stronger than the income effect, region B ends up with the worst public sector. On the other hand, the cases displayed in point 2. lead to much less clear-cut results, as they are outcomes of a situation "in between" strong redistribution and no redistribution. What needs to be underlined, from these results, is that if the system does not entail a high redistributive component, the *ex-ante* worse off region C is likely to be a "net loser" in a federalist framework.

14. - Endogeneity of $\hat{p}$

Having clarified what is the relationship between the relative performances of public healthcare of each region and the specific income distribution, in this section we proceed, as we did in Section 2, by considering the health risk factor as an endogenous variable. This probability of illness plays a role in the political equilibrium because it directly determines the cost of private insurance to individuals, *i.e.* of the alternative to the public good; as we already saw, this is particularly relevant in the case of non-redistributive public healthcare provision.

Coherently with our previous discussion, we consider each region's average risk factor, as a function of income: the latter negatively influences the former. Again, we model it as follows:

$$\forall i,\ p_i = \hat{p} + \alpha \frac{y_i - \hat{y}}{\hat{y}}$$

where α is a constant, $\hat{y}$ and $\hat{p}$, as before, are country averages. Further from our previous assumptions, $\hat{p}_A < \hat{p}_B < \hat{p}_C$.

When the public system of healthcare provision entails redistribution, as we saw, different *scenarios* are possible. In order to understand how endogeneity of the risk factor affects them, it is important to recognize that, by modelling this parameter as an inverse function of income, we implicitly give more strenght to the income level effect, which in some cases might revert the outcomes in terms of relative public healthcare quality.

In order to make the picture more clear, we summarize here the *scenarios* and elaborate on them, one at the time.

1. If $\frac{\partial g_j}{\partial \hat{y}_j} > 0$, then $\frac{\partial g_j}{\partial \alpha_j} > 0$, $\frac{\partial g_j}{\partial \beta_j} < 0$; given that $\alpha_A = \alpha_C$ and $\beta_A > \beta_B > \beta_C$, we have $g_A < g_C$, $g_B < g_C$, and the relationship between g_A and g_B is unclear. With p endogenous, as said, the income level effect becomes more important: $g_A > g_B > g_C$;
2. If $\frac{\partial g_j}{\partial \hat{y}_j} < 0$, two alternative cases are possible:
   1. $\frac{\partial g_j}{\partial \alpha_j} < 0$, $\frac{\partial g_j}{\partial \beta_j} > 0$; we have $g_A > g_C$, $g_B > g_C$: endogeneity of p leads to $g_A > g_B$, so that the final ranking is $g_A > g_B > g_C$.
   2. $\frac{\partial g_j}{\partial \alpha_j} < 0$, $\frac{\partial g_j}{\partial \beta_j} < 0$; we have $g_A > g_B$, $g_A > g_C$, endogeneity of p causes g_B to be greater than g_C, so that, again, $g_A > g_B > g_C$.

When, instead, the public system does not entail redistribution, we showed that the more equal region ends up with the highest level of healthcare quality. Even in this case, however, the introduction of region-specific average risk factors may revert this result; $p_A < p_B$ in fact pushes towards *A* having a higher level of quality than *B*, for a given amount of tax revenues.
As we can see, including the risk factor in the analysis as an endogenous variable positively and directly correlated with income gives more strength to the income levels effect, increasing its relevance with respect to income inequality effect, leading to a result that merely depends on the size of the fiscal base and in which the richer a region, the higher its level of healthcare spending.

15. - Discussion

The analysis we have performed until here sheds light on the possible effects of fiscal federalism on the level of public healthcare quality. As we saw, economic theory usually considers federalism as welfare enhancing, in that it is capable to better shape the public services to the tastes of the users/voters. Despite this, in a framework like the current Italian one, in which regions are different in terms of average income and inequality, the superiority of decentralization may be put under question. Poorer and more unequal regions, in fact, may be left behind,

because they have a smaller fiscal base, and the distribution of income is such that the preferred tax rate will be low: as a result, only a small amount of resources will be invested in the public sector. This is particularly true in the case in which the system is not redistributive.

On the other hand, the best performing regions will either be the richer ones or the less unequal, according to which effect (income or income distribution) is stronger: as we showed, in a situation leading to an equilibrium of the "ends against the middle" type, the system is likely to reward regions with more income homogeneity, and to punish the low-income, inequal districts. Of course, this result is not properly desirable, as the latters are also those which start from an *ex-ante* bad situation. These regions are hence likely to be worse off in a decentralized system, left behind in a "trap" in which average and total income is low, inequality is high and the public sector is poor in quality and inefficient. This justifies the search for tools able to smooth the negative effects of decentralization, which we can observe, by a great extent, in the Italian history of reforms toward fiscal federalism. Nonetheless, a large debate exists on the effectiveness of such measures, and on their desirability from the point of view of the better-off regions. A tradeoff emerges between having an homogeneous level of public good quality everywhere in the country, and having instead high-performance regions together with low-performance ones: the debate is clearly political, other than economic.

16. - Conclusion

Object of the present work has been the theoretical analysis of the determinants of the level of quality of public healthcare, when this service is financed by a proportional income tax rate and a private alternative is available. As we saw, in the case in which the system of public provision is not redistributive, the Median Voter theorem cannot be applied due to a violation of one of its fundamental assumptions. A political equilibrium, however, still exists, and it can be shown to depend, directly, on the size and characteristics of the middle class, and, in turn, on the distribution of income. In equilibrium, in fact, a coalition of middle income voters, who are willing to use public healthcare and hence favor a tax increase (*i.e.* an improvement in quality) are opposed to a coalition of "end" voters who instead want a tax decrease, either because they are too poor to pay or too rich to prefer public over private. As explained, in this *scenario* the tax rate prevailing in a majority voting is the one preferred by the poorer voter among the

middle 50%, when voters are ranked according to their income. As a consequence of this, the more dispersed across the mean (*i.e.* more unequal) is the distribution of income, the poorer the decisive voter will be: hence lower will also be the quality level that the public healthcare sector is able to reach. As we argued, this issue becomes relevant in a context of a country where a federal system of taxation and public good provision is in place: we showed how, under certain conditions, the differences in outcome formation in terms of healthcare quality between regions depend not only on regions' total and average income, but also on the degree of inequality in each of them.

The analysis performed in this work has been motivated by the current Italian situation. The country has in fact been undergoing a process of decentralization of powers to local entities; its regions, however, are sharply different under several perspectives, and according to many, fiscal federalism might even end up widening the disparities in terms of average income and economic growth. Given that federalism is still an ongoing process in the country, this work has been purely theoretical; indeed, an interesting area for further research could be to implement an empirical testing of the model on Italian data.

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The Impact of Longevity Risk on the Term Structure of the Risk-Return Tradeoff

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The increase in worldwide life expectancy finds a major drawback in the higher-than-expected liabilities that annuity providers will face in the next few years by paying more retirees for a longer period of time. Longevity-Linked Securities have recently been subject to great interest from academics and practitioners as capable of hedging longevity risk through financial markets. Objective of this paper is the analysis of the long-term risk-return tradeoff and its term structure when an ideal longevity-linked security is added to stocks, bonds and T-Bills investment opportunities and the effect of Longevity Risk on the optimal asset allocation in efficient portfolios.
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1. - Introduction

It is a matter of fact that worldwide life expectancy has gone through major improvements throughout the past century, and that these improvements are still in place. Even if nature has (up to now) posed a limit to human life at around 120 years[1], discoveries in the fields of healthcare and medicine, coupled with higher quality of life, have led to an overall increase in longevity, especially at old ages.

If in 1967 a US male aged 65 had a life expectancy of 12.99 years, by 1987 this value increased to 14.69 and to 17.52 by 2007. Similarly, the total (male and female) life expectancy at birth during the period 1959-1961 was 69.9, it was 75.4 during the period 1989-1991 and 77.5 in 2003 (Shrestha, 2006). Finally, following the so-called phenomenon of "rectangularization" (the shift to the right of the frequency of deaths), in 1971 the modal age of death in the US was 79 years, while in 2000 it was 86 years (Canudas-Romo, 2008).

Although these data and estimates sound encouraging, they represent a major issue for pension funds, insurance companies and annuity providers in general. Longevity risk is the risk that an annuitant will live more than forecasted by the annuity provider, such that the company will have to pay an annuity for a longer-than-expected period after her retirement.

Several solutions have been implemented in the past few years in order to hedge longevity risk. Traditional ones encompass reinsurance and increase in premia paid by the insured, while an alternative has been recently found in longevity-linked securities, created in order to transfer longevity risk to the financial markets. The Longevity Bond, in particular, is an asset designed to provide its buyer with a longevity risk hedge due to the particular structure of its coupons, which are directly proportional to the longevity of a reference population and thus mimicking and offsetting the behavior of the pension annuities' liabilities.

The fact that a demographic variable such as longevity risk can be hedged through financial markets raises the question as to whether the two are correlated. Although intuition would suggest little or no correlation, a recent stream of financial literature highlights several links between demography and financial variables. Goyal (2004); Poterba (2001); Della Vigna and Pollet (2007); Ang and Maddaloni (2005) find mixed evidence on the effect of demographic changes on financial variables. Their work is at the basis of the study carried out by Geanakoplos, Magill and Quinzii (2004) (GMQ henceforth), who propose a demographic

[1] *www.grg.org*

model with overlapping generations able to relate the so-called Middle-Aged to Young (MY henceforth) ratio to Stock markets during the past century.

The MY ratio is constructed as the relative weight of the Middle-Aged (40-49 years) generation relative to the Young one (20-29 years) in a particular year, and the fundamental assumption of the GMQ model, derived from the US population demographic structure over the past century, is that natality follows cycles of 20 years of particularly high birth rates. Accordingly, MY has been high in correspondence of periods registering high births, and low in the next 20 years period in correspondence of low birth rates.

The economic intuition linking this pattern in births with financial markets is that if individuals desire to maintain nearly constant consumption streams throughout their lives, they will have to invest more when earning more (i.e., when they are Middle-Aged), borrow money when Young and sell off when Retired. Other else being equal, this will favor Stock markets when the Middle-Aged to Young ratio and the demand for savings are high (*i.e.* when the relative amount of the Middle-Aged generation is high with respect to the Young one). This behavior is confirmed in Geanakoplos *et* al. (2004) by the empirical relation registered during the last century between the behavior of the S&P index and the MY ratio.

A successive study by Favero, Gozluklu and Tamoni (2011) documents the existence of a slowly-evolving trend in the Dividend Price ratio determined by MY. The results of their work show that MY is always significant in forecasting regressions for real stock market returns. The effect of MY is negative on the regressions of the slowly-evolving mean of the Dividend Price ratio and positive for returns. Moreover, the use of MY dominates alternative approaches proposed by the literature to capture the evolving mean in the Dividend Price ratio.

From this starting point, the purpose of this paper is twofold: first, we construct a proxy for the postwar longevity risk borne by an hypothetical US annuity provider with exposure to a diversified portfolio of retirees, which we name Longevity Shock. Second, employing the asset allocation model developed by Campbell and Viceira (2004), we show not only how this demographic shock correlates to financial variables throughout the second half of the past century, but also the extent to which this correlation can vary depending on the investment horizon. Given the long-term nature of longevity risk, these findings would be particularly relevant for an annuity provider interested in hedging her exposure with longevity-linked securities.

The rest of the paper is organized as follows: section 2 describes the Lee - Carter (1992) model and the derivation of our Longevity Shocks. Section 3 describes the

theoretical framework used to relate Longevity Shocks to financial markets with particular reference to the Campbell - Viceira (2005) model. In section 3 we also implement this particular model in a multi-horizon framework to understand the long-term structure of the correlation between financial and demographic variables and to consequently interpret our results. Section 4 concludes.

2. - Longevity Shocks

As stated in the introduction, the main objective of this work is to understand the relationship between longevity risk and financial markets. This would allow us to draw some interesting conclusions on issues which might have been so far ignored or neglected and should instead be considered by supranational agencies, Governments, annuity providers and other companies concerned with longevity risk.

In order to do so, we make three steps. First, we derive a variable which we consider a suitable proxy for the overall US longevity risk during the second half of the last century. Secondly, we replicate a model allowing us to derive the term structure of the risk-return tradeoff of financial markets. Thirdly, we implement the model adding longevity risk and interpret our results. Each of these steps will be explained in the following sections.

This section is devoted to the description of Longevity Shock, which we define as the error between realized and forecasted longevity of a particular set of US males and females' cohorts during the period 1952-1995. This Shock is, per se, not a pure financial asset nor the return on a Longevity Bond (for a detailed description of the mechanics underlying Longevity Bonds, please refer to Appendix A). The price and the returns of the latter are, in fact, affected by both longevity risk[2] and by interest rate risk (which determines at which rate the coupons of the Bond shall be discounted).

Longevity Shocks can have three, mostly overlapping, interpretations:

- they can be seen as a proxy for what happens at the numerator of the Longevity Bond equation, as difference between expected and realized longevity;
- they can be seen as a year-by-year measure of the longevity risk borne by an annuity provider with exposure to a diversified cohort of US retirees during the postwar period;

[2] The numerator of the equation for the price of Longevity Bonds is affected by longevity through the reference rate for the coupons in Graph 5. If longevity is higher (lower) than expected, the bond will pay a higher (lower) coupon.

- finally, they can be interpreted as the annual return of a short-term synthetic contract which pays the difference between fixed (expected at time t) and variable (*i.e.* realized at $t + 1$) longevity, namely a longevity swap with annual resetting. This last interpretation will also help the reader understanding their meaning as financial returns in the context of the asset allocation model described in section 3.

We will now describe the derivation of Longevity Shocks starting from the description of the widely used Lee-Carter model (see Lee and Carter, 1992) from which we obtain our forecasts of longevity[3].

2.1 *The Lee - Carter Model*

The model in its base form was developed by Lee and Carter in (1992), and was further refined by successive studies. We decided to focus our analysis on its original version because of its wide use and the ease of its comprehension.

Model Description The power of the Lee-Carter model lies in the fact that the only relevant variable in forecasting mortality rates is the so-called mortality factor, k, unique amongst all ages. The central mortality rate $m_{x,t}$ for age x at time t moves in the Lee - Carter model according to the following equation:

$$\ln[m_{x,t}] = a_x + b_x k_t + \varepsilon_{x,t} \tag{1}$$

where a_x and b_x are age-specific constants and k_t is a time-varying mortality index. In particular, b_x tells us which mortality rates decline rapidly and which decline slowly in response to a change in the mortality index k. The error term $\varepsilon_{x,t}$, with mean 0 and variance σ^2, reflects age-specific influences not captured by the model.

The main problem is how to determine the time-varying mortality index k_t, which is by itself not observable. The model described in equation *(1)* cannot, in fact, be specified with ordinary regression methods, as there are no regressors: on the right-hand side of the equation we only find parameters to be estimated (a_x and b_x) and the unobservable index k_t.

[3] The terminology used in the next subsection requires a basic understanding of mortality rates and survival probabilities. Please refer to Appendix B for a brief introduction to the subject.

The Singular Value Decomposition method (SVD henceforth), is used by the authors to obtain a unique solution to the estimation problem[4]. In order to find a unique solution to equation *(1)*, the authors[5] first impose the constraints that $\Sigma_t k_t = 0$ and $\Sigma_x b_x = 1$. The first normalization implies that a_x is the empirical average of $\ln[m_{x,t}]$, and Equation *(1)* can be rewritten in terms of the mean-centered log-mortality rate as

$$\ln\left[m_{x,t}\right] - \overline{\ln\left[m_{x,t}\right]} := \widetilde{m}_{x,t} = b_x k_t + \varepsilon_{x,t}$$

Grouping all the $\tilde{m}_{x,t}$ in a unique (*XxT*) matrix $\tilde{m}$, the authors use SVD to obtain estimates for b_x and k_t. Now, if $\tilde{m}$ can be decomposed as $\tilde{m}$=USV′, b is represented by the first normalized column of *U*:

$$b = \frac{u_1}{\sum_{x=0}^{X} u_{x,1}}$$

On the other hand the mortality index vector $k = [k_1, k_2, \ldots, k_T]$ is given by

$$k = \lambda_1 \left(\sum_{x=0}^{X} u_{x,1} \right) v_1$$

where $v_1 = [v_{1,1}, v_{1,2}, \ldots, v_{1,T}]$' is the first column of the *V* matrix and λ_1 is the highest eigenvalue of the matrix *S* (see Girosi and King, 2007 and Giacometti *et* al., 2012).

The values of mortality rates obtained with this method will not, in general, be equal to the actual number of deaths. The authors hence re-estimate k_t in a

[4] SVD is a technique based on a theorem of linear algebra stating that a ($m \times n$) rectangular matrix *M* can be decomposed into the product of three matrices - an ($m \times m$) orthogonal matrix *U*, a diagonal ($m \times n$) matrix *S*, and the transpose of an orthogonal ($n \times n$) matrix *V*. The SVD of the matrix *M* will be therefore be given by $M = U SV'$ where $U'U = I$ and $V'V = I$. The columns of *U* are orthonormal eigenvectors of *AA'*, the columns of *V* are orthonormal eigenvectors of *A'A*, and *S* is a diagonal matrix whose elements are the square roots of eigenvalues from *U* or *V* in descending order.

[5] The explicit derivation of b_x and k_t is not so clear in the original paper Lee R.D. - Carter L.R. (1992). Girosi F. and King G. (2007); Giacometti R. *et* al. (2009), (2012) give more detailed explanations on how to obtain these values.

second step, taking the values of a_x and b_x as given from the first-step SVD estimate and using the actual mortality rates. The new values of k are obtained such that, for each year, the actual death rates are equal to the implied ones. This two-step procedure allows to take into account the population age distribution, providing a very good fit for 13 of the 19 age groups, where the model explains over 95% of the variance over time. For seven of these, the model explains more than 98% of the variance.

The next step after fitting the model is that of making adequate forecasts for the mortality rates. Thanks to the mortality index k, which is unique amongst all age groups and moves in a quite persistent fashion, making forecasts is much easier. The authors find that an adequate ARIMA model describing the behavior of the mortality index k during the period 1900-1989 is

$$k_t = k_{t-1} - 0.365 + 5.24flu + e_t \qquad (2)$$

Where *flu* represents a dummy variable for the 1918 influenza epidemic[6]. The R^2 of this regression is 99.5%.

The combination of Equations *(1)* and *(2)* allows to make forecasts about mortality rates from which to derive longevity rates and related Longevity Shocks. We will now explain in detail this step.

Forecasting Mortality rates We use the yearly central mortality rates for the total US population (males and females) from the Berkeley Human Mortality Database[7]. The mortality rates refer to age groups 0-110+ for the period 1933-1995. This is the main difference between our study and that of Lee and Carter (1992), as the authors use age groups of five years, but we prove that the model is consistent with single-age datasets. We select the period 1933-1951 to derive the fitted values of the mortality index k_t, and the consequent years 1952-1995 to make forecasts on the levels of Longevity Shocks.

Forecasts are made on a year-by-year basis, since Longevity Shocks are calculated as the unexpected error between the estimates of longevity from the previous year and the realized longevity rates. We therefore recursively estimate the parameters a_x, b_x and the ARIMA model of k_t from 1951 to 1994 to account for im-

[6] According to the authors, neglecting this variable provides substantially unchanged point forecasts and parameters, but a 57% wider confidence interval for the last forecast of k_t in 2065.

[7] *http://www.mortality.org/cgi-bin/hmd/country.php?cntr=USA&level=1*

provements/deteriorations in US longevity during the selected period. This gives us forty-four estimates for the vectors k, a and b in equation *(1)* as well as forty-four estimates for the intercept and the AR(1) parameter in Equation *(2)*. Since the data start from 1933, we do not need to take the *flu* dummy into account.

Table 1 shows the values of a_x and b_x we obtain for the last estimate, when the model is estimated on the largest sample 1933-1994. Our results are not radically different from those obtained by Lee and Carter (1992), who use five-year age groups, while we make forecasts for single ages.

Graph 1 plots the mortality index k_t relative to the 1933-1994 sample. We can clearly see that the model is able to detect an almost perfectly (decreasing) linear trend in mortality across cohorts by means of just one regressor, the index k. Knowing the stochastic process for k, the linear trend therefore makes it possible to forecast the evolution of future mortality rates (and, consequently, survival probabilities) conditional on the current value of k. This is probably the reason why the Lee-Carter model has become so popular between practitioners in the actuarial world, as its forecasts are extremely easy and robust at the same time (for further reference on the *ex-post* performance of the Lee-Carter model, refer, amongst others, to Booth *et* al., 2006; Giacometti *et* al., 2012; Girosi and King, 2007 and Lee, 2000).

Turning back to Graph 1, the index decreases with a slope in line with the one estimated by Lee and Carter. We should pay particular attention in comparing this Graph to a similar Graph in their paper, however, since the index is particularly subject to data specification. The results are in this sense closer to those obtained by Li and Chan (2007) for the US population.

Finally, modeling the series of k_t estimated through the whole 1933-1994 sample, we obtain the following ARIMA process

$$k_t = k_{t-1} - 0.6034 + 0.976\, k_{t-1} + e_t$$

which is very similar to Equation *(2)*. We then estimate mortality rates accordingly.

2.2 *Longevity Shocks: Definition and Derivation*

Once obtained Lee-Carter forecasts of mortality rates, the next step is that of finding a suitable definition of Longevity Shock. This definition must respond to the following criteria:

- it should cover unexpected improvements/deteriorations in longevity, defined as the realized differences between expected and realized longevity;
- it should be as comprehensive as possible, reflecting the behavior of the whole retired US population (males and females aged from 65-110+) during the period 1952-1995;
- it should reflect the longevity risk borne by an annuity provider with a diversified portfolio of US annuitants.

As for the first point, for each year from 1952 to 1995 we develop mortality forecasts based on the Lee-Carter model for the whole retired population 65-110+. In our analysis we consider age groups from 65 onwards because this is the typical retirement age, at which point insurance companies and pension funds start paying annuities. We assume that if an unexpected increase in longevity is registered in a particular year, the annuity provider will be able to adjust the premia for those who are still working. The risk is therefore concentrated to the part of the population which is retired, because here no premium adjustment can be made. Anyway, we should keep in mind that particularly for old ages (higher than 90-94 years), the estimates are quite noisy due to the high variability of mortality rates[8]. The time-t expected longevity $E_t(L_{x,t+1})$ for each of the 46 age groups is then given by

$$E_t(L_{x,t+1}) = (1 - E_t(m_{x,t+1}))$$

where $E_t(m_{x,t+1})$ is the time-t expectation of the central mortality rate of age group x for the following period $t + 1$.

The realized longevity rate for age group x at time $t + 1$ is similarly given by $L_{x,t+1} = (1 - m_{x,t+1})$ and the difference between the realized longevity rate and the expected one is our age-specific $t + 1$ Longevity Shock, $\eta_{x,t+1}$[9].

[8] If for example there were only ten people alive at the age of 109 at the beginning of 1976 in the US and of these ten people only five survived to the end of 1976, then $m(109, 1976) = 50\%$. Similarly, if there were only ten people alive at the age of 109 at the beginning of 1977 and of these ten people seven survived to the end of 1977, then $m(109, 1977) = 70\%$. These volatile changes in mortality rates from one year to another make it very hard to make good forecasts for very high ages.

[9] Notice that this definition does not take into account Cumulative Survival Rates, as Shocks are based on forecasts made each year relatively to the following one, only. This avoids both the problem of making long-term forecasts of mortality and is consistent with the periodic (yearly) adjustments to mortality projections made by actuaries. Again, for the difference between our longevity factors and cumulative survival rates, please refer to Appendix B.

As for the second and the third points, the problem is determining a unique measure of the Longevity Shock for each year instead of forty-six shocks corresponding to each age group. In order to do so, we create a vector of weights representing a diversified portfolio of annuitants of an hypothetical US pension fund. We consider the US 65-110+ years-old population distribution for the years 1951-1994, whose data we downloaded from the Berkeley Human Mortality Database. In this portfolio the (changing) weight assigned to each Longevity Shock in year $t + 1$ is equal to

$$\omega_{x,t} = \frac{pop_{x,t}}{\sum_{x=65}^{110} pop_{x,t}}$$

where $\omega_{x+1,t+1}$ is the weight assigned to $\eta_{x+1,t+1}$ and $pop_{x,t}$ is the US retired population aged x at time t.

We assume that forecasts of mortality rates are made at the end of the year previous to that of the realization of longevity. Population weights are therefore chosen such that the portfolio of insured that will experience a particular mortality rate in year $t + 1$ is the one that the hypothetical annuity provider had on its book at the end of t. The portfolio both represents the highest possible degree of diversification, since it both takes into account the whole retired US population and it gives less weight to more volatile forecasts corresponding to high-age groups. Moreover, its weights take into account periodic changes in the balances of the population structure, making it appealing also in terms of interpretation. The Longevity Shock (which again the context of asset allocation can be seen as the return on a longevity swap with the diversified portfolio of annuitants as underlying) employed in our asset allocation setting is then obtained by weighting the cohort-by-cohort difference between forecasted and realized longevity by ω as:

$$\mathrm{ls}_t = \sum_{x=65}^{110} \omega_{x,t} \cdot \eta_{x,t}$$

Graph 2 plots Longevity Shocks for the period considered. As we can see, this "demographic" specification provides us with constantly positive Shocks reflecting the overall age-weighted unexpected improvement in US longevity in the period 1952-1995. Some points are worth noting:

- the magnitude of the Longevity Shocks is extremely low, in the order of 0.4% for year and with a standard deviation of 0.2%;

- still, the Lee - Carter forecasting procedure seems to carry a very small downward (upward) bias in forecasting longevity (mortality). Graph 2 shows that on average the model slightly underestimates longevity with respect to the realized one in the next year. This modest but positive bias is driven by the high variability in the estimates for old ages (95+) cited above, even if these cohorts receive less weights than the others. This tells us that the Lee-Carter model, despite its appeal, widespread use and relative robustness in forecasting, has historically underestimated longevity risk, and that the elderly have on average lived longer than expected;
- this should be a further reason to be interested in (and concerned about) longevity risk. If the Lee-Carter model is the gold standard for actuarial practitioners, this persistent positive bias in mortality forecasting should have been covered by an appropriate hedging. Switching perspective, if we consider Longevity Shocks as the returns on a long position on a longevity swap (receiving variable and paying fixed longevity), we can clearly see a positive return for the long investor to offset the longer-than-expected life of her underlying exposure;
- finally, we should keep in mind that a bias in the model is, per se, not a big problem if promptly recognized and dealt with by increasing the price of longevity-linked products. In Appendix D, we directly address this issue by considering whether the variable we derive has been priced in the US market for annuities during the postwar period, and finding empirical evidence supporting our interpretation of Longevity Shocks as a proxy for longevity risk.

3. - Term Structure of Longevity Risk

This section is devoted to the implementation of a model which allows to find different values of expected returns, variances and correlations of a set of variables depending on a selected investment horizon. Its aim is that of analyzing whether the unexpected increase/decrease in overall US longevity during the years 1952-1995 has been related to financial markets and, if so, how.

The original model, whose replication is described in detail in Appendix C, is the one developed by Campbell and Viceira (2005). This model has the great advantage of disentangling long-term correlations between financial markets and longevity risk by including the Longevity Shocks derived in the previous section in a multi-horizon investment setting. The results are, on one hand, interpreted

in a risk perspective, analyzing how variances and correlations of financial and demographic variables both vary depending on the investment horizon and can be affected by longevity risk. On the other hand, the risk-return profile of our variables is analyzed in terms of optimal asset allocation, interpreting the long-term longevity risk-return term structure in an optimal asset allocation perspective. In fact, we also derive the composition of the Global Minimum Variance Portfolio in presence of Longevity Shocks intended as a synthetic asset written on pure longevity risk and draw conclusions about its relative composition.

3.1 *The Theoretical Framework*

Campbell and Viceira (2005) propose a very simple yet effective Vector Auto-Regressive model of order one (from now on, VAR(1)), which finds a wide range of applications in macroeconomic theory. The basic prediction of this model is that every component of a vector of variables depends on the *n*-lag (in this case, the lag length is one) values of the same vector plus an error term.

The variables used in the original framework are excess returns on Stocks and Bonds, real returns on T-Bills plus three factors which are commonly recognized as good returns' predictors. These are the short-term interest rate, the Dividend Price ratio and the Yield Spread between long-term and short term Bonds. Further details on the variables' specifications are given in the next subsection. In *formulae*, we have that each one of the six variables can be represented by the following process

$$r_{i,t} = \varphi_{j,0} + \sum_{i=1}^{r} \varphi_{j,i} r_{i,t-1} + \varepsilon_{j,t} \text{ for } i = 1, 2\ldots, j, \ldots 6$$

or alternatively, in vector notation,

$$R_t = \boldsymbol{\Phi}_0 + \boldsymbol{\Phi}_1 R_{t-1} + \varepsilon_t \tag{3}$$

where, in the original model, R_t is a (6 × 1) column vector of the variables at time *t*, $\boldsymbol{\Phi}_0$ is a (6 × 1) column vector of the intercepts of the model, $\boldsymbol{\Phi}_1$ is a (6 × 6) matrix of coefficients assigned to the one-period lagged variables and ε_t is a (6 × 1) vector of error estimates. In this framework, we add to the VAR(1) longevity shocks seen as returns on a longevity swap written on a pure demographic variable

and compare the results with those obtained by replicating the original model (see Appendix C).

This model allows us both to take into account mutual relationships between the variables included in the VAR(1) and to understand how these are related in a context with different investment horizons. The conditional expectations and variances which we derive from this model are in fact extremely different from the unconditional ones, which are simply the historical mean and variances of the sample, and this is where the Campbell - Viceira model proves most useful. The investor who uses the VAR(1) model in order to make forecasts about the expected risk-return structure will differ in many ways from the investor who uses unconditional expectations and variances (see Campbell and Viceira, 2005):

- first of all, the former will have a different return expectation on each period t (based on the $t-1$ values of both the state variables and assets' returns) if compared to the constant unconditional expectations of the latter;
- secondly, the VAR(1) investor will have a different and dynamically changing expectation for the variance structure, which will also decrease as part of the variability in the forecasts is explained by the model. The risk will be embedded in the error term which represents the part of return which the model is not able to predict;
- thirdly, the risk-return profile of each asset will differ depending on the holding period. While in fact for the "unconditional" investor the per-period return of an asset and its relative risk are constant through time, this is not true for the VAR(1) investor, who will be able to allocate assets differently according to the period forecasts of annualized expected values, variances and correlations of returns.

3.2 Data

As explained in section 2, we derive Longevity Shocks with annual frequency. Since adapting this series to the quarterly model originally used in Campbell - Viceira (2005) is both hardly feasible (lack of longevity data for frequencies higher than yearly) and meaningless (for example, because there are some months of the year which experience particularly high death rates), we decided to adapt the Campbell - Viceira model to the annual Longevity Shocks ranging from 1952 to 1995, inclusive[10]. Again, please refer to Appendix C for details on the replication

[10] For the detailed replication using quarterly data please refer to the original thesis Bisetti E. (2011).

of the Campbell - Viceira model using annual financial variables only.

The financial data, covering the period 1890-1995, refer to Campbell *et* al. (2003) and are available on the author's webpage[11]. In particular, the six time series are built as follows:

- short-term *ex-post* real T-Bill rate: return on 6-month commercial paper bought in January and rolled over July, minus the Producer Price Index (PPI);
- excess Return on Stocks: log return on the S&P 500 Stocks, from which the short-term nominal interest rate has been subtracted;
- excess Return on Bonds: returns are obtained using the loglinear approximation described in section 10 of Campbell, Lo and MacKinlay (1997)

$$r_{n,t+1} = D_{n,t} y_{n,t} - (D_{n,t} - 1) y_{n-1,t+1}$$

where n is the Bond maturity, the Bond yield is $Y_{n,t}$, the log Bond yield is $y_{n,t} = (1 + Y_{n,t})$ and $D_{n,t}$ is the Bond duration, calculated at time t as

$$D_{n,t} \approx \frac{1 - \left(1 + Y_{n,t}\right)^{-n}}{1 - \left(1 + Y_{n,t}\right)^{-1}}$$

with n set to 20 years and $y_{n\text{-}1,t+1}$ approximated by $y_{n,t+1}$. Subtracting the nominal T-Bill rate, we obtain the excess return on bonds;

- nominal T-Bill rate: return on 6-month commercial paper bought in January and rolled over in July;
- Log Dividend Price ratio: natural logarithm of the S&P 500 dividend series minus the logarithm of the S&P 500 price series;
- Yield Spread: difference between the log yield of the long Bond and the short yield on commercial paper.

3.3 *VAR(1) Estimation*

Table 3 shows the results of the VAR(1) estimate including Longevity Shocks, which we can compare to those in Table 2, for financial variables only. As for the upper part of Table 3, no major changes take place in the coefficients attached to the six financial variables with respect to Table 2. For those variables whose ex-

[11] *http://scholar.harvard.edu/campbell/data.*

planatory power is significantly different from zero, in particular, the signs are the same as in Table 2.

The overall fit of the model is slightly greater in Table 3 than in 2. In order to make meaningful comparisons between the two versions of the VAR(1), we report the adjusted R^2 for both of them. Adding Longevity Shocks increases the adjusted R^2 of the model for all the equations but the one relative to the Yield Spread, and therefore seems meaningful.

The coefficients attached to the Longevity Shocks are always significant and their sign is negative in the predictive equations of the three financial assets. A positive Longevity Shock today would, according to our results, predict lower returns on real T-Bills, Bonds and Stocks. The fourth row shows the coefficients of the equation of Longevity Shocks. The variable is quite persistent[12] and lagged Bond returns have explanatory power over it. The overall fit of the equation is quite high (the R^2 is in this case 64.6%).

The last three rows represent the three state variables. In this case, too, no major changes occur when Longevity Shocks are added to the system. The variables show very high persistence and the coefficient of the lagged real T-Bill equation is positive both in the equation for the nominal T-Bill and in the one of the Yield Spread. The lagged nominal T-Bill rate acquires explanatory power in the Yield Spread equation, while interestingly Longevity Shocks receive a positive and significant weight in forecasting the Dividend Price ratio.

Comparing the bottom parts of Tables 3 and 2, we can immediately notice a general drop in standard deviations of the regression residuals when adding Longevity Shocks to the VAR(1). This is not a surprise, as adding new regressors decreases the residuals' variance[13]. However, the correlation structure of the residuals looks pretty similar to the one without Longevity Shocks. The residuals' correlations between T-Bills (both real and nominal), Bonds and Stocks slightly decrease in all the three cases as Longevity Shocks show the same (negative) sign

[12] In section 2 we explained, by making reference to Graph 2, that the persistent behavior of Longevity Shocks is not surprising, given the high volatility characterizing forecasts of longevity at ages 95+. *Ex-post*, this bias in the forecasting model leads to the conclusion that a positive shock to longevity today would imply a positive shock tomorrow, posing some doubts on the appropriateness of the term "shock". Instead, the empirical evidence in Appendix D tells us the opposite: longevity has, according to our results, systematically exceeded expectations during the second half of the last century, and actuaries have consequently adjusted the prices of annuities to cope with this.

[13] This is the reason why we chose to use the adjusted R^2 rather than the simple R^2 to explain the overall fit of the model.

in their forecasts, thus decreasing their residuals' common variation.

Longevity Shocks are negatively correlated with real T-Bill rates, excess Stock returns and nominal T-Bill rates. They are instead positively correlated with excess Bond returns, the Dividend Price ratio and the Yield Spread. Noticeably, the Shocks show their highest levels of correlation with the Dividend Price ratio (the variable whose effects are the most relevant at medium/long horizons) and the lowest with the short-term real T-Bill. This issue will be investigated further in the next subsection, where the correlation structures are analyzed in relation to different investment horizons.

We can draw the following conclusions from our results on the relationship between financial markets and longevity risk:

- Longevity Shocks display an extremely low variance, much lower for example than that of a T-Bill (both in real and in nominal terms) and also lower than that of the three state variables;
- an unexpected increase in longevity today forecasts a positive Longevity Shock for tomorrow. This reflects the overall improvement in the longevity profile of the US population which is not accounted for by the Lee - Carter model;
- the current value of Longevity Shocks is negatively correlated with Stocks and real T-Bills' returns and positively correlated with excess Bond returns. This not only confirms the widespread opinion that investing in longevity risk offers an attractive diversification opportunity, but also strengthens it as the correlation between financial markets and longevity risk is negative;
- at the same time, positive Longevity Shocks predict low returns on Stocks, Bonds and T-Bills, and high Dividend Price ratios;
- adding Longevity Shocks to the original VAR(1) with annual data leads to an overall improvement of the predictive power of the equation, as measured by its adjusted R^2.

3.4 *K-Period Analysis of Risk and GMV Portfolio*

This section is devoted to the analysis of variances and correlations of the six financial variables and Longevity Shocks. The main point is understanding whether unexpected improvements in Longevity are correlated with financial markets in a *K*-period investment horizon framework, and, if so, the extent of these correlations.

Longevity Shocks and Financial Variables Looking at Graph 4*a*, reporting the standard deviations of real T-Bills, Stocks, Bonds and Longevity Shocks for different

horizons, we can make some immediate comparisons with its counterpart Graph 3*a*.

First of all, Longevity Shocks show the lowest risk for any investment horizon. Their standard deviations pass from a low of 0.155% to a high of around 0.5% at a 40 years' horizon. This increase (which, despite its low absolute value, more than triples the risk of the variable) is driven by the high persistence of Longevity Shocks and by the mean-averting effect of the Dividend Price ratio. On one hand, in fact, the Dividend Price ratio displays positive correlation with Longevity Shocks. On the other hand, a positive shock in the Dividend Price ratio forecasts a high level of Longevity Shock for the next period. The combined effect causes mean-aversion.

As for the other variables' risk, we can notice an overall decrease in the levels of standard deviation, explained in the previous subsection with the increased number of regressors. Their shape for different investment horizons is, however, almost left unchanged with respect to Graph 3*a*.

The standard deviation of Stocks' returns does not change, except for the fact that the mean-averting effect of the Dividend Price ratio is slightly more pronounced in this case (its coefficient passes from 0.08 to 0.36 in the equation of Stocks' returns). Similar conclusions can be drawn for Bonds, whose risk profile is identical to the one displayed in Graph 3*a*.

As for real T-Bills' standard deviation, we can notice a small decrease in the curve at very long horizons (around 20 years) corresponding to a reduced mean aversion effect. This could again be imputed both to the higher mean-reverting power of the Dividend Price ratio when Longevity Shocks are added to the VAR(1) system but also to the lower persistence of the real T-Bill's return itself.

Graph 4*b* shows correlations between the three financial assets' returns (Bonds, T-Bills and Stocks) and Longevity Shocks. Starting from the initial values in Table 3, the correlation between Bonds and Longevity almost drops to a minimum of -60% at a horizon of seven years. This is justified by the persistence of Longevity Shocks and by their explanatory power on excess Bond returns. A positive Longevity Shock today, in fact, translates into a positive Bond return today. At the same time, a positive Longevity Shock forecasts a negative excess Bond return and a positive Longevity Shock for the next period. These counterbalancing effects imply that the decrease in correlations between Bonds and Longevity Shocks will take more time to reach its full effect relative, for example, to the correlations between Stocks, real T-Bills and Longevity.

After this initial drop, however, more persistent variables such as the Dividend

Price ratio, the nominal T-Bill rate and the Yield Spread take back the Bonds/Longevity correlation to around -30% as all have the same signs in the predictive equations of Longevity Shocks and Bonds.

Similar conclusions can be drawn for Stocks and Longevity. The negative correlation is, on one hand, driven by the opposite signs of the lagged Longevity Shocks' coefficients in the equations of excess Stock returns and in that of Longevity Shocks. On the other hand, it is further strengthened by the negative correlation between the two variables. This means that a positive Longevity Shock implies a negative excess Stock return today, and forecasts a negative excess return on Stocks and a positive Longevity Shock for the next period. This effect therefore takes a very short time to be fully incorporated in the Stocks/Longevity correlations (in particular, the minimum is reached around a 5-years' horizon, and corresponds to a value of -55%).

This also holds true for real T-Bills and Longevity. The medium-term reversion effect is even more pronounced here and the lowest levels of correlation are displayed around 3-years' investment horizon. The influence of Longevity Shocks leaves soon room to the more persistent Dividend Price ratio and nominal T-Bill yield, whose effects lead the final correlations at a 40-years horizon to around 20%.

Our results confirm the opinion according to which longevity risk is an interesting diversification opportunity with respect to Stocks (at any investment horizon), and with respect to T-Bills (at an horizon from 0 to 15 years). The long-term longevity-risk return profile will, however, radically change depending on the investment horizon and this shall be accounted for as the investment horizon of such an investment should be a very long one.

To see what happens to the term structure of correlations of financial variables, we compare Graph 4*c* and Graph 3*b*. We can notice that the shape of the curves does not change much when adding Longevity Shocks into the VAR system. The only relevant difference lies in Stocks and Longevity Shocks for an investment horizon between 5 and 15 years. In fact, the correlation no more shows the drop which we imputed to the nominal T-Bill rate's coefficient in Graph 3*b*. Even if the coefficients attached to the lagged nominal T-Bill rate still show opposite signs in forecasting Stocks and Bonds, their effect is partially offset by the fact that a positive Longevity Shock forecasts negative real T-Bill and Stocks' returns. The fact that Longevity Shocks have a significant explanatory power affecting T-Bills and Stocks is also clear if we compare Graphs 4*b* and 3*b*. We can clearly see in 4*b* that starting from an horizon of around five years, the correlations of T-Bills and Stocks with Longevity are increasing. At the same time, the correlation

between Stocks and T-Bills in Graph 4*c* decreases as driven by the nominal T-Bill, but less than in 3*b*. This is precisely due to the effect of the common variation of Stocks and T-Bills with Longevity Shocks.

K-period GMV with Longevity Shocks Graph 4*d* shows the composition of the Global Minimum Variance portfolio (the efficient portfolio with the lowest possible variance) when Longevity Shocks are taken into account (again, remember that from a financial point standpoint we could view longevity shocks as the returns on a longevity swap, thus making the comparison meaningful). As we have already noticed, Longevity Shocks always show the lowest variance in the set of variables, and therefore receive a weight of around 100%. Moreover, given the decrease in the Bond's standard deviations (see Graph 4*a*), from ten years onward Bonds receive slightly higher weights, (around 0.5%). This is also given by the high negative correlation between Longevity Shocks and Bonds, which displays its lowest values (around -60%, see Graph 4*b*) precisely at an horizon of around 10 years. Stocks almost always receive zero-weights, given the high levels of their variance. From 10 years' horizons, the weight assigned to T-Bills is even negative, meaning that the investor will borrow money to finance her low-risk investment in Longevity and Bonds.

Our results tell us that an annuity provider interested into hedging its longevity exposure by means of longevity-linked securities will also be able to have an effective diversification opportunity for its traditional asset classes' risk given the extremely low variance of longevity risk and its negative correlation with financial markets.

3.5 *Placing the Results in the Literature*

How can our results be related to those in this field (in particular to those in Geanakoplos *et* al., 2004 and Favero *et* al., 2011), with respect to the correlation we found between financial markets and longevity? The two studies we cited focus on how the population's demographic structure relates to Stock market's returns and to the Dividend Price ratio. The effect of the demographic variable MY (see section 1) in explaining the former is positive and negative in explaining the latter. Our results intuitively confirm those in the literature: the effect of Longevity Shocks for the retired population is positive in explaining the Dividend Price ratio and negative in explaining Stock returns. A positive Longevity Shock in the retired population would, at a first glance, imply a relatively lower value of MY[14], a higher number of

[14] Using the overlapping generation model described in GMQ, this would represent an odd period with relatively high Retired and Young people.

retirees divesting for retirement and a consequent decrease in stock markets.

We must, however, make some remarks relative to the differences between our model and that in Geanakoplos *et* al. (2004):

- the GMQ model does not take into account mortality risk as the death of an individual is assumed to occur at the age of 80 (at the end of the retirement period). The model does not leave room for longevity improvements (either expected or unexpected) which are the central issue of this work, but only to the intuition that a positive Longevity Shock in the retired generation implies a relatively higher concentration of retirees, which is not automatic (see the next point);
- our analysis of Longevity Shocks considers exclusively the retired US population, not accounting for the Middle-Aged and Young generations' longevity. This has been done in order to relate unexpected improvements in longevity of the retired population (corresponding to the coupons of an hypothetical Longevity Bond) to financial variables. A positive Longevity Shock referred to the retired population does not, however, automatically imply a lower value of the MY ratio. The improvement in longevity could in fact be the same for all the US population (including Young and Middle-Aged), leaving MY substantially unchanged, or it could instead be more pronounced for the Middle-Aged rather than for Retired people, increasing MY;
- in our model, the retirement period begins at 65 years and Longevity Shocks are calculated from retirement until the age of 110+. This period comprehends three generations from the GMQ definition: the first one, going from 65 to 79, the second one from 80 to 99 and the third one from 100 to 110+. While in the overlapping generation model ages higher than 80 are not considered, they represent a remarkable piece of information when computing Longevity Shocks.

Despite these differences, the fact that both the GMQ model and our VAR estimate predict significant relationships between demographic and financial variables represents per se the adequate incentive to further investigate this issue in a context of general equilibrium, whose analysis is however far out of the scope of this paper.

4. - Conclusions

Section 3 showed our results regarding the dynamic relationships between unexpected changes in the US longevity during the years 1952-1995 and typically

financial variables such as Stocks, Bonds and T-Bills' returns. This unexpected improvement/deterioration in longevity, called a Longevity Shock, has been derived in section 2 as the retired-population-weighted difference between observed longevity and its Lee-Carter estimate.

The common opinion that a purely demographic variable such as longevity is not related to financial markets does not hold true according to our results. Longevity Shocks display in fact negative correlations with real T-Bill and excess Stock returns and positive correlation with the Dividend Price ratio during the period considered.

Moreover, the level of the correlation between Longevity Shocks and financial markets radically changes across different investment horizons in the Campbell-Viceira model, and this result can be of foremost importance for an annuity provider interested into hedging its longevity exposure with a Longevity Bond. In fact, the ideal investment strategy for such a security would be a buy-and-hold approach, but this contrasts with the fact that the longevity-driven coupons of the bond are revised annually[15] . The analysis carried out in section 3 using the Campbell - Viceira model was therefore aimed at finding the long-term longevity risk-return tradeoff profile for a buy-sell strategy in Longevity Bonds both for short- and for long-term horizons, and in relation to other investment opportunities.

A diversified portfolio of Stocks would, for instance, display negative correlation with longevity for investments horizons from one to forty years, but the level of this correlation radically changes according to the period considered, translating in different optimal asset allocation weights.

The effect is more pronounced for Bonds and T-Bills. As for the former, the initially positive correlation between Bonds and longevity rapidly decays below zero for every investment horizon from 2 to 40 years. If an annuity provider decides to buy a Longevity Bond today in order to hedge her exposure, she will have to take into account that long-term interest rates are negatively correlated with longevity risk. As for the latter, the results are even more interesting. If the T-Bill could be considered an effective hedge of longevity risk up to 15 years, this

[15] Longevity Shocks are, as we define them, a year-by-year measure of the longevity risk, consistent with the fact that actuaries revise their expectations about longevity each year. The duration of an ideal investment in the Longevity Bond (whose longevity risk is described by Longevity Shocks) is an extremely short one (one year), and the asset allocation strategy for the Bond would be that of buying and selling it at each revision of longevity rates. This strategy however explicitly contrasts with the buy-and-hold (or, at least, very long duration) nature of a Longevity Bond designed to hedge long-term longevity risk.

would not hold true for longer horizons. The correlation between short-term interest rates and longevity turns in fact from being negative to positive for an investment horizon of 15 years, changing the optimal asset allocation structure.

Our results obviously depend on our particular specification of the model used to forecast mortality rates[16], but they show that a non-financial variable such as longevity can possibly have a great impact on financial variables. Making reference to the previous literature in the field, in particular to Favero *et* al. (2011) and Geanakoplos *et* al. (2004), it would be then worth investigating the economic and demographic motivations of this relationship, in order to further enhance the creation of a liquid market for longevity-linked securities by means of a better understanding of their underlying dynamics.

[16] The Lee - Carter model is the most widely used by practitioners, so our estimates of longevity can be the same as that of the industry.

APPENDIX

A. Longevity Bond

Aim of this appendix is to introduce the reader to the Longevity Bond by making reference to the EIB/BNP issue of 2004. This asset was designed to provide its buyer with a hedge against longevity risk by means of the structure of its cash flows, and has been subject to increasing interest both from academics and practitioners as part of the so-called Longevity-Linked Securities.

Bond Cash Flows The Bond was aimed at being the first financial product publicly exchanged on financial markets to provide a hedge against longevity risk. This would have been achieved through:

- long-term tenor. The Bond was designed to start in 2003 and last through 2027, providing the hedger with 25 years of protection against longevity risk. In particular, the asset was designed for annuity providers interested in hedging their longer-term, more volatile cash flows;
- cash flow profile (Graph 5) directly proportional to the cumulative survival rate, CSR_t of the underlying cohort. The index CSR_t was based on the cumulative survival rate of a cohort of English and Welsh males aged 65 in 2003. The index was based on publicly available data from the UK Office for National Statistics (ONS).

The higher the longevity (measured by the cumulative survivorship rate) on a particular year, the higher the coupon associated with that period, and *vice versa.* The insurance company faced with increasing liabilities due to higher annuity payments would have compensated them by means of the increased value of the Bond.

Three actors were active during the issue of the Bond, namely the European Investment Bank, BNP Paribas and Partner Reinsurance. The European Investment Bank is the European Union's financing institution, whose shareholders are the members of the EU according to their relative economic weight (expressed in Gross Domestic Product terms). The EIB issued the Longevity Bond and guaranteed its cash flows as part of the Bank's objective to promote economic and social cohesion throughout the European Union. During the issue BNP Paribas acted as structurer, manager and book-runner in the primary market, and as market maker in the secondary market. It also entered a swap with the EIB in order to transform the fixed interest rate, longevity-linked liabilities into floating interest

rates, longevity-risk-free obligations. The third player, Partner RE, provided significant expertise in the longevity field and reinsured BNP Paribas from its longevity risk exposure.

The cash flows coming from and flowing to the EIB, represented in Graph 6, were designed to guarantee that the EIB would have been free from interest rate, currency and longevity risks while issuing the Bond. This was achieved through:

- an interest rate swap between the EIB and BNP (Flow 2 in the Graph), according to which the EIB would have paid floating Euros while receiving fixed Sterling. This allowed the EIB to be free from interest rate and currency risks;
- a mortality swap between the EIB and Partner Re (Flow 3 in the Graph). The EIB would have paid a fixed $\hat{S}(t)$ while receiving floating $S(t)$ correspondingly to each Bond coupon[17].

The sum of the two components allowed the offsetting of the final EIB liability, a floating longevity, Sterling denominated Bond (Flow 1 in the Graph).

Basis Risk The Longevity Bond did not provide a perfect hedge. A perfect hedge is achieved when the risk of the initial position is totally offset by the hedge, and the correlation between the two positions is -100%. In most of the cases this is not achievable nor achieved, as most of the market participants look for a partial hedge to have some chances of profits.

The difference between the cash flows of the initial and hedging positions gives rise to basis risk. In the particular case of the Longevity Bond, basis risk was given by multiple sources (Azzopardi, 2005):

- the longevity of different samples inside the same cohort could show different trends;
- the age distribution of the insurance company/pension fund could be different from that of the Reference Population (English and Welsh males aged 65 in 2003);
- hedger's portfolio might have included females, too. Females have historically shown different longevity rates from males;
- all lives were equally weighted (independently, for example, from being smokers or non-smokers, etc.);
- the pension fund could have had liabilities for reversionary pensioners (this happens when, in case of death of the insured, the remaining balance of his pension is paid to a nominated person);

[17] The swap was actually an OTC contract between BNP and Partner Re, such that BNP paid $\hat{S}(t)$ in Sterling and received $S(t)$ in Euros. This is why Flow 2 in the picture passes through BNP.

- the pension fund might have had liabilities for escalating payments (payments to the annuitant increasing with time), causing a mismatch between increasing cash paid and decreasing coupons from the Bond;
- the cash flows from the Bond covered the first 25 years from 2003. It's more than reasonable that many people aged 65 in 2003 will still be alive in 2028 (when they will be 90). A possible solution would have been designing another type of survivor Bond (see Blake and Burrows, 2001), with the last payment occurring at the death of the last survivor in the reference cohort.

Despite the high basis risk of the Longevity Bond, which led to its only partial subscription and to its withdrawal, this instrument's profile is particularly interesting from our perspective as its coupons were designed to directly reflect longevity risk, whose extent we measured in section 2.

B. Mortality Rates and Survival Probabilities

In actuarial literature (see for example Pollard, 1973 and Thatcher *et* al., 1998), the number of people in a given cohort who survive to reach exact age x at time t is denoted by $l_{x,t}$. Out of these, the number of people that survive 12 months to reach exact age $x + 1$ at $t + 1$ is $l_{x+1,t+1}$. The number of people who died within these 12 months is therefore given by

$$d_{x,t} = l_{x,t} - l_{x+1,t+1}$$

while the proportion of people died between t and $t + 1$ is by

$$q_{x,t} = \frac{d_{x,t}}{l_{x,t}}$$

For sufficiently large cohorts, we can interpret $q_{x,t}$ as the probability of dying within 12 months of reaching age x in year t.

Similarly, the central death rate $m_{x,t}$ at age x is found by dividing the number of people who died between t and $t + 1$ while aged x (after having reached exact age x but before reaching exact age $x + 1$) by the average number of people living in age group x between t and $t + 1$. If a population is stationary, (the number of people who leave the age group during the year, either by reaching age or by dying, is exactly balanced by the number who enter the age group on reaching

their x^{th} birthday), the number living in the age group x is constant throughout the year, say $n_{x,t,t+1}$. Then the central death rate $m_{x,t}$ is given by:

$$m_{x,t} = \frac{d_{x,t}}{n_{x,t,t+1}}$$

If however the population is nonstationary, $m_{x,t}$ is often estimated as the average of the observed populations aged x at t and t+1, or as the population at mid-year. For cohorts with a known survival function[18] $s_{x,t}$, the average number living at age x during the year is:

$$N_{x,t} = \int_0^1 S_{x+z,t+z}\, dz$$

and the central death rate is given by

$$m_{x,t} = \frac{d_{x,t}}{N_{x,t}}$$

In this sense, central mortality rates represent the average yearly rate at which people die between age x and x + 1 with the rate expressed as a fraction of those living in the age group. Our definition of longevity rate in section 2 as

$$L_{x,t} = (1 - m_{x,t})$$

perfectly captures the idea of the average rate at which people aged x at time t survive to age x + 1 in year t + 1. In this respect, this definition slightly differs from that of period survival probability (conditional on being alive at the beginning of time t), defined as $1 - q_{x,t}$, because it takes into account the rate at which people enter or exit cohort x during the period from t to t + 1.

Moreover, since we consider only year-to-year differences between expected and realized longevity rates, our specification needs only take into account the cumulative survival probability:

[18] The details on how the Human Mortality Database calculates central mortality rates can be found on its Methods Protocol at *http://www.mortality.org/Public/Docs/MethodsProtocol.pdf*. These ready-made estimates have the two great advantages of public availability and a commonly agreed-upon framework to rely upon.

$$S_{x,t} = \prod_{z=1}^{z} \left(1 - q_{x+z,t}\right)$$

which represents the probability that an individual aged x at time t will survive to age $x + Z$, conditional on mortality rates at time t[19].

C. Term Structure of Risk-Return Tradeoff

In this appendix we provide detailed explanations about the replication of the Campbell-Viceira (2005) model with annual data.

VAR(1) ESTIMATION Table 2 shows the results of our VAR(1) estimation for the yearly sample (period 1952-1995), coupled with its corresponding *t*-statistics. The bottom part of the Table reports correlations of the innovations of the VAR(1).

Starting from the real T-Bill equation in the upper parts of Table 2, we can see that the coefficient attached to the lagged real T-Bill rate is positive and significant, while that on the Yield Spread coefficient is negative. This means that a positive shock to the real T-Bill rate today predicts a higher T-Bill rate for the next period and conversely that a positive shock to the Yield Spread today predicts a lower T-Bill rate for the next period. The fore- casting power of the equation is high, 59.4%.

The second row shows how it is difficult to predict Stocks' returns, as the forecasting power of each of the six lagged explanatory variables is very poor. All the coefficients are not statistically different from zero and the predictive equation shows a small R^2 of 7.6%. Excess returns on the Bond are explained by the lagged values of real T-Bill returns, Yield Spread and excess Bond returns (the latter two with negative coefficients, the first one with positive coefficient), and the predictive power of the equation is very high in this case, with an R^2 of 58.9%. We should, however, keep in mind that the results could reflect approximation error in constructing excess Bond returns.

[19] A more correct procedure would be that of incorporating expectations on future mortality rates in the estimate of cumulative survival probabilities. Equation *(4)* would become

$$S_{x,t} = \prod_{z=1}^{z} \left(1 - E_t\left[q_{x+z,t+z}\right]\right)$$

The last three rows show coefficients and relative t-statistics for the state variables. All of the three show high persistence, and the Dividend Price ratio moves as an AR(1) process. The nominal T-Bill yield and the Yield Spread are also explained by the lagged real T-Bill rate and the Yield Spread by the lagged nominal T-Bill rate.

The bottom part of Table 2 shows standard deviations (on the main diagonal) and cross-correlations (off the main diagonal) of the regression residuals. As we can see, the most relevant correlations are those between the Dividend Price ratio and excess Stock returns, excess Bond returns and the nominal T-Bill rate and finally the nominal T-Bill rate and the Yield Spread. The variable which shows the highest variability is the excess Stock return, followed by the Dividend Price ratio. The results are overall very satisfactory, and they resemble those obtained by Campbell, Chan and Viceira (2003).

K-period Mean-Variance Analysis Looking at Graphs 3*a* and 3*b* we can see how the intuition underlying the Campbell-Viceira model holds true. Both per-period annualized standard deviations and per-period correlations of assets' returns show different patterns for different forecasting horizons[20]. The maximum horizon has been chosen to be equal to 40 years, because this duration is consistent with that of a longevity-linked security (ideally, a Longevity Bond).

Starting from Graph 3*a*, we can notice that the standard deviation of Stocks decreases from a high of 14% to a low of 9% at long horizons, driven by the Dividend Price ratio. This variable is in fact highly negatively correlated with the current level of Stocks' returns, but at the same time forecasts a high value of Stock returns for the next period, causing mean reversion and decrease in variance.

A similar behavior is followed by the Bonds' standard deviations. In this case the initial increase in risk is due to the mean-averting effect of the Yield Spread. This variable is positively correlated with the current value of the Bond return, and at the same time its lag-one coefficient is positive in the equation of excess Bond returns. This effect causes mean aversion, whose effect is higher at short term horizons of 5 to 10 years.

The real T-Bill is conversely characterized by mean-aversion, induced by the great persistence of this variable. This takes the value of its standard deviation from a low of 3% to a maximum of 8% at an investment horizon of 40 years. We can

[20] Again, the reader should refer to the original Thesis for more details on the specific mathematical derivation of the *K*-period Mean-Variance structures.

clearly notice how, for an investment horizon of 15 years onward, the risk of a T-Bill is even higher than that of the Bond. This is due to the fact that T-Bills held for short-term investment horizons (equal to their natural maturity) carry only a small inflation risk. On the other hand, a long-term investment in T-Bills carries a significant reinvestment risk, which radically changes their risk-return profile.

Graph 3*b* plots the correlations between the three assets for investment horizons up to 40 years. First, the correlation structure between Stocks and Bonds follows an initial increase mainly driven by the relevance of the nominal T-Bill yield at intermediate horizons (around 5-15 years). A positive shock to y corresponds in fact to an immediate decrease in Bond's returns (as the correlation between the two variables is highly negative), but also predicts a low return on Stocks. This effect takes some time to be fully incorporated into the correlations between Stocks and Bonds, such that the highest values of correlations are realized at horizons of around 10 years. At longer investment horizons, a shock to the more persistent Dividend Price ratio predicts shocks of opposite sign to Bonds and Stocks, lowering back the correlation to around zero.

Second, real T-Bills and Bonds are affected in the same way by a shock to the nominal T-Bill yield. This effect corresponds to an immediate increase in the correlation between the two variables for horizons up to 5 years, followed by a decrease explained by the opposite signs of the Dividend Price ratio in predicting Bonds and T-Bills' returns.

Finally, the initial drop in correlations between Stocks and T-Bills is due to the opposite signs of the lagged nominal T-Bill coefficient in explaining these two variables. This drop is, for forecasting horizons higher than 15 years, offset by the fact that the coefficients on the Dividend Price ratio have the same sign in the predictive equations of T-Bills and Stocks.

Global Minimum Variance Portfolio The fact that an investment in either T-Bills, Stocks or Bonds can have a different risk-return profile for different investment horizons has important implications for optimal portfolio allocation. Traditional mean-variance asset allocation (see Markowitz, 1952) focuses on risk at horizons between one month and one year, and when the term structure of risk is flat this model can also hold true for asset allocations with longer horizons. Nonetheless, as we just showed, the term structure of the risk-return profile of different assets is far from being constant.

In order to make this point clear we will now consider a particular portfolio, the Global Minimum Variance (GMV henceforth) portfolio. This is represented by the

leftmost point in the mean-variance diagram, and has the interesting property of always having the smallest variance amongst all the efficient investments. When a riskless asset is available, this portfolio will be 100% invested in the riskless asset. Otherwise its composition will be a combination of the available assets (3 in this case).

Graph 3*c* shows the composition of the GMV portfolio. The relative weight of the T-Bill decreases from a high of around 120% at investment horizons of 5 years to a low of 50% at horizons of 40 years. Correspondingly, the relative weight associated to the Bond is slightly higher than that of the T-Bill (around 60%), and the weight assigned to Stocks, in relation to their high risk, is always slightly negative (*i.e.* the GMV investor will sell Stocks short for every investment horizon).

Graph 3*d* plots instead the annualized standard deviation of the real return on the GMV portfolio, together with the annualized percentage standard deviation of the real return on the T-Bill. As we can see, the risk of the GMV portfolio is always lower than that of the T-Bill, in contradiction to traditional financial theory according to which the T-Bill is "risk-free". This effect is even clearer for long investment horizons, where the spread between the two standard deviations is more than 1.5% (even if around 60% of the overall portfolio is invested in Bonds, 60% in T-Bills and Stocks are sold short for a percentage equal to 20% of the portfolio).

D. Longevity Risk Premia in Life Annuities

This appendix is devoted to the analysis of the risk premia for Longevity Risk embedded into Life Annuities. Its aim is that of finding out whether Life Annuities' premia during the second half of the twentieth century include a premium for longevity risk (under our definition of Longevity Shock). In order to do so, we run regressions on the log returns of Life Annuities Premia during the period 1952-2007 and relate them with different definitions of Longevity Shocks and other explanatory variables.

The data are relative to the premia for immediate $1 monthly life annuities in the US for 65-year-old males. For each year, they are represented by the mean value of a sample of prices applied by different US companies in different months. We also add the maximum and the minimum values of these prices in order to have a measure of their dispersion when performing regressions. The series ranges from 1952 to 2007 and decreases roughly constantly from 1952 to 1988. Since a lot of variability is present in prices from 1988 to 2007, excluding this period

to match it with the Campbell - Viceira control sample of section 3 could represent a problem in terms of interpretation of the results after more than ten years. We therefore increase the range of Longevity Shocks up to 2007. The data are the same we used in section 3, which we download from the Berkeley Human Mortality Database.

Moreover, since a relevant component of Life Annuities is related to the behavior of interest rates (according to Brown *et* al., 2001 «the annuity premium has fallen continuously since the late 1950s as the general level of interest rates rose»), we take also their effect into account in the predictive regression of the returns on premia. Unfortunately the data relative to the Campbell - Viceira model do not include the period 1996-2007, and therefore we use another specification for the short-term interest rates, using the annualized 3-months T-Bill rates data from the Federal Reserve Bank of St. Louis' website[21].

Table 4 shows our results. The upper part of the Table is dedicated to the regression where the dependent variable is the end-of-year t-1 log return on the mean annuity premium and the independent variables are the T-Bill rate and Longevity Shocks with no lag, one year and two years' lag (identified by the letter k). Since annuity premia are referred to the males-only US retired population and our original definition of Longevity Shocks is relative to the whole (males and females) population, we specify Longevity Shocks based on the US male population, only[22]. Our results are satisfactory. The coefficients attached to the T-Bill rate are almost always significant, confirming Brown *et* al. (2001) in the negative relation between interest rates and annuity prices. More interesting for our analysis, however, is the reaction of annuity premia to a Longevity Shock. As we can see, the coefficients attached to the Shocks are always positive. The middle and the bottom part of the Table, which show the results of the regressions carried out with the minimum and maximum values of the premia as dependent variables, give us a measure of dispersion confirming this. A Longevity Shock, according to our results, carries a positive premium as the unexpected increase in longevity is reflected into a higher premium paid by the insured. Moreover, using k-lagged Longevity Shocks tells us when their effect is included into annuity premia.

As we can see, the coefficient attached to the Longevity Shock, γ, gains more significance the higher the value of k. The values of R^2, too, increase with k. They

[21] *http://research.stlouisfed.org/fred2/series/TB3MS?cid=116*

[22] The data have the same source and the same reference period as the Longevity Shocks relative to the total population.

pass from 8.19% to 12.92% and from 16.13% to 21.05% when the mean and minimum premia, respectively, are used[23].

Longevity Shock this year is, according to our results, not immediately included into the premium: even if the coefficients have the right sign in the equation with $k = 0$, they are not statistically significant. Longevity Shocks are, instead, reflected into premia one to two years after they have occurred. Considering Δpr^{mean} and Δpr^{min} , the premia attached to longevity risk range from 6.3169 to 8.4930. Moreover, all four coefficients are statistically significant at a 95% confidence level.

This means that if the population demographic structure remains unchanged from *t*-1 to *t* and an unexpected 1% increase in longevity is registered during year *t*-1 then, correcting for the short-term interest rate, annuity premia returns will be adjusted upwards by around 7% at time *t*. Similarly, if the population demographic structure remains unchanged from *t*-2 to *t* and an unexpected 1% increase in longevity is registered during year *t*, *t*-2, then annuity premia returns will increase by around 8% at time *t*.

[23] Intuitively, pr^{min} should be the least affected by firm-specific charges and size, as usually the more diversified and big the annuity provider, the higher the economies of scale and the lower the premia charged to the insured. The increase/decrease in the prices should then best reflect interest rate and longevity risk.

E. Tables

TABLE 1

ESTIMATES FOR THE PARAMETERS a_x AND b_x FROM THE LEE-CARTER MODEL

SELECTED AGES	a_x	b_x
65	-3.75	0.007
70	-3.37	0.007
75	-2.93	0.007
80	-2.51	0.008
85	-2.06	0.006
90	-1.64	0.005
95	-1.30	0.002
100	-1.11	-0.002
105	-0.964	0.001

Note: : Fitted Values of a_x and b_x from the LEE R.D. - CARTER L.R. (1992) model at selected ages.

TABLE 2

VAR(1) ESTIMATION RESULTS - FINANCIAL VARIABLES ONLY
ANNUAL SAMPLE 1952-1995

	LAGGED DEPENDENT VARIABLES							
	Real T-Bill	Ex. Stock Return	Ex. Bond Return	Nominal T-Bill	D/P Ratio	Yield Spread	R^2	$adjR^2$
Real T-Bill	0.70	-0.04	-0.04	0.44	0.01	-0.87		
	(4.07)	(-1.14)	(-0.73)	(1.97)	(0.18)	(-2.05)	0.59	0.52
Ex. Stock Return	0.63	-0.25	-0.11	-0.76	0.08	-0.05		
	(0.90)	(-1.50)	(-0.33)	(-0.58)	(0.50)	(-0.02)	0.08	-0.08
Ex. Bond Return	0.61	0.03	-0.44	0.24	-0.05	4.21		
	(2.68)	(0.418)	(-2.85)	(0.48)	(-1.15)	(5.64)	0.59	0.52
Nominal T-Bill	-0.20	0.01	0.06	0.84	0.01	0.06		
	(-3.46)	(0.79)	(1.88)	(8.83)	(1.55)	(0.39)	0.77	0.73
D/P Ratio	-0.85	-0.10	0.38	-0.20	0.99	-0.68		
	(-1.67)	(-0.63)	(1.29)	(-0.18)	(6.93)	(-0.39)	0.76	0.72
Yield Spread	0.13	-0.02	-0.01	0.15	-0.01	0.56		
	(3.10)	(-1.36)	(-0.12)	(2.30)	(-1.44)	(4.94)	0.62	0.55
	CROSS-CORRELATIONS OF RESIDUALS							
Real T-Bill	3.20	0.45	0.01	-0.16	-0.44	0.20		
Ex. Stock Return	-	14.08	-0.01	-0.15	-0.76	0.22		
Ex. Bond Return	-	-	5.77	-0.69	-0.25	0.23		
Nominal T-Bill	-	-	-	1.26	0.31	-0.85		
D/P Ratio	-	-	-	-	12.71	-0.20		
Yield Spread	-	-	-	-	-	0.94		

Note: VAR(1) coefficients with relative *t*-statistics in parentheses. Cross-correlations of residuals with percentage standard deviations on main diagonal.

TABLE 3

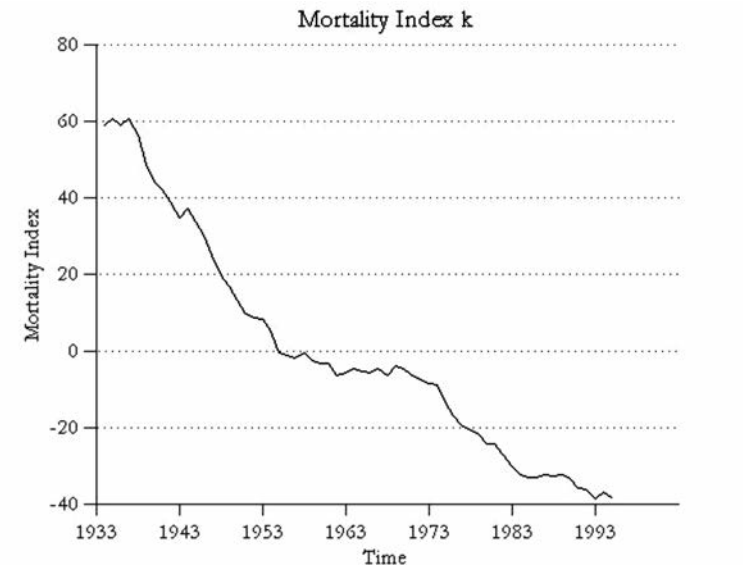
VAR(1) ESTIMATION RESULTS - LONGEVITY SHOCKS - ANNUAL SAMPLE 1952-1995

	Real T-Bill	Ex. Stock Return	Ex. Bond Return	Longevity Shock	Nominal T-Bill	D/P Ratio	Yield Spread	R^2	$adjR^2$
Lagged Dependent Variables									
Real T-Bill	0.57	-0.04	0.02	-11.03	0.58	0.07	-0.67		
	(3.74)	(-1.10)	(0.28)	(-2.63)	(2.41)	(1.77)	(-1.80)	0.66	0.60
Ex. Stock Return	0.10	-0.21	0.15	-46.31	-0.17	0.36	0.83		
	(0.16)	(-1.45)	(0.48)	(-3.28)	(-0.15)	(2.05)	(0.54)	0.22	0.06
Ex. Bond Return	0.41	0.04	-0.35	-17.30	0.46	0.05	4.54		
	(1.92)	(0.80)	(-2.09)	(-2.52)	(1.04)	(0.98)	(5.88)	0.64	0.57
Longevity Shock	-0.01	0.01	-0.01	0.48	0.01	0.01	0.04		
	(-1.77)	(0.59)	(-2.27)	(2.81)	(1.01)	(1.48)	(1.20)	0.65	0.57
Nominal T-Bill	-0.18	0.01	0.04	2.35	0.81	0.00	0.02		
	(-2.75)	(0.80)	(1.42)	(1.35)	(8.51)	(0.01)	(0.09)	0.78	0.73
D/P Ratio	-0.34	-0.14	0.14	43.98	-0.77	0.73	-1.51		
	(-0.78)	(-1.11)	(0.43)	(3.05)	(-0.73)	(4.36)	(-1.09)	0.80	0.76
Yield Spread	0.13	-0.02	-0.01	-0.15	0.15	-0.01	0.57		
	(2.56)	(-1.38)	(-0.07)	(-0.11)	(2.15)	(-0.85)	(4.71)	0.62	0.54
Cross-Correlations of Residuals									
Real T-Bill	2.91	0.35	-0.17	-0.40	-0.08	-0.32	0.21		
Ex. Stock Return	-	12.95	-0.17	-0.26	-0.07	-0.71	0.23		
Ex. Bond Return	-	-	5.38	0.18	-0.67	-0.12	0.24		
Longevity Shock	-	-	-	0.12	-0.16	0.22	0.15		
Nominal T-Bill	-	-	-	-	1.23	0.25	-0.86		
D/P Ratio	-	-	-	-	-	11.53	-0.22		
Yield Spread	-	-	-	-	-	-	0.94		

Note: VAR(1) coefficients with relative *t*-statistics in parentheses. Cross-correlations of residuals with percentage standard deviations on main diagonal

GRAPH 1

MORTALITY INDEX *k*t AS FROM OWN ESTIMATES (1933-1994)



GRAPH 2

LONGEVITY SHOCKS FOR TOTAL US POPULATION, YEARS 1952-1995

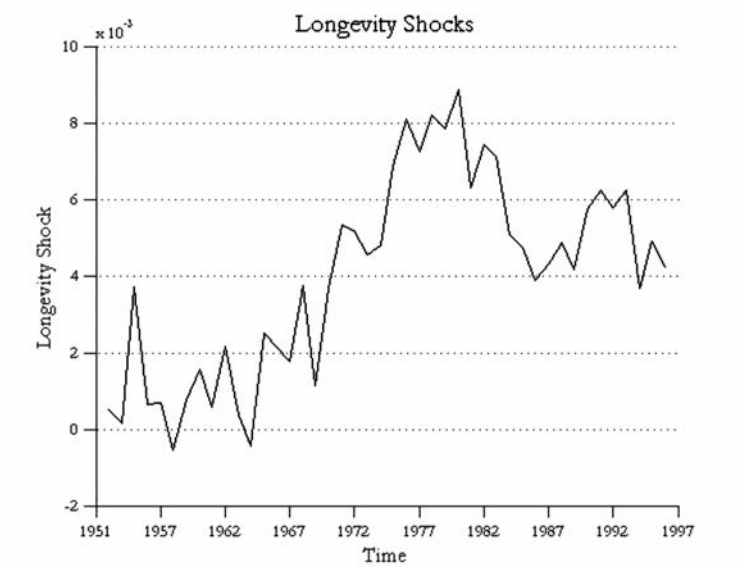


TABLE 4

REGRESSIONS ON ANNUITY PREMIA RETURNS
END-OF-YEAR *t–1* RETURNS AND LAG *k* LONGEVITY SHOCKS

$\Delta pr_t^{mean} = \alpha + \beta r_{t-1} + \gamma lsm_{t-k} + \varepsilon_t$

	α		β		γ		R^2
	(t)		*(t)*		*(t)*		
$k = 0$	0.0238	(**)	–0.4599	(**)	3.5652	–	0.0819
	(1.9080)		(–2.1064)		0.9666		
$k = 1$	0.0286	(**)	–0.5530	(***)	6.3169	(**)	0.1148
	(2.3245)		(–2.5633)		(1.6940)		
$k = 2$	0.0297	(***)	–0.5739	(***)	7.2275	(**)	0.1292
	(2.4562)		(–2.7143)		(1.9389)		

$\Delta pr_t^{min} = \alpha + \beta r_{t-1} + \gamma lsm_{t-k} + \varepsilon_t$

	α		β		γ		R^2
	(t)		*(t)*		*(t)*		
$k = 0$	0.0363	(***)	–0.7027	(***)	4.6303	–	0.1613
	(2.7572)		(–3.0439)		(1.1873)		
$k = 1$	0.0407	(***)	–0.7870	(***)	7.1358	(**)	0.1901
	(3.1258)		(–3.4468)		(1.8083)		
$k = 2$	0.0425	(***)	–0.8213	(***)	8.4930	(**)	0.2105
	(3.3372)		(–3.6879)		(2.1630)		

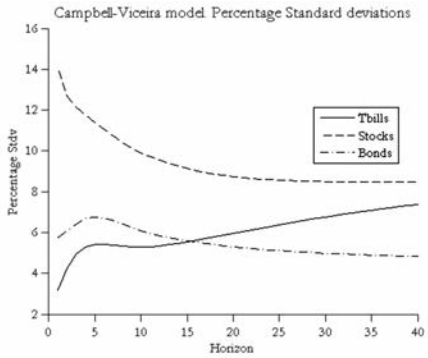
$\Delta pr_t^{max} = \alpha + \beta r_{t-1} + \gamma lsm_{t-k} + \varepsilon_t$

	α		β		γ		R^2
	(t)		*(t)*		*(t)*		
$k = 0$	0.0207	–	–0.4003	–	3.3661	–	0.0211
	(0.9449)		(-1.0431)		(0.5192)		
$k = 1$	0.0272	–	–0.5263	(*)	7.0743	–	0.0375
	(1.2464)		(–1.3744)		(1.0688)		
$k = 2$	0.0330	(*)	–0.6376	(**)	10.7677	(*)	0.0651
	(1.5473)		(–1.7099)		(1.6378)		

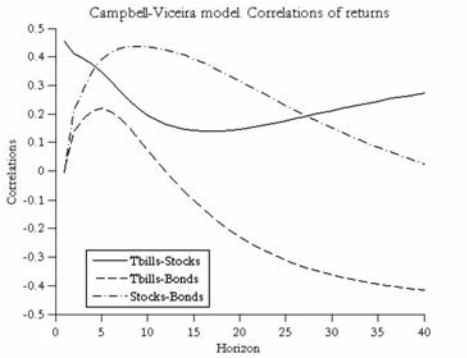
Note: Results for the predictive regressions of returns of premia with Longevity Shocks calculated over the male-only US population. Δpr^{mean}, Δpr^{max} and Δpr^{min} indicate the returns on the average, maximum and minimum levels of life annuities' premia available for each year, respectively. r_t indicates the annualized return on the 3-months T-Bill rate at the end of year $t - 1$. lsm_{t-k} indicates the k-lag Longevity Shock for the males-only US retired population. (*), (**) and (***) stand for the significance of coefficient at 0.9, 0.95 and 0.99 confidence levels, respectively

GRAPH 3

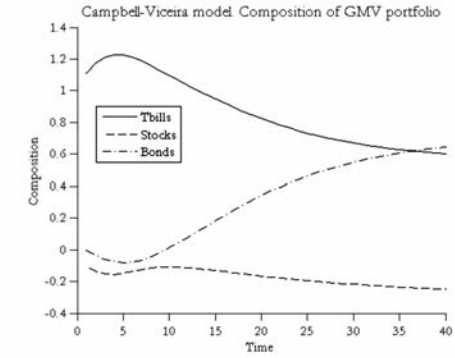
K-PERIOD MEAN-VARIANCE ANALYSIS FROM THE CAMPBELL - VICEIRA MODEL



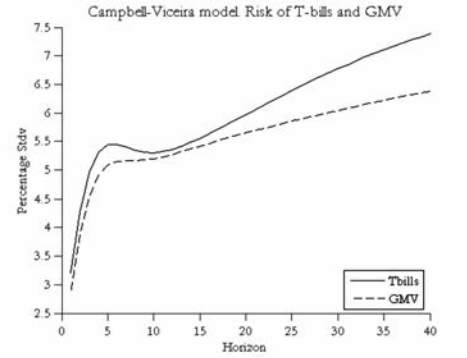
(*a*) Standard Deviations of T-Bills, Stocks and Bonds



(*b*) Assets' Correlations



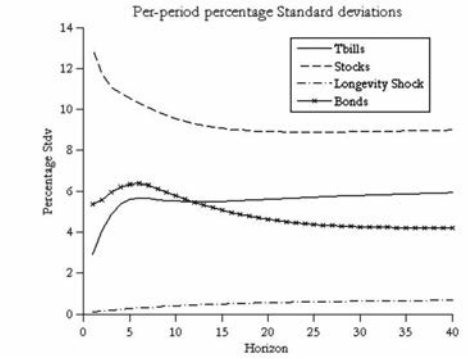
(*c*) Composition of the GMV portfolio



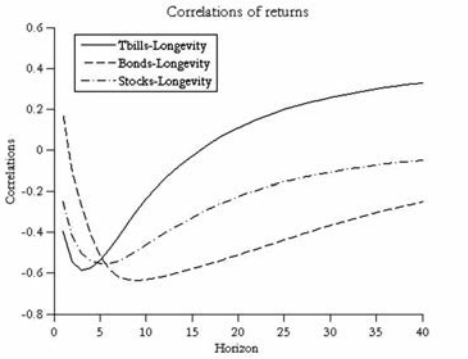
(*d*) Risk of the GMV portfolio compared to a T-Bill

GRAPH 4

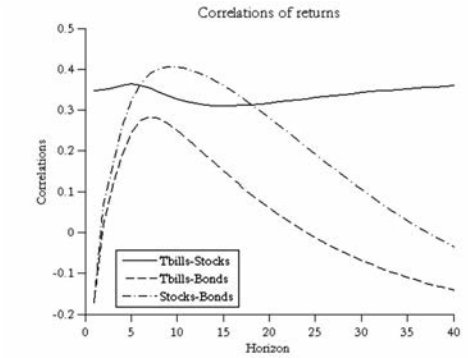
K-PERIOD MEAN-VARIANCE ANALYSIS FROM THE CAMPBELL - VICEIRA MODEL WHEN LONGEVITY SHOCKS ARE ADDED TO THE VAR SYSTEM



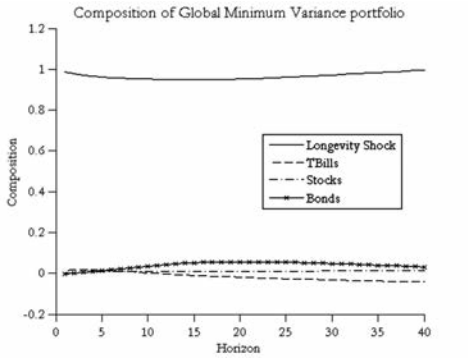
(*a*) Standard Deviations of T-Bills, Stocks, Bonds and Longevity Shocks



(*b*) Correlations of Longevity Shocks with T-Bills, Stocks and Bonds



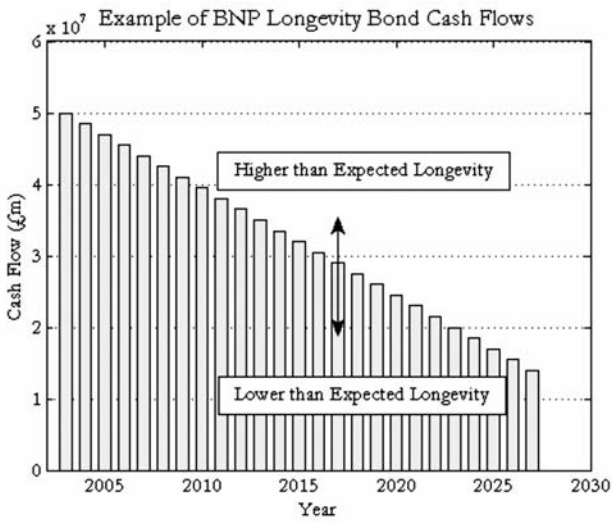
(*c*) Correlations of T-Bills, Stocks and Bonds



(*d*) Composition of the Global Minimum Variance portfolio

GRAPH 5

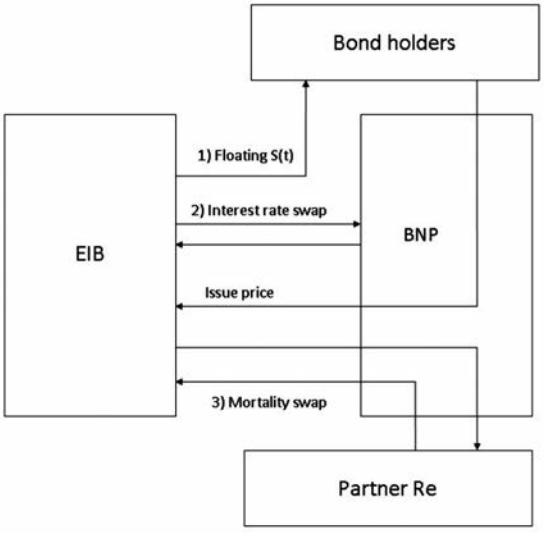
EXAMPLE ON LONGEVITY BOND'S CASH FLOWS



Source: AZZOPARDI M. (2005).

GRAPH 6

STRUCTURE OF CASH FLOWS



Source: BLAKE D. *et* AL. (2006).

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The 2008 - Financial Crisis and the Effects on International Trade: New Empirical Evidence

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The purpose of this study is to analyze the effect of financial crises on international trade flows. For this purpose, Impulse Response Functions (IRFs) of trade flow to financial crisis occurrences are estimated for a large set of advanced and developing economies over the period 1960-2009. The results of this analysis show that trade flows are significantly reduced in the aftermath of financial crises. However, while debt crises have very persistent effects on imports and exports, the effect of banking and currency crises is reversed over the medium-term. The results are robust to different set of controls and robustness checks.
[JEL Classification: G01; F14].

Keywords: financial crises; international trade; globalization.

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1. - Introduction

In recent years, economies around the world have experienced the largest economic crisis since World War II. This crisis originated in the United States in 2008 and has spread rapidly to the rest of the world, leading to significant economic losses[1]. Among the channels through which the crisis has affected many economies, trade flows have played a significant role. The reduction in trade, experienced during the period 2008-2009, has not presence in history[2], and it has been exacerbated by protectionist policies put in place in many countries. Trade flows have contracted by almost 20%, with a contraction in trade volumes eight times larger than figures in world production. These trade losses have been the result of increased trade elasticity, from around 1% during the period 1974-1985 to about 3.4% in the most recent years[3]. Among the possible explanations of such an increase of trade elasticity, globalization of production processes plays a very important role. Since 1990, development of globalization has been facilitated by technological progress in transportation and by reduction in trade barriers. In this context, the following factors have played a significant role[4]:

- *compositional effects:* demand for capital goods and durable consumer goods were more sensitive to the effects of the crisis than the demand for services and other goods. Therefore, the manufacturing sector was the most involved in the crisis because it is the category more related to international trade than any other;
- *supply chains:* the procurement of inputs for the production of final goods has undergone major changes caused by the advent of globalization, and interdependence between trade and production, especially in the manufacturing sector, has remarkably increased;
- *trade financing:* the disruption of the financial system has led to a large contraction in trade financing. Moreover, in this context, companies have increasingly experienced difficulties in access to credit market.

In order to analyze the factors causing the "Great Collapse of Commerce", Cheung and Guichard (2009)[5], basing on an aggregate world trade equation, find that vertical integration has greatly affected the world demand. In addition, they

[1] See Furceri D., Mourougane A. (2009).
[2] See Imf (2010).
[3] See Cheung C., Guichard S. (2009).
[4] See Imf (2010).
[5] See Cheung C., Guichard S. (2009).

show the significant implications deriving from synchronization of advent of the crises effects. The authors conclude that changes in elasticity of international trade in short term are magnified by synchronization of crises.

The analysis of these aspects shows the dual role played by globalization: on the one hand, it has favored spreading of the crisis, and on the other hand, it has generated essential advantages for the world economy and is likely to positively affect the economic recovery. If it is true that integration has facilitated the spread of the recession, it is also true that, out of the maze of the crisis, the best way forward is globalization, which reduced barriers to international trade and allows we to take advantage of the great benefits that flow from it[6]. In fact, when the mechanism of globalization works efficiently, economic growth accelerates reaching higher levels than those achievable under circumstances of closed markets; for this reason, the integration of markets is an excellent tool for economic recovery.

Protectionist policies could make ineffective the economic recovery measures adopted in the context of crisis: in the long run, they do not lead to efficient results, rather they erode competitiveness, growth, employment and real wages; moreover, the adoption of protectionist measures may lead to a "trade war" among countries, exacerbating the negative effects of recession.

The reasons which have induced countries to adopt protectionist policies are various: first, protectionist policies are easier to implement than liberal policies, which require the collaboration among countries, thus a collective action that is difficult to coordinate; second, they instill a false confidence generating a wider public opinion consensus; third, many organized interest groups have lobbied Governments of many countries for the adoption of such policies, drawing significant short-term profits.

A crisis can affect international trade by means of factors which also play a different role in the spread of the crisis in relation to the type of the downturn that occurs. In the context of banking crisis undoubtedly the collapse of the banking system and the consequent restriction in accessing credit undermines the productive system, especially if it is characterized by highly integrated supply chains, promoting a rapid spread of crisis. In a context of currency crisis, nominal devaluation of the currency and the consequence change in the terms of trade affects trade flows. Debt crisis can affect trade flows through a collapse of confidence and international credibility; an insolvent country, unable to re-pay its debt, is likely to be excluded from international markets.

[6] See Baldwin R., Evenett S. (2009).

The effect of different types of financial crises on trade has been recently analyzed by the IMF World Economic Outlook (chapter 4, October 2010). The results of this study suggest that financial crises have significant and long lasting effects on trade flows, with the effects being particularly large for debt and banking crises. In particular, the results suggest that after the occurrence of financial crises, imports flows decrease by 16% after two years and by 20% after 5 years. The effect is less significant for exports flows: 3% after two years and 8% after 5 years.

The aim of this work is to expand this analysis also by considering the role of macroeconomic and structural variables in shaping the response of trade to financial crises.

The rest of the paper is organized as follows: the next section describes the data and the empirical methodology; section 3 presents the results and section 4 concludes.

2. - Empirical Evidence

The methodology of analysis adopted by the International Monetary Fund utilizes aggregate data on international trade and it is based on the use of a gravity model that considers the possible linguistic affinities between countries and the spatial proximity between borders by the inclusion of a set of dummy variables. In our opinion, in a context of globalized economy, the inclusion of variables that take into account spatial proximity and linguistic affinities could seem restrictive because transport costs and cultural barriers play an increasingly marginal role. Furthermore, the results obtained by IMF surprise because the economies of the world cannot register growth rates of trade flows that can reduce the gap compared to pre-crisis levels. In other words, countries indefinitely succumb.

In this paper we have tied to apply a different methodology based on the estimation of Impulse Response Functions (IRFs), thus based on an autoregressive model that utilized panel data. The choice of estimating the IRFs is due to a number of advantages: first, an autoregressive model utilizing historical data to predict future events seems to be a valid choice, and second, as it will be explained later, this method ensures more precise estimates and ease of calculation.

2.1 *Data*

Data used in this empirical analysis are extracted from the *"World Development Indicators & Global Development Finance"* of the *"World Data Bank".* Information

over periods of crisis comes from Laeven and Valencia (2008[7] and 2010[8]). The authors identify three types of crisis episodes: "banking crisis" (130 events), "currency crisis" (166 events) and "debt crisis" (54 events). Data for financial integration are taken from Lane and Milesi-Ferretti (2007)[9]; information about development of financial markets has been taken from Beck and Demirgüç-Kunt (2009)[10]. The sample used in the analysis covers an unbalanced panel of 213 countries since 1960 to 2009.

2.2 *Empirical Methodology*

The dynamic impact of financial crises on trade flows is estimated by constructing IRFs in reference to the data of imports, exports and their sum. For imports the following equation has been estimated:

$$(1) \qquad Gimp_{i,k} = \alpha_i + Trend + \Sigma^2_{j=1} \beta_j Gimp_{i,k-j} + \Sigma^2_{j=0} \delta_j D_{i,k-j} + \varepsilon_{i,k}$$

where: $Gimp_{k-j}$ of the generic country *i* is the annual growth rate of its imports and it is calculated as follows:

$$(\Delta) \qquad Gimp_k = ln\ imp_{t+k} - ln\ imp_{t-1}$$

and "k" = 0, ..., 8 is the period considered; "α_i" takes into account country fixed effects; "Trend" represents a time trend; the lags considered are two; "β_j" captures changes in the rate of imports growth; "δ_j" is the coefficient expressing the impact of the crisis on imports; "D_i" is a dummy variable assuming value 1 in case of crises and zero otherwise; "$\varepsilon_{i,k}$" is the stochastic error.

The same procedure has been used for exports and total trade flows (*exp+imp*):

$$(2) \qquad Gexp_{i,k} = \alpha_i + Trend + \Sigma^2_{j=1} \beta_j Gexp_{i,k-j} + \Sigma^2_{j=0} \delta_j D_{i,k-j} + \varepsilon_{i,k}$$

$$(3) \qquad Gtot_{i,k} = \alpha_i + Trend + \Sigma^2_{j=1} \beta_j Gtot_{i,k-j} + \Sigma^2_{j=0} \delta_j D_{i,k-j} + \varepsilon_{i,k}$$

This method guarantees IRFs are not influenced by the number of lags considered, which are included as control variables. Thus they are not directly used

7 See Laeven L., Valencia F. (2008).
8 See Laeven L., Valencia F. (2010).
9 See Lane P.R., Milesi-Ferretti G.M. (2007).
10 See Beck T., Demirgüç-Kunt A. (2009).

for the calculation of IRFs and the structure of equations does not impose any permanent effects. In addition, confidence bands associated with them are easily calculated using the standard deviation of the coefficient representing the impact of the crisis on the flow of goods each time considered (imp., exp. or their sum), and Monte-Carlo simulations are not required[11].

2.3 *Heterogeneity in the Response*

To assess whether structural variables can affect the response of trade to financial crises, the following set of variables has been considered (see appendix 1 for more details):

- *Size* – size of countries is a very interesting feature to include in the analysis. It is typically found that larger economies are less dependent from foreign markets than smaller economies, so it is interesting to see whether a relationship exists between the effects of the crisis and the size of countries, considering two indicators:
  1. a strictly economic measure as the *GDP*;
  2. a demographic measure such as *Population*;
- *Trade Openness* – the effect of crises on trade flows is likely to be larger for countries which are more open to trade. In this study we have calculated an index, here called "Openness" expressing openness degree of economies towards international markets. Trade openness is calculated by:

$$Openness = (Imports + Exports) / GDP \cdot 100$$

- *Financial Integration* – financial integration can significantly influence the effects of the crises. Indeed, if on one side it may expose a country to international crises, on the other side it can boost economic recovery. Financial integration is calculated by:

$$FI = (Total\ Assets + Total\ Liabilities) / GDP$$

- *Financial Development* – financial markets development may influence the effects of the crises, as a developed financial market could be more exposed to the crises because of its complexity, but it could provide the basis for a more

[11] See Kilian L. (1996).

rapid economic recovery. In order to consider financial markets development two indicators have been considered:

1. *FD = (Bank Deposit / GDP) + (Stock Market Capitalization / GDP)*
2. *FDC = Private Credit* $_{\text{Deposit Banks and other institution}}$ */ GDP*

In order to test the influence of these variables on the effects of the crises, they are included in equations *(1)*, *(2)* and *(3)* as interaction with the dummy variable. For example, with regard to GDP's data, the variable of interaction *dim*1 will be:

$$dim1_{K} = (ln(GDP)_{i,t} - Media_{ln(GDP)}) \cdot Dstart_{i,K} \tag{4}$$

obtaining the following equations:

$$Gimp_{i,K} = \alpha_i + Trend + \Sigma^{2}_{j=1}\,\beta_j\, Gimp_{i,K-j} + \Sigma^{2}_{j=0}\,\delta_j\, D_{i,K-j} + \gamma_K\, dim1_{i,K} + \theta_K\, ln(GDP)_{i,K} + \varepsilon_{i,K} \tag{5}$$

$$Gexp_{i,K} = \alpha_i + Trend + \Sigma^{2}_{j=1}\,\beta_j\, Gexp_{i,K-j} + \Sigma^{2}_{j=0}\,\delta_j\, D_{i,K-j} + \gamma_K\, dim1_{i,K} + \theta_K\, ln(GDP)_{i,K} + \varepsilon_{i,K} \tag{6}$$

$$Gtot_{i,K} = \alpha_i + Trend + \Sigma^{2}_{j=1}\,\beta_j\, Gtot_{i,K-j} + \Sigma^{2}_{j=0}\,\delta_j\, D_{i,K-j} + \gamma_K\, dim1_{i,K} + \theta_K\, ln(GDP)_{i,K} + \varepsilon_{i,K} \tag{7}$$

3. - Results Obtained: Estimates of the Annual Data

3.1 *Unconditional Effects*

Banking Crises

Graph 1 shows IRFs of trade flows for banking crises. Starting with import flows, we can see that imports fall, on average, by 13% in the first two years following the crisis, with an effect coming statistically significant up to 3 years. Also exports contract in the first two years although the effect is significantly limited (lower -4%). As a result, total trade flows decrease by around 8% in the first two years following the crisis but they recover over the medium-term.

Currency Crises

Even in case of currency crisis, reduction of import flows is significantly large in the first two years, reaching on average about 13%; as for banking crises, the following years are characterized by a slow recovery. Exports are characterized by a moderate reduction in the first two years reaching on average 3%. IRFs of trade flows obtained utilizing equation *(5)* show that the effect of currency crises on trade flows is very similar to the case of banking crises: initial reduction in average is nearly 8% in the first two years, thus recovery is slower and it is only after the sixth year that we see a marked difference compared to previous case.

Debt Crises

Using again equations *(1)*, *(2)* and *(3)* and taking into account time periods of debt crises, we have estimated the effects which debt crises have on international trade. In contrast to banking and currency crises, debt crises have a larger and very persistent effect on trade flows. Imports have decreased on average by more than 30% in the short-term and even after nine years the effect does not seem to be mitigated. Similarly, exports are reduced on average by about 10% in the first years, with the effect increasing over time reaching about 20% after eight years. As we see, total trade flows have decreased by about 20% after two years and by 25% after 9 years.

One of the most surprising result is the greater impact which crises have on imports than exports. This result could find different explanations and deserves further study. As history shows, in times of crisis, rise of nationalist movements, moving consumer demand in favor of domestic products over imported goods, and also the same nationalist sentiments lead to establish protectionist policies[12]. Another aspect which has not to be underestimated is weakness of state budgets and the financial markets which causes a reduction in domestic demand and frees further resources to export. All this causes a greater drop in imports.

The results are overall robust to different specifications: *(i)* inclusion of a deterministic trend; *(ii)* inclusion of time fixed effects and *(iii)* inclusion of a measure of the duration of the crises.

3.2 Heterogeneity of the Response

After having analyzed the effects the crises have on trade flows, we try to assess the role of structural variables in shaping the response of trade flows to crises. In

[12] See Bussière M., Perez-Barreiro E., Straub R., Taglioni D. (2010).

order to put in evidence the significance of the results, we plot IRFs for three different values of the structural variables considered (the first quartile (Q1), the mean and the third (Q3) quartile of distribution) which differ from the mean response only when the coefficient of interaction term is statistically significant. Table 2 shows distributions of variables for the three crises.

Size

The importance of size in shaping the response of trade flows to financial crises is estimated by considering both initial level of GDP and population. Starting with GDP, Graph 2 shows the response of trade flows to banking, currency and debt crises. As figure shows, the interaction of GDP in a context of banking crises does not provide any statistically significant effect and leaves unchanged IRFs. The only difference is for the value of exports which does not become positive in the sixth year, but at the end of the seventh.

Even in case of currency crisis, IRFs for imports are almost unchanged. In contrast, we find a statistically significant effect for exports for two-three years following the currency crisis. Overall, however, the sum of imports and exports remains almost unchanged.

In case of debt crisis, we find a significant impact for exports. Smaller countries are less affected while exports seem to decrease more over the medium-term for larger countries. However, the effects on total trade flows are not statistically significant. Overall, qualitatively similar results are obtained when population is considered as a measure of economic size. However, it is worth to stress that adding "*GDP*" or "Population" does not change the results for the average IRF and this suggests that our baseline results are robust to these additional controls.

Trade Openness

As a next step, we have included trade openness in the estimation of equations *(5)-(7)*. The results for banking crises suggest that more open countries are generally more affected by the crisis. This is particularly the case for exports. Results obtained for debt and currency crises show that exports tend to reduce more quickly for countries with a higher level of trade openness.

Also in this case the average IRF is qualitatively similar to the one obtained in the baseline, suggesting our baseline results are robust.

Financial Integration

To assess the role of financial integration in shaping the response of trade flows to financial crises, we have included the indicator proposed by Lane and Milesi-Ferretti in equations *(5)-(7)* as a control and interaction term. The results obtained with this exercise show that, while financial integration has not a statistically significant impact to affect the response of trade flows to financial crises in the short-term, over the medium term more financially integrated countries are generally characterized by a more rapid recovery in terms of trade flows. The results are particularly statistically significant in case of currency crises.

Financial Development

The effect of financial development in shaping the response of trade flows to financial crises is presented in Graph 6 and Graph 7. The results show that, while the average IRFs for all categories of trade flows and types of crises are qualitatively similar to those obtained in the baseline, financial development has not statistically significant effects on the response of trade flows to crises. The only exception is for debt crises, where the effect on exports seems to be larger for less financially developed economies, suggesting the economic recovery is a positive function of the level of financial development.

4. - Conclusions

The aim of this work is to increase empirical literature on financial crises effects on trade. Overall, our results confirm that financial crises have significant negative effects also in terms of trade flows. However, in contrast to the IMF World Economic Outlook, we find that these effects tend to be reversed over the medium-term. An exception is for debt crisis, for which both imports and exports are negatively and persistently affected. The analysis also shows that larger countries are able to compensate for first the negative effects on exports and suffer a greater decline in imports. This result is favored by their better production capabilities. Market openness degree affects results in a negative way: more integrated countries are subject to more severe side effects in case of crises and this seems to be due to greater exposure to international markets allowing a more rapid spread of recession. The results for financial integration and financial development suggest that generally more integrated and developed countries are also the ones with the largest reduction in trade flows. Despite these findings, the idea of giving inte-

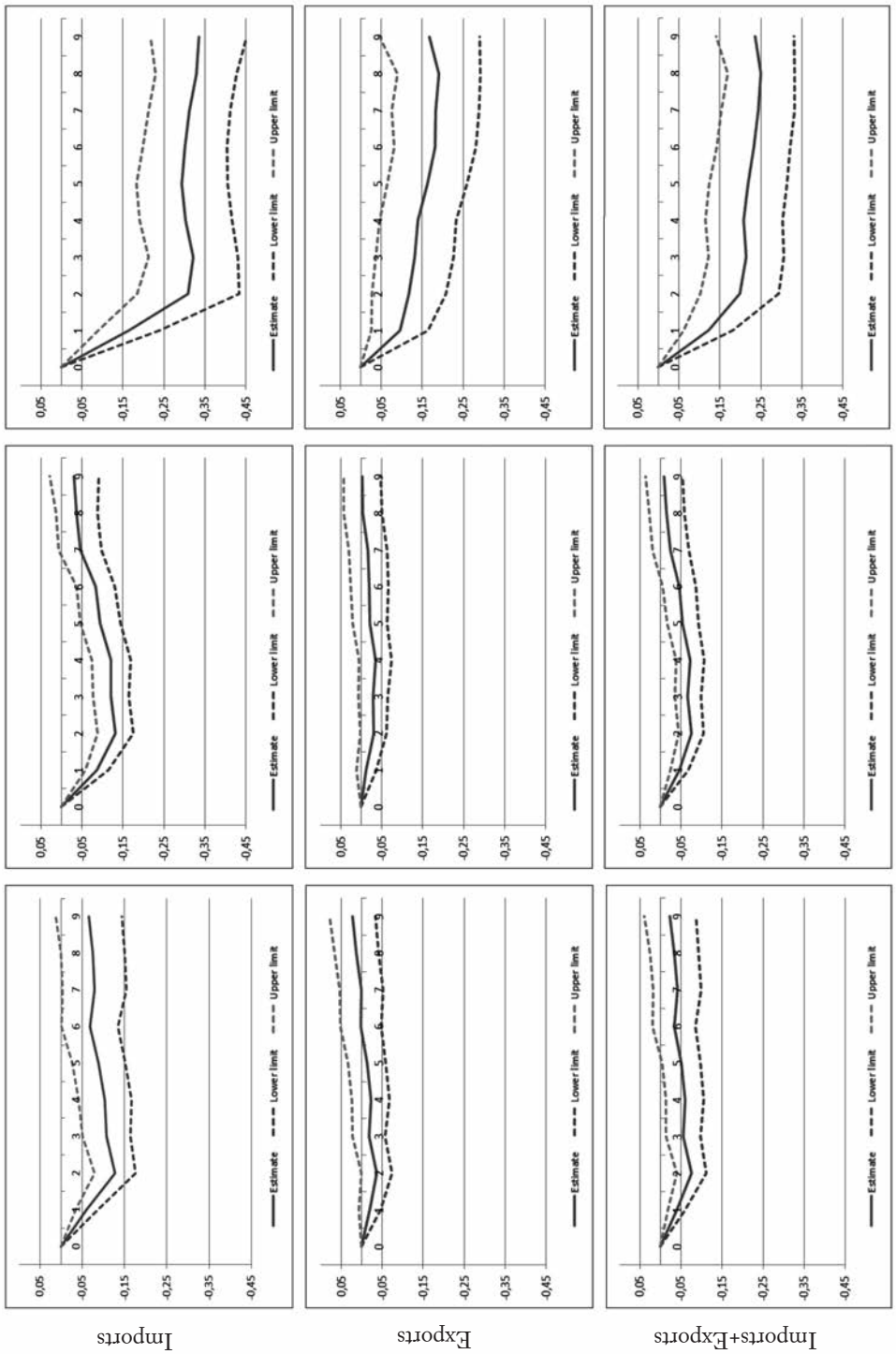
grated and developed markets up is definitely wrong. Under normal conditions, consequent benefits are numerous and quite indispensable. The wiser choice is to create markets in which conditions of transparency and efficiency have to become two indispensable rules. International institutions are called for playing a more important role in this regard. In fact, their work is crucial to guarantee the conditions for economic recovery and the installation of a set of rules and sanctions to ensure necessary transparency and market stability.

A prerogative for a resumption of trade is conclusion of multilateral agreements and the coordinated efforts of all countries to combat protectionist pressures, showing consequences which protectionism has had in the past. The work of international organizations should not be construed by individual countries as an obstacle to resumption of national economy but it must be seen as an opportunity for economic growth involving the entire planet.

The topics focused in this study deserve to be further investigated in order to identify the best conditions to prevent bursting of the crises and to identify the most effective tools to combat their spread.

GRAPH 1

TRADE FLOWS IN CASE OF CRISES



Note: dotted lines represent 95% confidence bands.

Table 1

MAIN RESULTS

K	Banking Crisis			Currency Crisis			Debt Crisis		
	Imports	Exports	Exp. plus Imp.	Imports	Exports	Exp. plus Imp.	Imports	Exports	Exp. plus Imp.
1	-0,06	-0,02	-0,039	-0,086	-0,012	-0,046	-0,164	-0,095	-0,122
	(-4,54)***	(-1,43)	(-3,64)***	(-5,93)***	(-1,00)	(-4,16)***	(-4,34)***	(-2,69)**	(-3,95)***
2	-0,127	-0,037	-0,076	-0,132	-0,03	-0,075	-0,308	-0,118	-0,198
	(-5,18)***	(-1,92)**	(-4,16)***	(-5,88)***	(-1,86)*	(-4,82)***	(-4,86)***	(-2,54)**	(-4,06)***
3	-0,107	-0,018	-0,055	-0,12	-0,029	-0,067	-0,321	-0,131	-0,214
	(-3,70)***	(-0,88)	(-2,61)**	(-5,46)***	(-1,60)	(-4,09)***	(-5,78)***	(-2,72)***	(-4,54)***
4	-0,104	-0,022	-0,059	-0,121	-0,034	-0,072	-0,303	-0,139	-0,208
	(-3,24)***	(-0,95)	(-2,56)**	(-5,04)***	(-1,71)*	(-4,21)***	(-5,26)***	(-2,93)***	(-4,34)***
5	-0,089	-0,013	-0,05	-0,095	-0,021	-0,054	-0,294	-0,162	-0,219
	(-2,78)***	(-0,55)	(-2,10)**	(-3,80)***	(-0,97)	(-2,77)***	(-5,16)***	(-3,27)***	(-4,49)***
6	-0,068	0,002	-0,033	-0,083	-0,02	-0,046	-0,301	-0,181	-0,233
	(-1,97)*	-0,07	(-1,23)	(-3,50)***	(-0,88)	(-2,26)**	(-5,75)***	(-3,56)***	(-5,10)***
7	-0,079	0,001	-0,041	-0,046	-0,016	-0,025	-0,312	-0,182	-0,243
	(-2,07)**	-0,03	(-1,37)	(-1,71)*	(-0,67)	(-1,11)	(-6,16)***	(-3,34)***	(-5,29)***
8	-0,075	0,012	-0,034	-0,037	-0,004	-0,015	-0,329	-0,191	-0,25
	(-1,94)*	-0,46	(-1,12)	(-1,45)	(-0,17)	(-0,71)	(-6,51)***	(-3,69)***	(-6,00)***
9	-0,065	0,023	-0,023	-0,031	-0,002	-0,009	-0,335	-0,168	-0,236
	(-1,64)	-0,81	(-0,72)	(-1,02)	(-0,10)	(-0,37)	(-5,59)***	(-2,68)**	(-4,91)***

Significance: ***=1%, **=5%, *=10%.

TABLE 2

MEAN AND QUARTILES

Banking Crisis			
Variables	Mean	First Quartile	Third Quartile
GDP (ln)	23,64	21,96	25,27
Population (ln)	16,08	15,11	17,04
Openness	68,61	35,69	86,01
FI	1,35	0,57	1,46
FD	0,83	0,35	1,12
FDC	0,40	0,15	0,55

Currency Crisis			
Variables	Mean	First Quartile	Third Quartile
GDP (ln)	23,01	21,75	24,41
Population (ln)	15,94	15,01	16,93
Openness	71,22	37,80	88,85
FI	1,12	0,56	1,38
FD	0,72	0,31	0,96
FDC	0,30	0,12	0,36

Debt Crisis			
Variables	Mean	First Quartile	Third Quartile
GDP (ln)	23,11	21,86	24,54
Population (ln)	16,07	15,02	17,27
Openness	69,91	37,32	88,32
FI	1,31	0,64	1,48
FD	0,66	0,28	0,84
FDC	0,27	0,13	0,33

Table 3

TESTS ON TRADE FLOWS

Test on Imports

K	Banking Crisis			Currency Crisis		Debt Crisis	
	Time trend	Time F.E.	Duration	Time trend	Time F.E.	Time trend	Time F.E.
1	-0,059	-0,061	-0,019	-0,086	-0,069	-0,165	-0,123
	(-4,47)***	(-4,39)***	(-4,37)***	(-5,90)***	(-4,83)***	(-4,35)***	(-3,00)***
2	-0,125	-0,111	-0,039	-0,131	-0,106	-0,309	-0,233
	(-5,06)***	(-4,76)***	(-5,32)***	(-5,81)***	(-5,00)***	(-4,87)***	(-3,60)***
3	-0,103	-0,088	-0,040	-0,118	-0,087	-0,321	-0,223
	(-3,51)***	(-3,17)***	(-4,55)***	(-5,28)***	(-4,11)***	(-5,79)***	(-3,70)***
4	-0,097	-0,081	-0,038	-0,117	-0,079	-0,302	-0,180
	(-2,97)***	(-2,61)**	(-3,72)***	(-4,77)***	(-3,37)***	(-5,26)***	(-2,65)**
5	-0,079	-0,063	-0,035	-0,089	-0,048	-0,292	-0,150
	(-2,37)**	(-2,08)**	(-3,53)***	(-3,46)***	(-2,00)**	(-5,13)***	(-2,17)**
6	-0,055	-0,040	-0,029	-0,075	-0,033	-0,298	-0,146
	(-1,51)	(-1,26)	(-2,82)***	(-2,99)***	(-1,38)	(-5,68)***	(-2,28)**
7	-0,064	-0,060	-0,031	-0,036	0,004	-0,308	-0,162
	(-1,53)	(-1,72)*	(-2,63)**	(-1,28)	(0,15)	(-6,13)***	(-2,62)**
8	-0,057	-0,060	-0,025	-0,027	0,015	-0,324	-0,150
	(-1,32)	(-1,78)*	(-2,16)**	(-0,97)	(0,59)	(-6,54)***	(-2,72)***
9	-0,044	-0,048	-0,026	-0,020	0,024	-0,333	-0,133
	(-0,95)	(-1,33)	(-2,29)**	(-0,60)	(0,79)	(-5,61)***	(-2,27)**

Test on Exports

K	Banking Crisis			Currency Crisis		Debt Crisis	
	Time trend	Time F.E.	Duration	Time trend	Time F.E.	Time trend	Time F.E.
1	-0,019	-0,017	-0,010	-0,012	-0,011	-0,095	-0,087
	(-1,39)	(-1,11)	(-2,66)***	(-1,00)	(-0,87)	(-2,69)**	(-2,35)**
2	-0,036	-0,024	-0,016	-0,030	-0,024	-0,118	-0,098
	(-1,86)*	(-1,24)	(-3,71)***	(-1,84)*	(-1,51)	(-2,55)**	(-2,00)*
3	-0,016	-0,008	-0,012	-0,028	-0,019	-0,131	-0,109
	(-0,78)	(-0,36)	(-2,51)**	(-1,55)	(-1,09)	(-2,71)***	(-2,22)**
4	-0,018	-0,010	-0,014	-0,032	-0,017	-0,138	-0,100
	(-0,78)	(-0,41)	(-2,72)***	(-1,62)	(-0,88)	(-2,91)***	(-2,00)**
5	-0,007	0,002	-0,011	-0,018	0,000	-0,160	-0,108
	(-0,31)	(0,1)	(-2,19)**	(-0,82)	(0,01)	(-3,24)***	(-2,13)**
6	0,009	0,017	-0,007	-0,015	0,000	-0,179	-0,124
	(0,32)	(0,65)	(-1,19)	(-0,66)	(0,01)	(-3,51)***	(-2,52)**
7	0,009	0,007	-0,008	-0,010	-0,002	-0,178	-0,128
	(0,3)	(0,27)	(-1,30)	(-0,40)	(-0,07)	(-3,29)***	(-2,62)**
8	0,023	0,016	-0,006	0,004	0,014	-0,186	-0,123
	(0,74)	(0,57)	(-1,00)	(-0,14)	(0,61)	(-3,64)***	(-2,78)***
9	0,036	0,028	-0,006	0,007	0,019	-0,165	-0,099
	(1,08)	(0,95)	(-0,82)	(-0,29)	(0,79)	(-2,67)**	(-1,87)*

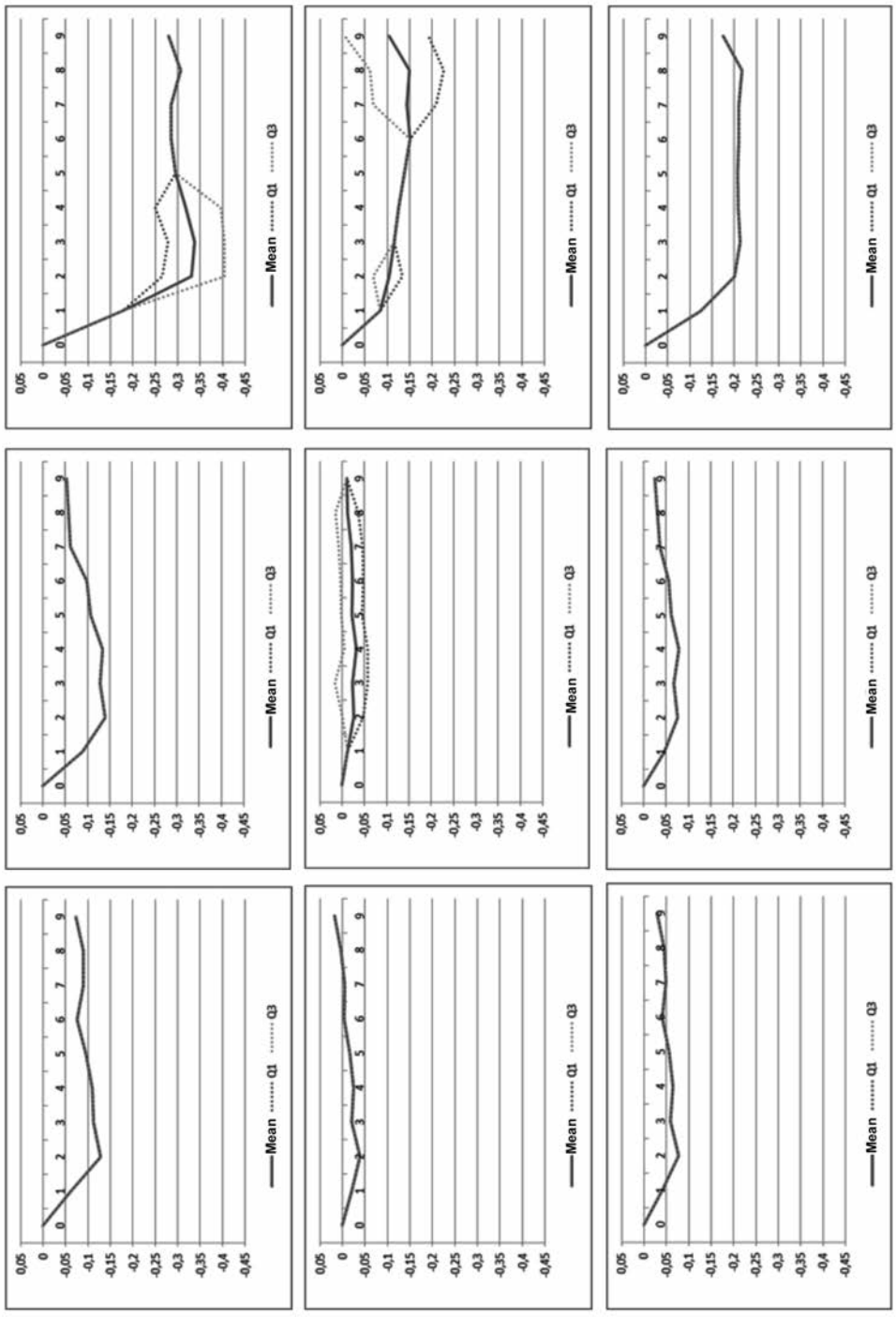
Significance: ***=1%, **=5%, *=10%. ·/·

Test on Imports + Exports

K	Banking Crisis			Currency Crisis		Debt Crisis	
	Time trend	Time F.E.	Duration	Time trend	Time F.E.	Time trend	Time F.E.
1	-0,039	-0,038	-0,014	-0,046	-0,038	-0,122	-0,096
	(-3,58)***	(-3,31)***	(-4,54)***	(-4,15)***	(-3,56)***	(-3,95)***	(-2,88)***
2	-0,075	-0,064	-0,025	-0,075	-0,062	-0,198	-0,152
	(-4,04)***	(-3,60)***	(-5,66)***	(-4,77)***	(-4,20)***	(-4,07)***	(-2,93)***
3	-0,052	-0,043	-0,024	-0,065	-0,048	-0,214	-0,154
	(-2,40)**	(-2,04)**	(-4,37)***	(-3,93)***	(-2,98)***	(-4,53)***	(-3,05)***
4	-0,054	-0,044	-0,025	-0,069	-0,045	-0,207	-0,127
	(-2,27)**	(-1,86)*	(-4,03)***	(-3,93)***	(-2,63)**	(-4,31)***	(-2,30)**
5	-0,042	-0,031	-0,023	-0,049	-0,022	-0,217	-0,119
	(-1,68)*	(-1,31)	(-3,71)***	(-2,44)**	(-1,19)	(-4,43)***	(-2,04)**
6	-0,023	-0,012	-0,018	-0,039	-0,012	-0,230	-0,125
	(-0,78)	(-0,48)	(-2,58)**	(-1,83)*	(-0,57)	(-5,02)***	(-2,29)**
7	-0,028	-0,028	-0,020	-0,016	0,007	-0,238	-0,138
	(-0,84)	(-1,01)	(-2,43)**	(-0,68)	(0,31)	(-5,25)***	(-2,64)**
8	-0,018	-0,025	-0,016	-0,006	0,019	-0,245	-0,126
	(-0,53)	(-0,94)	(-2,00)**	(-0,24)	(0,9)	(-6,03)***	(-2,89)***
9	-0,004	-0,012	-0,016	0,003	0,028	-0,233	-0,098
	(-0,12)	(-0,41)	(-1,90)	(0,11)	(1,18)	(-4,96)***	(-2,12)**

Significance: ***=1%, **=5%, *=10%.

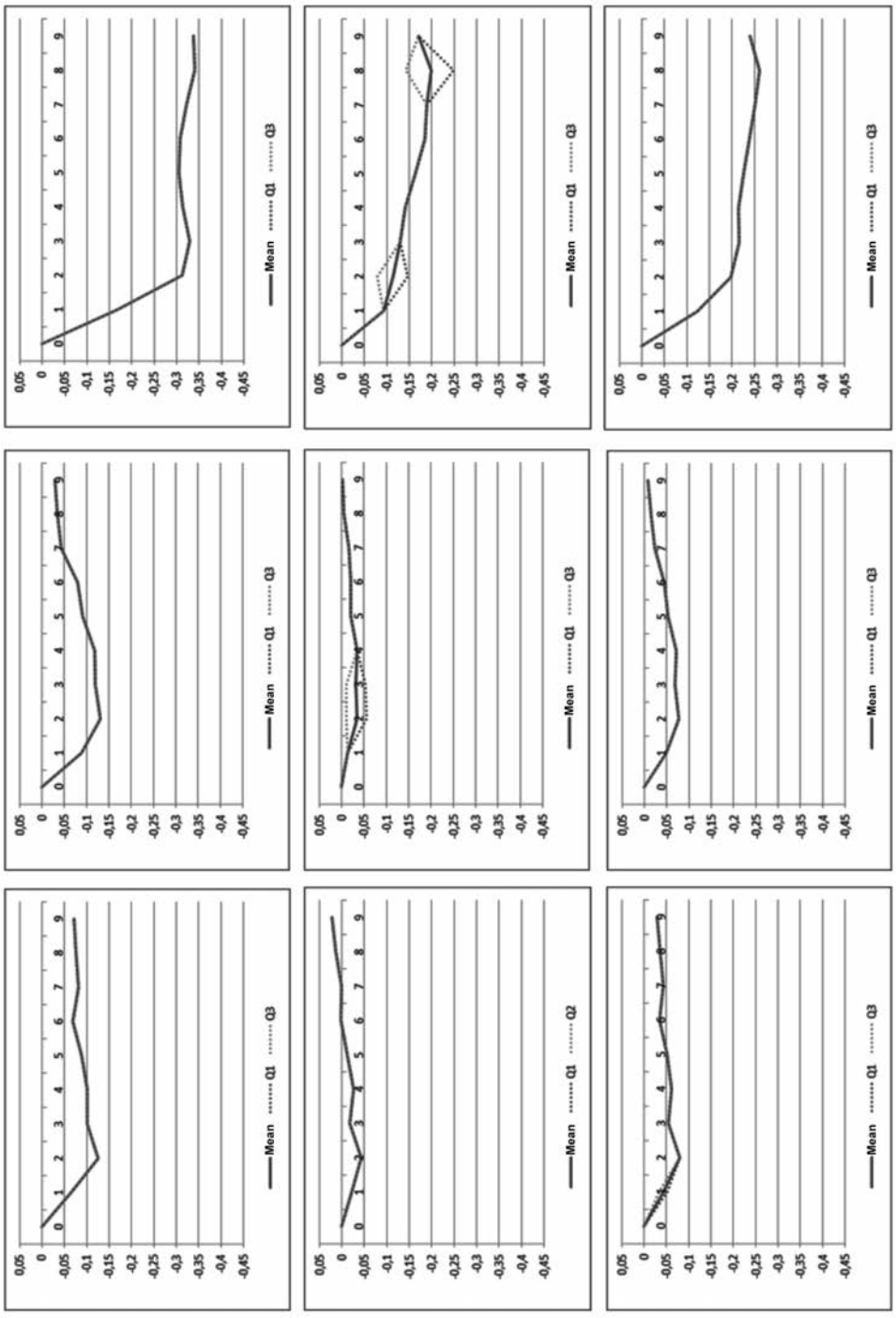
GRAPH 2



Note: dotted lines differ from average response only when the interaction term is statistically significant.

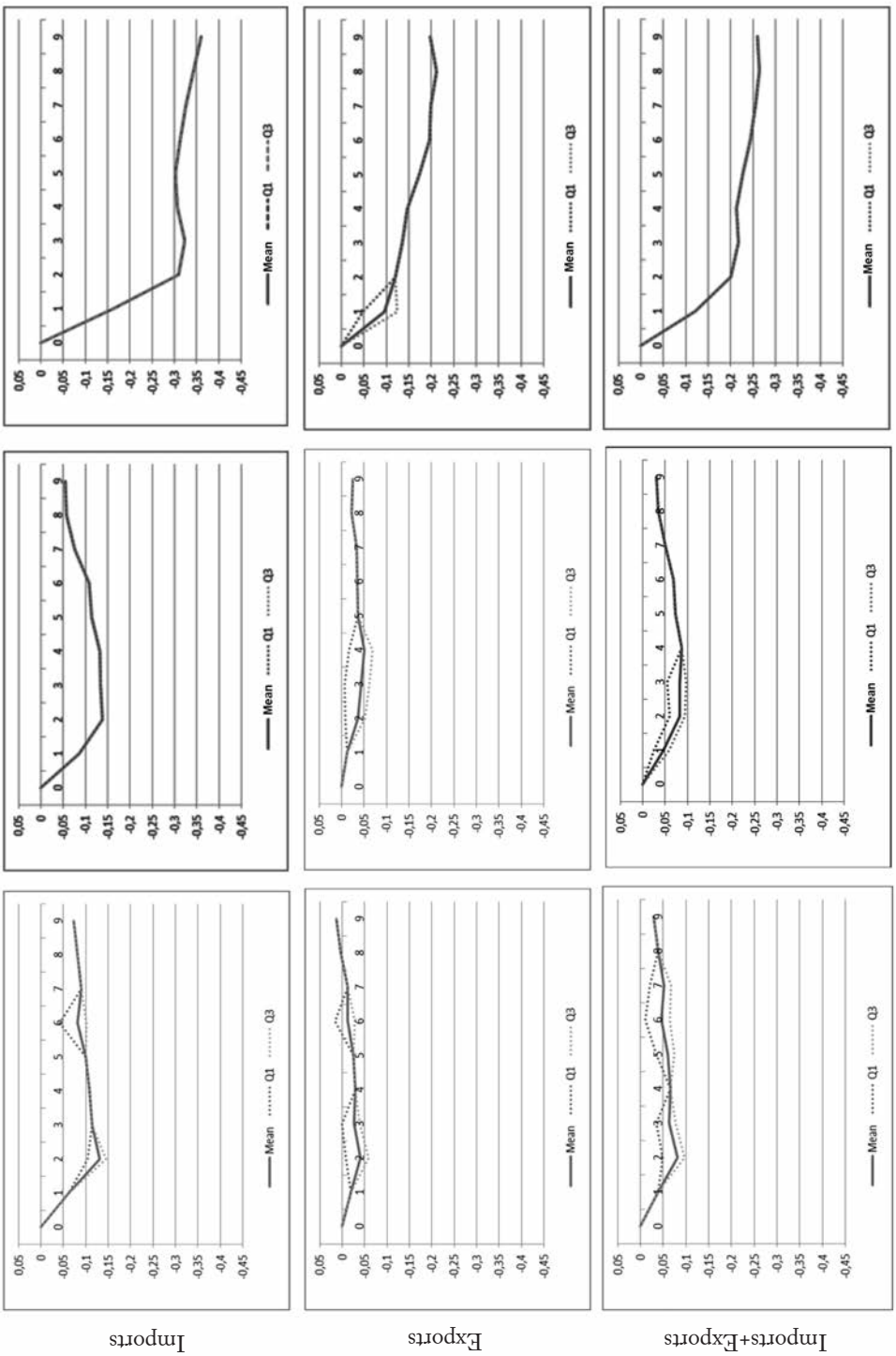
GRAPH 3

POPULATION AND CRISES



Note: dotted lines differ from average response only when the interaction term is statistically significant.

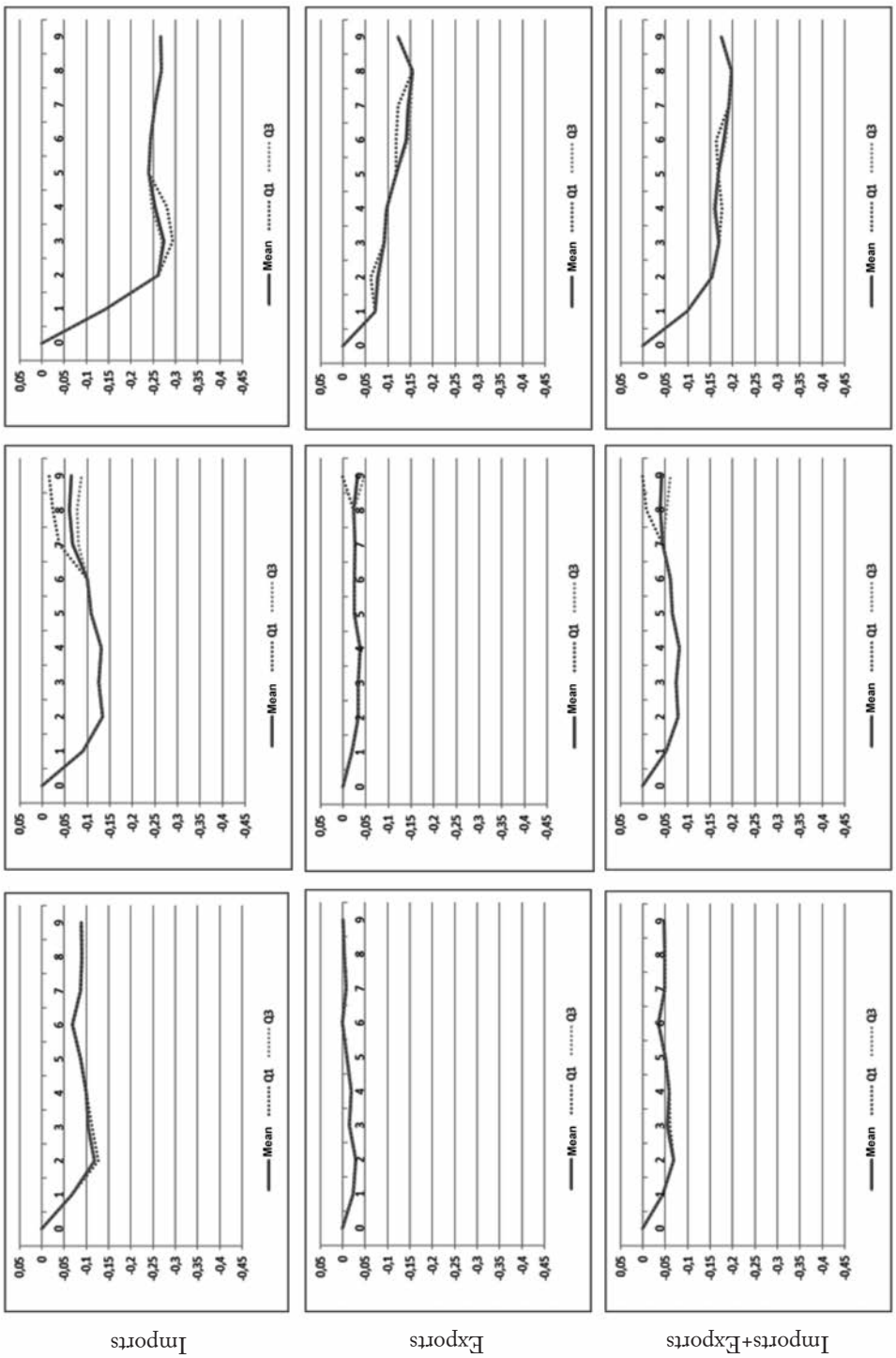
GRAPH 4



Note: dotted lines differ from average response only when the interaction term is statistically significant.

GRAPH 5

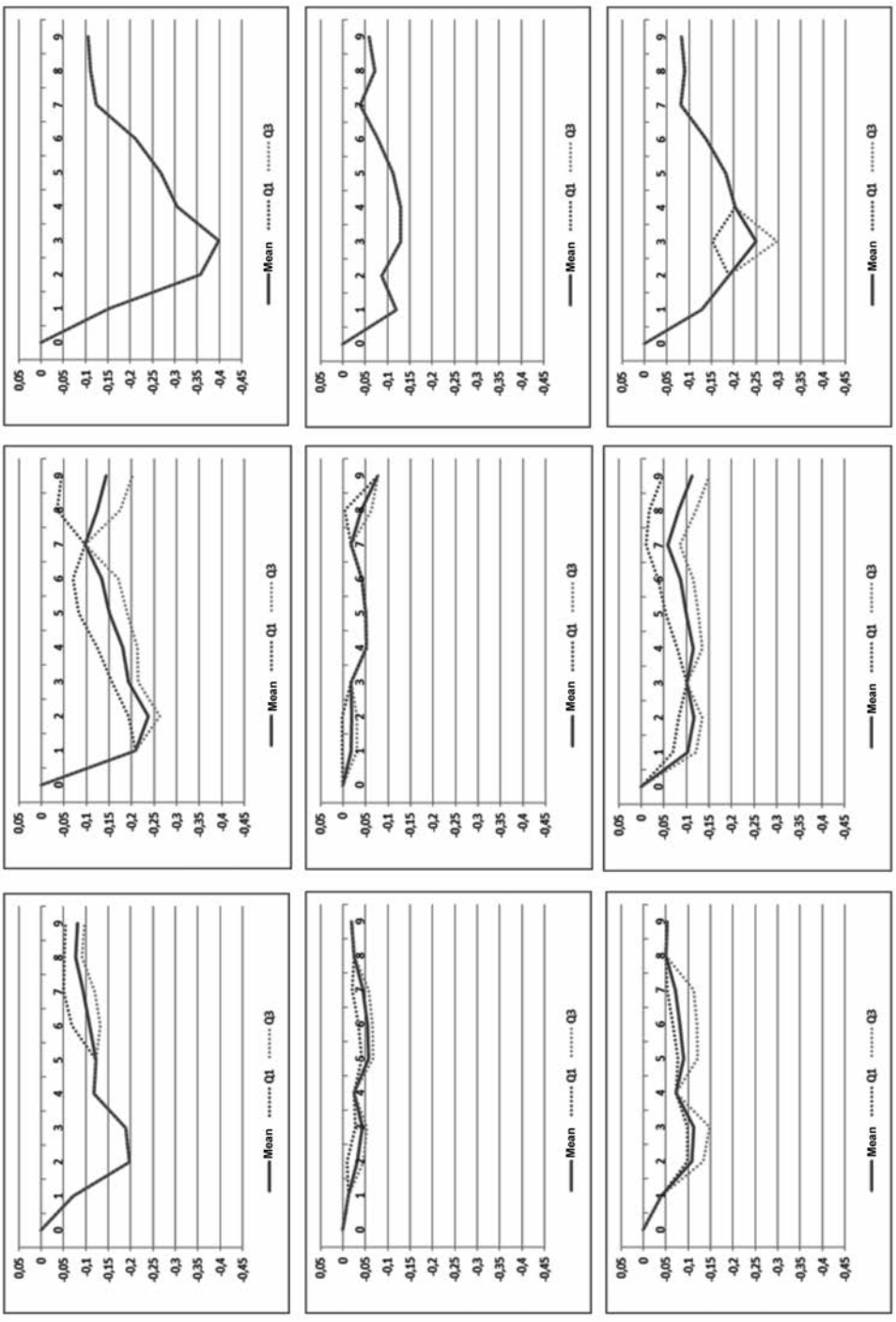
FI AND CRISES



Note: dotted lines differ from average response only when the interaction term is statistically significant.

GRAPH 6

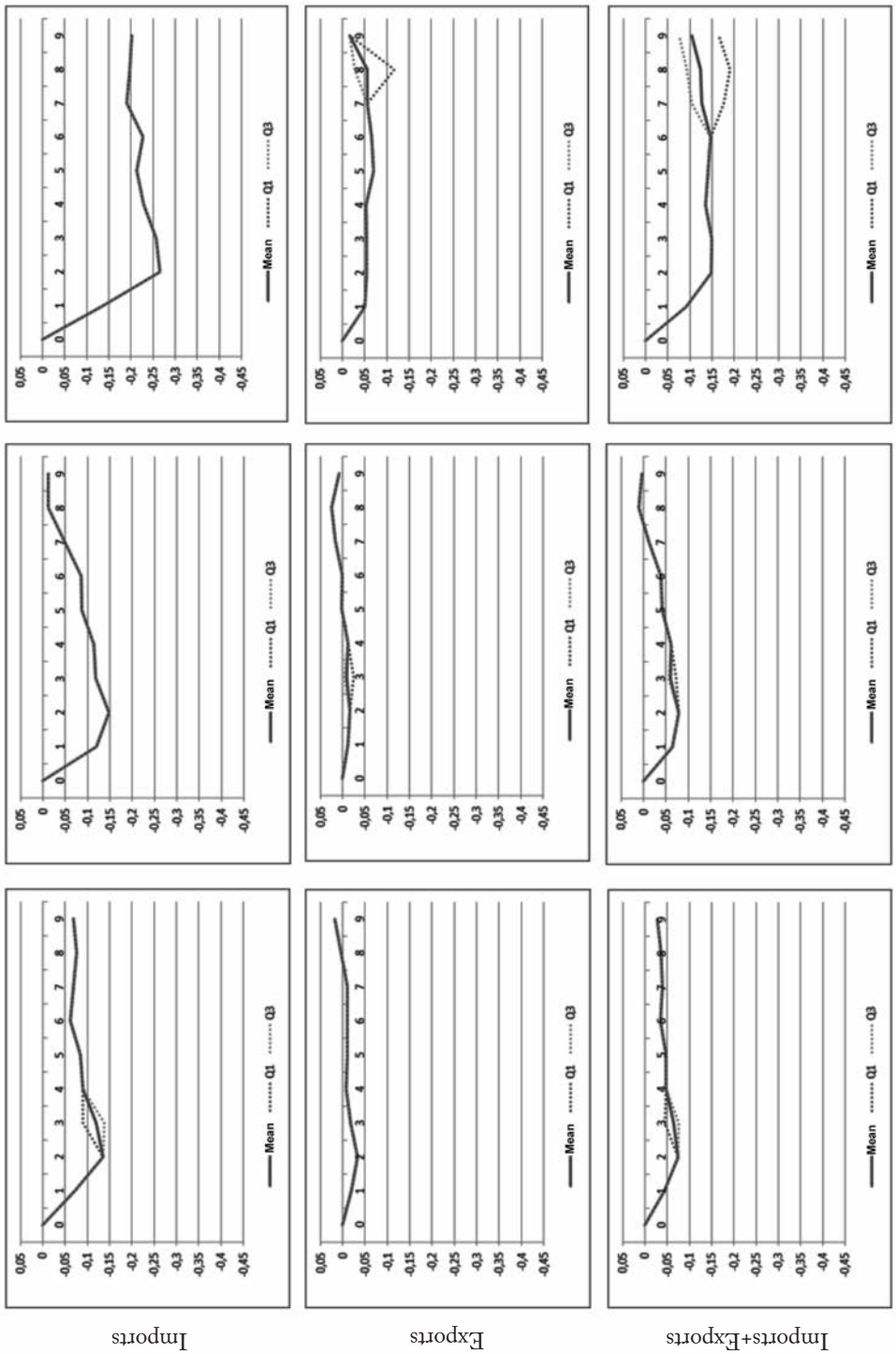
FD AND CRISES



Note: dotted lines differ from average response only when the interaction term is statistically significant.

GRAPH 7

FDC AND CRISES



Note: dotted lines differ from average response only when the interaction term is statistically significant.

APPENDIX 1 – VARIABLES

GDP

GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2000 U.S. dollars. Dollar figures for GDP are converted from domestic currencies using 2000 official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used.

Source: WORLD DATA BANK.

Imports

Imports of goods and services represent the value of all goods and other market services received from the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments. Data are in constant 2000 U.S. dollars.

Source: WORLD DATA BANK.

Exports

Exports of goods and services represent the value of all goods and other market services provided to the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments. Data are in constant 2000 U.S. dollars.

Source: WORLD DATA BANK.

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Population	Total population is based on the *de facto* definition of population, which counts all residents regardless of legal status or citizenship - except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of their country of origin. The values shown are midyear estimates.

Source: World Data Bank.

Total assets	Is calculated from: FDI assets + portfolio equity assets + debt assets + derivatives assets + FX reserves

Source: Lane P.R., Milesi-Ferretti G.M. (2007).

Total liabilities	Is calculated from: FDI liabilities + portfolio equity liabilities+ debt liabilities + derivatives liabilities

Source: Lane P.R., Milesi-Ferretti G.M. (2007).

Stock market capitalization	Value of listed shares to GDP, calculated using the following deflation method: {(0.5)*[*Ft/P_et* + *Ft1/P_et*-1]}/[*GDPt/P_at*] where *F* is stock market capitalization, *P_e* is end-of period *CPI,* and *P_a* is average annual *CPI*

Source: Beck T., Demirgüç-Kunt A. (2009).

Bank deposit	Demand, time and saving deposits in deposit money banks as a share of GDP, calculated using the following deflation method: {(0.5)*[*Ft/P_et* + *Ft*-1/*P_et*-1]}/[*GDPt/P_at*] where *F* is demand and time and saving deposits, *P_e* is end-of period *CPI*, and *P_a* is average annual *CPI*

Source: Beck T., Demirgüç-Kunt A. (2009).

Private credit deposit banks and other institution	Private credit by deposit money banks and other financial institutions to GDP, calculated using the following deflation method: {(0.5)*[*Ft/P_et* + *Ft*-1/*P_et*-1]}/[*GDPt/P_at*] where *F* is credit to the private sector, *P_e* is end-of period *CPI*, and *P_a* is average annual *CPI*

Source: Beck T., Demirgüç-Kunt A. (2009).

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Life Satisfaction and Unemployment: An Analysis from the Eurobarometer Survey

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The purpose of this work is to analyse the cost of unemployment in terms of self-reported life satisfaction in Europe between 1973 and 2002, by taking into consideration demographic characteristics such as age and gender. The structure of the work is as follows: in Section 2 I briefly review the existing literature on the well-being/unemployment relationship; in Section 3 I present the data and the composition of the sample; in Section 4 I describe the empirical strategy and the main results.
[JEL Classification: D60; J28; E24].

Keywords: life satisfaction; unemployment; cost of unemployment.

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1. - Introduction

Evaluating individual preferences among macroeconomic variables is fundamental in order to maximise the population's welfare.

The growing concern regarding the extent of unemployment in modern western economies is due to the fact that the non-pecuniary costs of unemployment are increasing and are considerably higher than the pecuniary costs linked with the loss of present and future flows of income (Winkelmann and Winkelmann, 1998; Helliwell and Putnam, 2004 and Brereton *et* al., 2008).

Furthermore, in the last few decades the increase in the social cost of unemployment has been directly related to the development of countries' economies. Indeed, in modern developed societies, the unemployment problem can be considered a pressing social pathology.

Clearly, the non-pecuniary costs of unemployment are linked to a variety of factors. They have been evaluated in relation to mortality (Junankar, 1991), crime (Junankar, 1987) and divorce rates (Sander, 1992).

An active research area has focused attention on the effect of unemployment on well-being and has tried to identify the principal channels of this relationship.

In the first place, unemployment has a negative influence on individuals' overall psychological well-being.[1] Contemporary literature has explored this topic in depth and shown that the negative influence of unemployment on well-being can pass through a worsening of psychological health, a reduction in self-esteem and an increase in mortality and suicides rates (Clark and Oswald, 1994; Goldsmith, Veum and Darity, 1996).

Moreover, there is a "social stigma" cost linked with joblessness, which is especially high in societies where work defines individuals' position.

Intrinsic motivations to work play a key role in determining the non-pecuniary costs of unemployment: elements such as passion, ambition and personal achievement are extremely important for individuals. Those who are unemployed are unable to satisfy their needs and therefore feel unhappier.

Economic literature has explored the topic of intrinsic motivations and found extensive evidence of the fact that individuals are supported in their work by a variety of personal motivations which account for a large part of their overall job satisfaction.

[1] Darity W. and Goldsmith A. (1996) provide a summary of the existing literature on the psychological effects of unemployment on well-being.

The social cost of unemployment (in terms of well-being) is high because it affects both unemployed and employed people: on the one hand, individual unemployment is associated with sharply lower levels of individual well-being and, on the other, high (national) unemployment rates have a negative effect on employed individuals since they are made to worry about their future working conditions.

I use the Eurobarometer Survey data for 15 European countries to analyse whether and to what extent being unemployed influences well-being in the period 1973-2002. I also try to understand how this relationship has changed over time.

Then, I try to analyse the impact of gender on the relationship between unemployment and life satisfaction and investigate the extent to which unemployment affects well-being differently according to gender.

Lastly, I try to understand whether unemployment affects well-being differently across age groups. With respect to the previous literature, my work innovates in the analysis of the evolution of the unemployment/well-being relationship and in considering the effect of this relationship on different age groups.

The work is structured as follows. Section 2 briefly reviews the literature on the unemployment/well-being relationship. Section 3 presents the data; Section 4 describes the empirical strategy and the results and Section 5 concludes.

2. - Unemployment and Well-Being

In modern economies unemployment has always been considered a social pathology with negative consequence for the society.

Firstly, unemployment entails economic costs because it involves an economy operating below its potential, producing with fewer resources and not optimising its production capacity.

Moreover, unemployed individuals represent a direct cost for the public sector since during the period of unemployment they suspend payment of taxes and often receive a form of compensation.

Traditionally, economists attempted to provide an estimate of the monetary costs of unemployment within a society.[2]

The approaches which interpreted the unemployment cost only in terms of a drop in real output dominated the public and academic debate for many years.

[2] See Okun A. (1970).

However, unemployment presents costs not only due to the fact that an economy operates below its potential and with fewer resources.

Unemployment is linked to a wide array of costs including those associated with the effect of joblessness on well-being. These costs are important since they affect an individual and a social dimension and often represent the major component of the total cost of unemployment.

Pecuniary and non-pecuniary costs of unemployment can be compared quantitatively in various ways. Clearly, the non-pecuniary costs must be monetized in order to find a form of comparability with the pecuniary costs. For example, at the individual level this can be done by comparing the pecuniary cost of becoming unemployed (*e.g.* salary) with the amount of income necessary to compensate the individual for the change in well-being associated with the loss of his job. Non-pecuniary costs may refer to a wide range of non-material benefits associated with work. Therefore, the comparison procedure varies with the particular aspect of analysis.

Starting with the work of Eisenberg and Lazarsfeld (1938), a great deal of economic research has focused on the relationship between unemployment and well-being.

This area of research has influenced the discussion on whether unemployment has to be considered a voluntary or an involuntary phenomenon. Keynesian theory, which dominated in the early 1950s and 1960s, considers unemployment as an involuntary phenomenon and supports government intervention in the economy to correct market distortions. According to this approach, well-being costs of unemployment exist and are very high for the individuals directly affected.

A different perspective is adopted by the New Classical Macroeconomics (NCM), which sees unemployment as the product of rational decisions made by individuals intending to leave their jobs at the prevailing wage rate and benefit from the social security system. According to this view, unemployed individuals should not suffer a lot as a result of their conditions.

The modern discussion of the phenomenon however goes beyond the opposition between the two traditional views.

In fact the prevailing discussion asserts that the unemployed suffer a loss that is equivalent to the difference between their previous wage and their benefits (net of the value of their non-market time).

Whether unemployment is voluntary or involuntary and to what extent unemployed individuals suffer are still open and debated questions: well-being research in economics brings a new perspective to this debate.

2.1 *Literature Results*

At a theoretical level, the well-being costs of unemployment can be divided into two broad categories: costs that affect unemployed individuals and costs that affect other individuals (including employed persons).

Referring to the first category of costs, what is known is that unemployment is associated with systemically lower levels of well-being (Helliwell, 2003; Lucas *et* al., 2004; Pittau *et* al., 2010).

Clark and Oswald (1994) use the British Household Panel to study the effect of unemployment on well-being in the United Kingdom and summarise their results as follow: «joblessness depresses well-being more than any other single characteristic including important negative ones such as divorce and separation».

The authors use an ordered probit model to estimate equations in which individual well-being levels are regressed on a set of personal characteristics. According to their findings unemployment enters negatively and is statistically significant in all the regression specifications. The quantitative magnitude of unemployment on well-being (-0.640) is higher than the one of other personal characteristics, which are notoriously considered detrimental in terms of life satisfaction, such as divorce (-0.173) and separation (-0.265).

Unemployment depresses individual well-being through various dimensions: it affects individual personal identity and his role in the society and is perceived as dramatic condition, significantly more than divorce and separation.

Winkelmann and Winkelmann (1995) use German panel data and find that unemployment has a large and negative effect, especially on male individuals.

The authors show that the effect is large enough to increase the probability that a middle-aged male is not satisfied by more than 10 percentage points.

According to their analysis, the non-pecuniary costs of unemployment represent the 75% of the individual total cost.

Many authors have also shown that the negative effect of unemployment on individuals' psychological well-being can exceed the consequences of the fall in income (Winkelmann and Winkelmann, 1998; Helliwell and Putnam, 2004).

Clark *et* al. (2008) use the first 23 waves of the German Socio-Economic Panel (GSOEP) and observe that the *compensating differential*, *i.e.* the increase in income that would make the unemployed just as happy as the employed, is an order of magnitude larger than the observed differences in income between unemployed and employed individuals.

The literature shows that the negative effects of unemployment on well-being are weaker in countries where the unemployment rate is higher (Clark, 2003;

Shields and Price, 2005). This can be explained by the fact that individuals often compare their personal situations with those of other individuals (or reference groups): the loss of well-being experienced by unemployed individuals is lower if other people also undergo the same experience.

The psychological costs of being unemployed have been documented by many studies.[3] It has been shown that joblessness increases cases of depression, frustration, anxiety, lower self-esteem, uncertainty and social isolation.

High unemployment rates also have a direct effect on the rest of the labour force, that is employed people. Di Tella *et* al. (2003) use the Eurobarometer Survey data and show that between 1975 and 1992 high unemployment rates in Europe have a strong negative effect on the well-being of employed individuals.

Amartya Sen (1997), has studied how joblessness that plague European countries today inflicts damages for the society.

The author identifies 9 different types of damages produced by massive unemployment:

1. *Loss of current output and fiscal burden*
   Unemployment determines a loss of income in two different ways: it cuts national output and it increases the share of output devoted to income transfers;
2. *Loss of freedom and social exclusion*
   Even if supported by government compensation, individuals who face a joblessness condition do not exercise much freedom in their decisions. When unemployed, individuals may face negative experiences such as an interruption of social activities, a sense of deprivation which create frustration and disillusionment;
3. *Skill loss*
   Being out of work due to unemployment for a long period of time may determine a loss of skills previously acquired on the job. This implies that when starting to work again, people have to reinvest in personal training;
4. *Psychological harm*
   The literature has shown that unemployment can cause intense suffering and worsening of individuals' mental health;
5. *Ill health and mortality*
   Clinical illness and higher rates of mortality are some of the direct negative effects of unemployment on individual well-being;

[3] See Goldsmith A., Veum J., Darity W. (1996); Ruhm C. (2000) and McKee-Ryan F. *et* al. (2005).

6. *Motivational loss*
   Weakening of motivations, disillusionment and discouragement can bring people to live their non-working period in a very negative way;
7. *Loss of human relations and family life*
   When unemployed, people could be less inclined to dedicate time to personal relations and family life. This could determine a worsening of the psychological tension within the family unit;
8. *Racial and gender inequalities*
   When unemployment is high, the most affected people could be minority groups (*e.g.* immigrant communities). Ethnic tension and gender division are often a reflection of the unemployment problem;
9. *Loss of social value and responsibility*
   There is some evidence showing that unemployment determines a loss in some important values, for instance respect of laws, civil responsibility, etc.
   High unemployment rates within a country often translate into social pathology. The latter requires specific attention and has to be faced with appropriate methods.

An interesting discussion refers to the existence and extent of a physiological and efficient level of unemployment, which would allow individuals to get into better jobs and find high quality matches.

According to some recent studies, having a job even if of low quality is associated on average with higher levels of individual well-being.

Grün *et* al. (2010) use data from the German Socio Economic Panel to analyse the impact on life satisfaction of the transition from unemployment to full-employment. In particular, the authors try to understand what effect the quality of new jobs has on life satisfaction. The authors conclude that: «Our main result is that we cannot identify a single job feature, nor a combination of such features that constitute such low quality jobs that remaining unemployed would be the better choice for the individual. On the contrary, the bulk of our evidence shows that even low quality jobs are associated with higher life satisfaction, and this effect is statistically significant for most specifications of "bad" jobs».

Wulfgramm (2011) uses panel data for the German work force to analyse the role of the biggest German activation programme, the "One-Euro-Job" programme and shows that individuals' life satisfaction rises significantly after moving onto the programme after being unemployed.

3. - The Data

The source of our data is the Eurobarometer Survey (EB),[4] performed on behalf of the European Commission (EC). The Eurobarometer database contains cross-country and cross-sectional data for various European countries and is designed to monitor the political and social attitudes in the member states. The methodology followed in building our database is very similar to that of Di Tella, McChulloch and Oswald (2001 and 2003).

The database provides measurements of a set of socio-economic and demographic characteristics; initially it covered nine European countries but, from 1973 on, the sample has been expanded.

In 2002 the survey included 15 EU countries and today it covers 30 countries, including new member states and new candidates.[5]

The sample we consider in our analysis is structured as follows. We consider 15 European countries: France, Belgium, the Netherlands, Italy, Luxembourg, Denmark, Ireland, the United Kingdom, Greece, Spain, Portugal, Finland, Sweden, Germany and Austria. Data for Austria and Sweden are available from 1994 onwards.

The period we look at is the one going from 1973 to 2002 (except 1974 and 1996). As of 2002 the income variable has not been recorded and therefore cannot be used as a control variable. Since income is an important determinant of individuals' life satisfaction we prefer to restrict our analysis to the period mentioned above. The variable of most interest is individuals' self-declared life satisfaction at the time of the interview.[6] The survey records information for this variable for a pool of 798.619 people living in European countries between 1973 and 2009 (except 1974 and 1996).

[4] The European Commission has been monitoring the evolution of public opinion in the member states since 1973. Every year a random sample of European citizens is interviewed on topics regarding socio-political and economic aspects of the decision-making process of the European institutions. The data recorded are a useful platform of information for the preparation of texts and decision-making.

[5] New countries include Cyprus, the Czech Republic, Estonia, Lithuania, Latvia, Malta, Poland, Slovakia, Slovenia, Bulgaria, Romania, Turkey, Croatia and Macedonia.

[6] The database provides information on individual self-declared life satisfaction and happiness. We prefer to use the life satisfaction variable since it is recorded for a longer period of time and it seems to have a better fit with the idea of individual well-being that we are trying to analyse.

The question regarding this variable is:

«On the whole, are you very satisfied, fairly satisfied, not very satisfied, or not at all satisfied with the life you lead? Would you say you are….».

The answers are given on a scale with values ranging from 1 ("very satisfied") to 4 ("not at all satisfied"). For analytical reasons the variable has been reclassified in the opposite direction to allow 4 to correspond to the maximum level of declared satisfaction. Other variables included in our analysis provide information on the respondents' gender, age, education, civil and working status and income.

Table 1 contains a summary description of the variables used in the empirical analysis.

The database contains data for approximately one million of European citizens, of which 52% are females and 21% have a high level of educational qualifications. More than 54% of the respondents are married and 7% are unemployed.

Our dependent variable is life satisfaction. It is regressed on country and year dummy variables, on a set of standard controls including gender, age, marital status, working status and educational level and on a dummy variable relative to the individual's unemployed (or employed) status. We use slope dummy variables to analyse the effect of unemployment on life satisfaction by gender and age. Table 2 reports some descriptive statistics of the main variables included in our analysis.

Tables 3 and 4 show how life satisfaction reports are distributed across individuals with different characteristics.

TABLE 1

DESCRIPTION OF THE VARIABLES USED

Variable	Source	Description
Life satisfaction	Eurobarometer	Self-declared life satisfaction on a scale ranging from 1 (not at all satisfied) to 4 (very satisfied)
Unemployed	Eurobarometer	Dummy variable (DV), which takes value 1 if the respondent is unemployed, 0 otherwise
Self-employed	Eurobarometer	Dummy variable (DV), which takes value 1 if the respondent is self-employed, 0 otherwise
Retired	Eurobarometer	Dummy variable (DV), which takes value 1 if the respondent is retired, 0 otherwise
Student	Eurobarometer	Dummy variable (DV), which takes value 1 if the respondent is student, 0 otherwise
Male	Eurobarometer	Dummy variable (DV), which takes value 1 if the respondent is Male 0 otherwise
Age	Eurobarometer	Exact age of the respondent
Age squared	Eurobarometer	Square of the age of the respondent
Middle education	Eurobarometer	Dummy variable (DV), which takes value 1 if the respondent has 15-18 years of education, 0 otherwise
Higher education	Eurobarometer	Dummy variable (DV), which takes value 1 if the respondent has more than 18 years of education, 0 otherwise
Married	Eurobarometer	Dummy variable (DV), which takes value 1 if the respondent is married, 0 otherwise
Separated	Eurobarometer	Dummy variable (DV), which takes value 1 if the respondent is separated, 0 otherwise
Widowed	Eurobarometer	Dummy variable (DV), which takes value 1 if the respondent is widowed, 0 otherwise
Income	Eurobarometer	Income ranging from 1 (min. value) to 13 (max value)
Unemployment	OECD	Unemployment rate (%)

Graph 1

AVERAGE LIFE SATISFACTION, BY YEAR

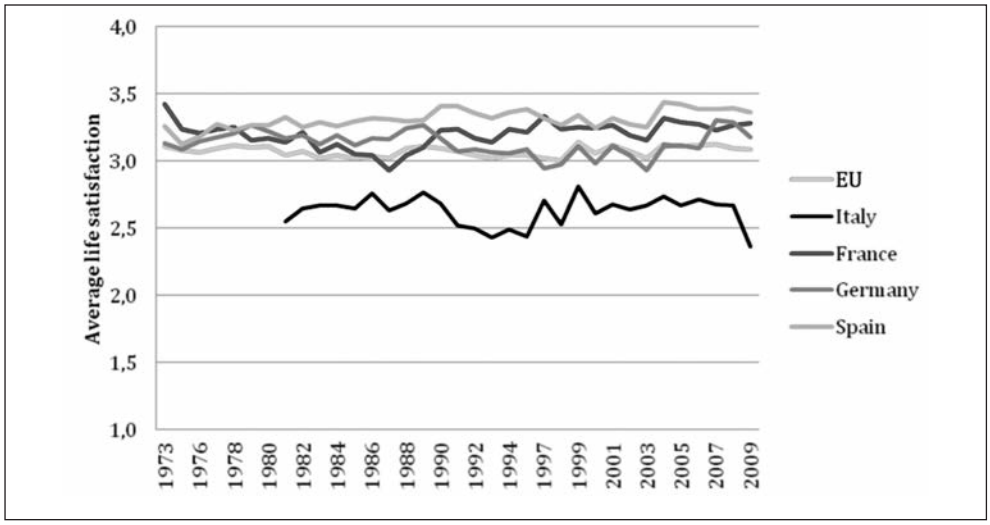


Table 2

SUMMARY STATISTICS OF THE MICRO-VARIABLES

Variable	Observations	Mean	Std. dev.	Min.	Max.
Life Satisfaction	798,619	3.07	0.74	1	4
Male	798,403	0.48	0.49	0	1
Age	797,052	44.10	18.153	15	99
Middle Education	780,896	0.35	0.47	0	1
Higher Education	780,896	0.20	0.41	0	1
Married	782,966	0.57	0.49	0	1
Separated	782,966	0.05	0.23	0	1
Widowed	782,966	0.08	0.28	0	1
Student	783,220	0.10	0.29	0	1
Unemployed	783,220	0.06	0.24	0	1
Retired	783,220	0.19	0.39	0	1
Employed	783,220	0.40	0.49	0	1
Income	451,106	6.60	3.32	1	1

According to individual answers (Table 3), 3.9% of all respondents report a score of 1 ("not at all satisfied"), 12.9% a score of 2 ("not very satisfied"), 54.9% a score of 3 ("fairly satisfied") and 28.3% a score of 4 ("very satisfied"). Moreover, unemployed and separated individuals report a relatively lower score of life satisfaction: 25% of the unemployed and 6.7% of the separated individuals declare themselves "not very satisfied".

Graph 1 reports the evolution of average levels of life satisfaction answers for some European countries (Italy, France, Germany and Spain) and for the European Union. There are some interesting cross-country differences in average levels of self-declared life satisfaction answers. Specifically, Spain has the highest average level of self-declared life satisfaction for the period 1973 to 2009, yet it historically had a high unemployment rate with respect to the average EU and Euro zone levels. How can this unexpected trend be explained? We can review some possible explanations.

Many authors argue that high levels of individual life satisfaction can be a result of the perception of ones' own situation with respect to the context: employed individuals in Spain could perceive their condition in a more positive way if compared with a critical labour market situation.

This effect may also be true for unemployed individuals: the perceived loss of well-being linked with joblessness is lower if other individuals undergo the same experience.

In addition, the standard of living in Spain is relatively high, as suggested by the evidence based on average living cost and average income level (OECD, 2012). If we look at the public sphere, there are high levels of civic participation and a strong sense of community.

Cross tabulation of life satisfaction by educational level and working status (Table 4) shows that education has a clear association with life satisfaction answers, especially when individuals are unemployed: highly educated individuals tend to report lower levels of life satisfaction when unemployed. This may be due to the fact that a higher educational qualification result brings unemployed individuals to face a higher opportunity cost.

A more intuitive relationship refers to the income-life satisfaction relationship. Income seems to influence well-being in a remarkable way. The distribution of the mean of life satisfaction scores by income quartile (Graph 3) shows that people belonging to the lowest level of income quartile tend to report constantly lower levels of life satisfaction.

The second variable of most interest is unemployment. We analyse the cost of being unemployed using a dummy variable referring to the working status of

the respondent. The variable's value is 1 if the respondent is unemployed or temporarily not working at the time of the interview, 0 otherwise.

The cost of being unemployed can be evaluated using various strategies. We focus on slope dummy variables and try to analyse the well-being cost with respect to age and gender.

GRAPH 2

DISTRIBUTION OF LIFE SATISFACTION IN EUROPE
(1973 - 2002)

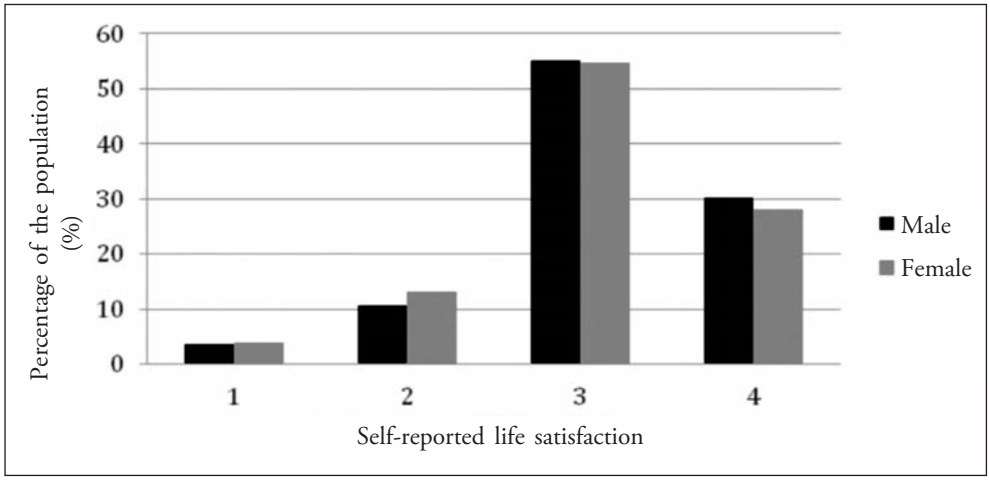


TABLE 3

LIFE SATISFACTION IN EUROPE (%)

		Marital status			Sex	
Reported life satisfaction	All (%)	Unemployed (%)	Married (%)	Separated (%)	Male (%)	Female (%)
Not at all satisfied	3.9	11.6	3.4	6.7	3.9	3.7
Not very satisfied	12.9	25. 7	11.9	22.2	13.3	12.7
Fairly satisfied	54.9	47	54.4	52.1	54.8	55.2
Very satisfied	28.3	15.7	30.3	18.8	28	28.4

Note: based on 798,619 observations.

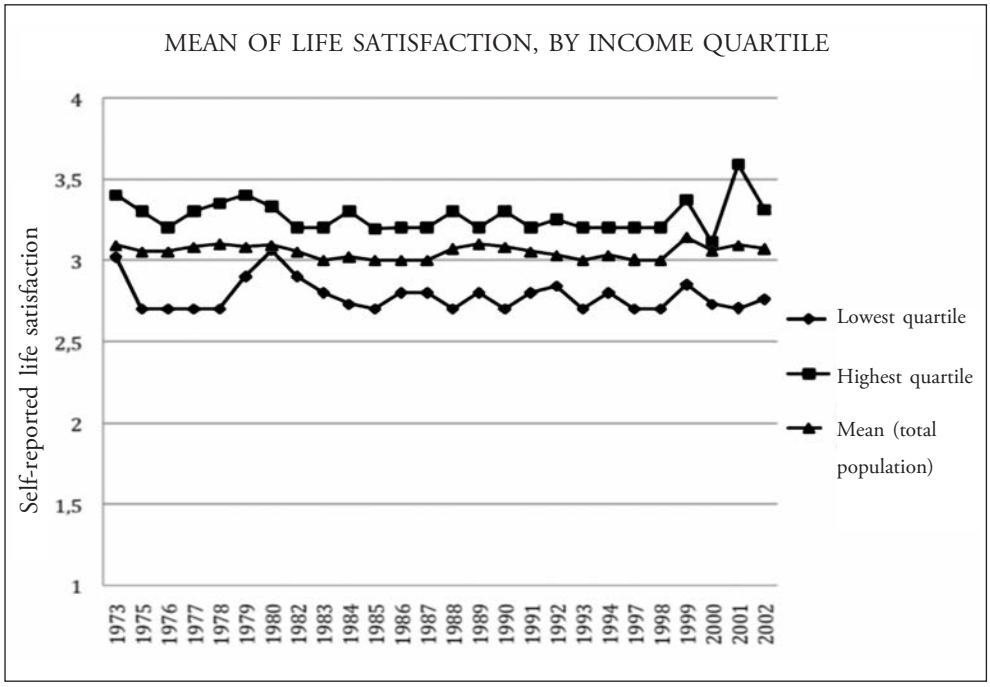
TABLE 4

AVERAGE LIFE SATISFACTION, BY EDUCATIONAL LEVEL AND WORKING STATUS

	Employed	Unemployed
Higher education		
Mean	3.24	2.64
Observations	152,114	8,900
Middle education		
Mean	3.11	2.54
Observations	251,416	22,006
Lower education		
Mean	2.97	2.59
Observations	251,296	14,312

GRAPH 3

MEAN OF LIFE SATISFACTION SCORES, LOWEST-HIGHEST INCOME QUARTILE



In order to evaluate gender inequalities among unemployed individuals we use a slope dummy defined as follows:

*Unemployed * Male*

Where "unemployed" and "male" are two dummy variables referring to the working status and the gender of the respondent.

For the evaluation of the costs of unemployment on different age classes we define 4 age groups: 15-28 years, 29-41 years, 42-64 years and over 64 years.

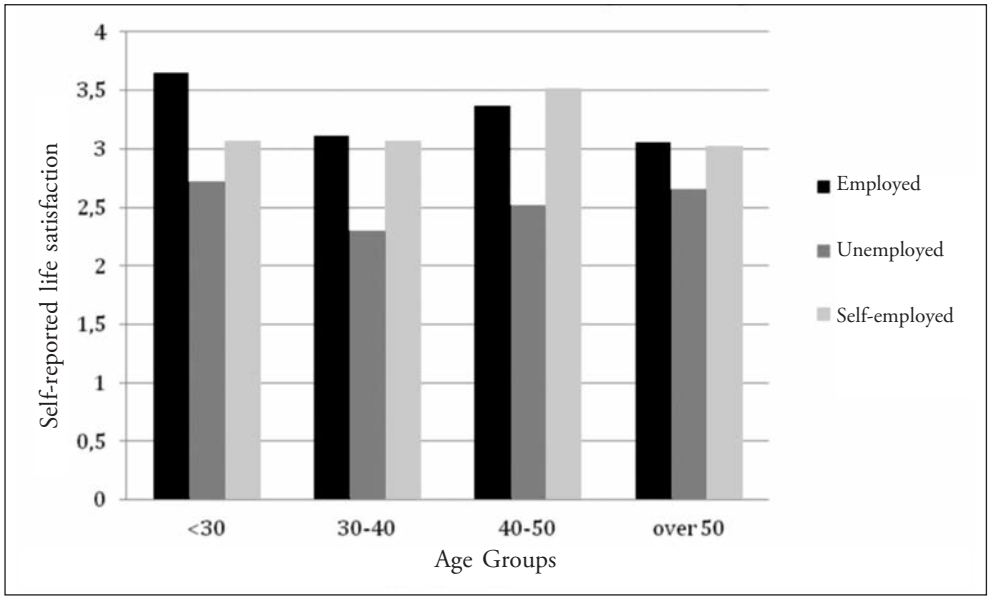
Subsequently, we create slope dummies for different age classes:

*Unemployed * Age class (n)* where $n = 1 \ldots 4$

Graph 4 reports the distribution of life satisfaction by age group and working status. It is clear that there is a powerful association between life satisfaction and unemployment in all the age groups.

Graph 4

DISTRIBUTION OF LIFE SATISFACTION, BY WORKING STATUS



4. - Empirical Strategy and Main Findings

Our empirical analysis starts by defining the regression specification. Since the dependent variable is discrete we use an Ordered Logit Model which takes the following specification:

$$LifeSAT_{ijt} = \alpha_j + \theta_t + \sum_{m=1}^{M} \beta_m CONTR_{mijt} + \rho U_{ijt} + \varepsilon_{ijt}$$

where *LifeSat* is the level of self-reported life satisfaction of individual *i* (*i* = 1, …, *n*), living in country *j* (*j*= 1, …, *m*) in period *t;* α_j and θ_t are respectively country and year dummy variables.

The vector CONTR_{mijt} represents the control variables and includes gender, marital and working status, education, income and age. U_{ijt} is a dummy variable (DV), whose value is 1 if the respondent is unemployed and 0 otherwise and ε_{ijt} is a random error term.

We start our analysis by running a one-stage regression of life satisfaction on the set of standard controls and the country and year dummy variables, including the respondents' own employment status for the period 1973-2002 and for all the 15 EU countries.

Results of the first regression are reported in Table 5. The first column of the table refers to the period 1973-2002. The second column refers to the period 1973-1988 and the third column to the period 1989-2002.

By looking at the results, we observe that the coefficients for the principal control variables are in line with the standard approach of the happiness literature for the whole period of time considered here.

Positive values of the coefficients are associated with variables such as having higher educational qualification, being married, being a student and income.

TABLE 5

LIFE SATISFACTION EQUATIONS IN EUROPE, ORDERED LOGIT

Life Satisfaction	(1) Y1973-2002	(2) Y1973-1988	(3) Y1989-2002
Unemployed	-0.963	-0.843	-1.020
	(-8.41)	(-8.86)	(-6.31)
Self-employed	0.216	0.089	0.328
	(1.27)	(2.40)	(1.12)
Retired	0.101	0.093	0.129
	(1.25)	(1.49)	(1.24)
Student	0.398	0.240	0.492
	(5.69)	(3.00)	(5.57)
Male	-0.078	-0.161	-0.023
	(-1.41)	(-4.27)	(-0.30)
Age	-0.051	-0.046	-0.055
	(-8.99)	(-9.33)	(-8.30)
Age^2	0.001	0.001	0.001
	(10.77)	(11.64)	(9.18)
Middle education	0.145	0.122	0.176
	(3.30)	(3.27)	(2.44)
Higher education	0.267	0.224	0.296
	(4.12)	(3.57)	(2.95)
Married	0.208	0.229	0.185
	(5.67)	(7.21)	(3.88)
Separated	-0.454	-0.530	-0.443
	(-12.91)	(-8.23)	(-11.93)
Widowed	-0.210	-0.289	-0.166
	(-3.83)	(-5.89)	(-2.42)
Income	0.101	0.105	0.101
	(15.01)	(9.69)	(12.77)
Observations	427,082	174,670	250,209
Pseudo R^2	0.092	0.082	0.101

Note: regressions are ordered logit with standard errors adjusted for cluster at the country level. The dependent variable is self-declared life satisfaction ranging from 1 ("not at all satisfied") to 4 ("very satisfied"). Year and country dummy variables are omitted for problems of space. *T*-statistics are in brackets.

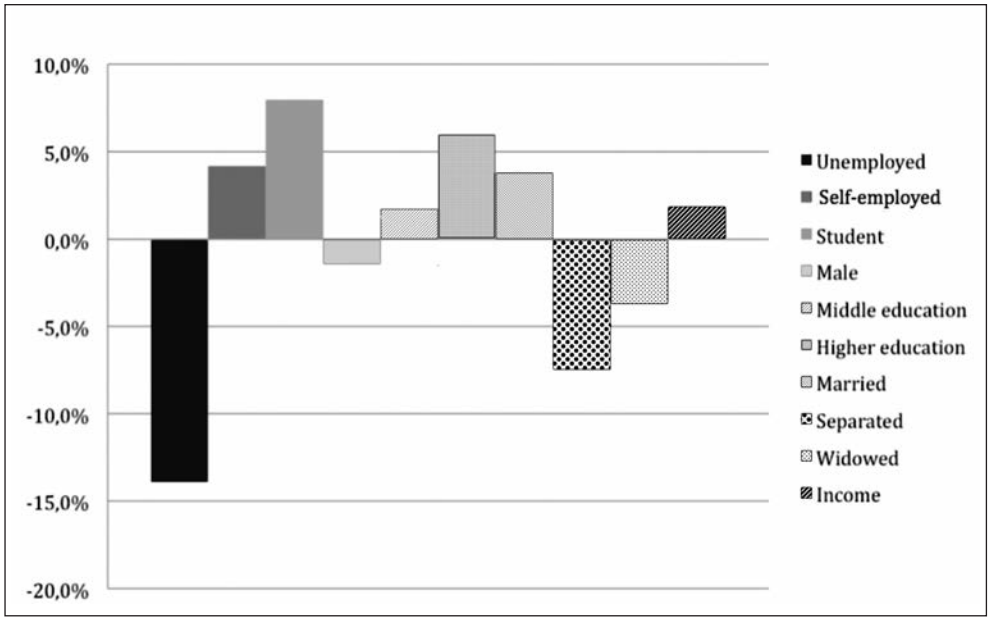
Higher educational qualifications have a positive influence on individuals' life satisfaction. Furthermore, the coefficient of this variable increased slightly in the period 1989-2002.

Being married influences life satisfaction positively in all the three regression specifications. We can assume that being married represents a cost (*e.g.* family and home maintenance) as well as a "stabilizing" element (*i.e.* a relational good which increases satisfaction). Results show that this variable has a positive and statistically significant coefficient indicating that the "positive effect" prevails.

However, this "positive" effect seems to slightly diminish over in time (the coefficient decreases from 0.229 to 0.185 in the period 1988-2002) suggesting perhaps that the influence of the economic costs of a family has been increasing in recent years.

GRAPH 5

THE MARGINAL EFFECTS FOR THE PROBABILITY OF DECLARING HIGH LEVELS OF LIFE SATISFACTION



Graph 5 reports the marginal effects for the probability of declaring a high level of life satisfaction.

Unemployed individuals have the lowest probability of declaring high levels of life satisfaction as against students who have the highest probability.

Being separated has a negative impact on the probability of declaring high levels of life satisfaction (Table 5 and Graph 5). This result is in line with the findings of standard research on happiness, which shows that divorce and separation are unambiguous, universally negative correlates of life satisfaction.

In the non-pecuniary domain of life events, marriage represents one of the most important source of life satisfaction. Being married influences individual social status with respect to other members in the society and has non-material relational benefits. It has been shown that, compared to single, married people enjoy better physical and psychological health and live longer (Layard, Helliwell

and Sachs, 2012). Marriage is also a source of economic advantages, such as insurance and buffers against life shocks.

Being divorced or separated influences negatively individual well-being because individuals are deprived of the above mentioned social and individual non-material benefits.

Regression results also show that income influences life satisfaction positively but the effect is not particularly strong with respect to other variables.

The variable of most interest for us is the dummy variable "unemployed". According to our results, being unemployed has a large negative effect on individuals' life satisfaction (-0.963) in the period 1973-2002.

Considering the percentages of individuals with the lowest level of life satisfaction in the entire sample for the various labour market statuses, it was found that 2% of the employed respondents, 4% of the retired respondents and 12% of the unemployed respondents report the lowest level of life satisfaction score ("not at all satisfied").

This means that if we randomly select an unemployed respondent he is more likely to report a low level of life satisfaction than a randomly selected retired or employed respondent.

As can be seen, the effect of unemployment is quantitatively large: it depresses individual life satisfaction more than any other personal characteristics.

If we analyse how this variable has changed over time, we find that the well-being cost of being unemployed has increased (more specifically, the coefficient changed from -0.843 to -1.020 in the period 1989-2002).

The confidence intervals for the two results do not overlap, confirming the significance of the result. By calculating the marginal effects for the probability of outcome 1 ("not at all satisfied") we find that:

- in the period 1973-1988 the probability of an unemployed respondent reporting the lowest level of life satisfaction is 4.1%;
- in the period 1989-2002 the same probability increases to 5.2%;

The probability of declaring lower levels of life satisfaction has increased in the time windows we have analysed. The overall evidence suggests that the non-pecuniary costs of being unemployed have a strong and significant negative impact on self-reported life satisfaction.

Moreover, these costs have notably increased between the period 1973-1988 and the period 1989-2002.

How can this result be explained? Firstly, the cost of living increased in Europe between 1973 and 2002. This could have negatively influenced people who ex-

perience unemployment and cannot afford the economic costs of (temporary or permanent) joblessness condition.

High living costs have transformed unemployment into an unbearable condition, especially for individuals responsible for the maintenance of a family unit.

Secondly, unemployment is linked with various psychological costs: it is often associated with a social stigma, which carries a significant cost for individuals. This high "stigma" cost is particularly relevant in societies where individuals' position is defined by their working status. Moreover, unemployed individuals face a high cost because of a direct effect on self-esteem and life satisfaction.

Intrinsic motivations for working (such as passion, ambition, personal achievements) influence life satisfaction positively and represent an important component of individuals' personal incentives.

Employment, in fact, is an important channel of transmission of non-pecuniary benefits, benefits, which, according to Sen (1975), refer to the "recognition aspect of employment".

The traditional "unemployment rate" approach is no more effective when faced with high non-pecuniary costs. The indicator underestimates the phenomenon and therefore should be integrated with new measures.

In this context, a country's welfare support provisions play a crucial role in determining how people experience their unemployment status. Unemployment benefits (which in some European countries, such as Sweden, may cover 80% of the wage individuals previously earned) produce various effects on individual welfare.

On the one hand, they have a positive effect on individuals since they help them to cope with a difficult economic situation; on the other, they do not provide individuals with a solution to the psychological damage they experience.

With respect to policy, the insights gained from research on well-being and unemployment help to shed new light on some important economic issues. They enlarge the boundary of empirical measurement and provide new valuable information for future research. In addition, they have direct implications for the process of economic policy formation (Frey and Stutzer, 2002).

Empirical findings have extensively demonstrated that the true costs of unemployment are much higher than the costs deriving from the individual loss of income and that unemployment has two different negative effects: it depresses life satisfaction at the individual level and reduces well-being for society as a whole.

When the non-pecuniary costs of unemployment are high, traditional labour market policies are not sufficient to compensate the unemployed for their job-

lessness condition since they are not able to compensate individuals for part of their true losses.

Our results demonstrate that active labour market policies should be prioritized in order to minimise the period of unemployment for individuals and support them in the search for new jobs.

These policies should be linked to educational support, labour retraining, professional requalification and job matching programmes, which help individuals maintain their abilities and skills over time and support their return to the labour market.

In this context an important support to counter long-term unemployment can also be given by employment programmes that are implemented in partnership with communities and aim to utilize the social economy, encouraging work and supporting the development of the local community.[7]

Clearly, employment policy programmes must be evaluated on the basis of their effectiveness and ability to produce concrete results. This point has been highlighted in the World Happiness Report,[8] which suggests that «employment policies must be judged by their efficacy, not merely by their intention. Yet governments should give great weight to policies that reduce involuntary unemployment, including retraining, job matching, public employment, low-wage subsidies, education support (to raise long-term skills) and other policies».

The integration of the traditional approach of policy formation with a broader view, which includes individual and social non-pecuniary costs of unemployment, is fundamental and can be the basis for a change in perspective and in the techniques of policy analysis.

With the deterioration of the macroeconomic outlook in Europe, policy makers face a major challenge: to increase the employment-population *ratio*, which according to the International Labour Organization (ILO) declined from 61.2% in 2007 to 60.2 % in 2010.

Active employment-generating policies are the only effective programmes for dealing with the problem of unemployment. Policies and programmes aiming only to provide economic assistance can generate distortionary effects and should therefore be implemented cautiously.

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[7] See Gyarmati D. *et* al. (2008).

[8] The World Happiness Report was commissioned for the first United Nations Conference on Happiness in 2012. The report was published by the Earth Institute of Columbia University and is edited by Jeffrey Sachs, Director of the Earth Institute, John Helliwell and Richard Layard.

4.1 *Unemployment and Gender*

In this section of the analysis we examine whether it is reasonable to think that there may be differences in the way unemployed males and females perceive their unemployment status.

Female participation in the labour force has increased sharply from the 1970s to today and we should expect unemployment to "hurt" males and females in the same way on average. Therefore, at a theoretical level there is no reason to think that gender influences how individuals perceive their working status.

Table 6 reports the results of the estimation of life satisfaction equations with the addition of an extra regressor (a slope dummy for gender).

The average level of life satisfaction of an unemployed male respondent is 2.52 while for an unemployed female it is 2.76.

The coefficient of the slope dummy is negative and significant at the 1% level, indicating that unemployment weighed more heavily on males than on females between 1973 and 2002.

What explanation can we give for a gender difference in the effect on life satisfaction of being unemployed?

The participation of females in the labour market has increased but is not high enough to compensate the negative effects on life satisfaction: men continue to suffer more than their (unemployed) female colleagues.

We may think that in a lot of European countries males are still often the main source of income within families and are responsible for their upkeep. Therefore, being unemployed could entail a high risk for the family's economic situation.

We may also add that in some European countries (*e.g.* Italy, Greece and Spain) there is "pressure" on men at different levels:

- a social/cultural pressure, which imposes the stereotyped model of the successful, performing, working man (and, conversely, the stereotyped image of the weak, unlucky unemployed man).
- a psychological pressure, which provokes a feeling of uneasiness and discomfort.

Females seem to be less involved by this "cultural and social pressure", perhaps because they find gratification and personal reward inside the family.

4.2 *Who is Hurt More?*

Our analysis studies the impact on individual life satisfaction of being unemployed considering various age classes:

- 15-28 years;
- 29-41 years;
- 42-65 years;
- over 65 years.

Table 7 presents the results of the regression of life satisfaction on the set of standard controls, the country and year dummy variables and the slope dummies for different age groups.

The slope dummy for the "over 65" age group is the base to avoid the dummy variable trap.

Results reveal heterogeneity in the effects of unemployment on different age groups.

TABLE 6

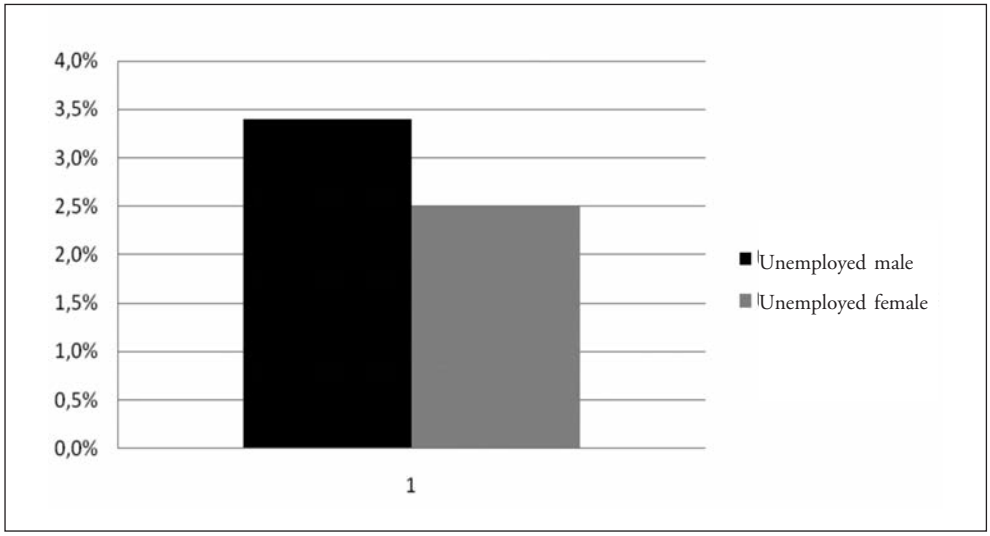
LIFE SATISFACTION EQUATIONS FOR EUROPE, ORDERED LOGIT

Life Satisfaction	**(1)**	
	1973-2002	*T*-statistic
Unemployed	-0.822	-4.77
Self-employed	0.213	1.22
Retired	0.098	1.18
Student	0.396	5.45
Male	-0.068	-1.43
Age	-0.051	-8.77
Age^2	0.001	10.56
Middle education	0.145	3.24
Higher education	0.266	4.08
Married	0.207	5.55
Separated	-0.456	-12.74
Widowed	-0.212	-4.09
Income	0.100	14.60
Unemployed* male	**-0.450**	**-3.84**
Observations	427,082	
Pseudo R^2	0.092	

Note: Regressions are ordered Logit with standard errors adjusted for cluster effects at the country level. The dependent variable is self-declared life satisfaction ranging from 1 ("not at all satisfied") to 4 ("very satisfied"). Year and country dummy variables are omitted for problems of space.

GRAPH 6

PROBABILITIES OF DECLARING LOW LEVELS OF LIFE SATISFACTION WHEN UNEMPLOYED



Being young (15-28 years old) is associated with a negative but not statistically significant coefficient. This is also the case for the second age group (29-41 years old).

The age group that seems to suffer most when unemployed is the group of individuals aged 42 to 65 years.

In fact being unemployed at this age level is very hard because reintegration is likely to be very difficult owing to structural problems present in the labour market.

The difficulty of reintegration is related to the fact that salaries in this age group could be high and therefore companies tend to recruit younger people (who cost less).

Being unemployed in this age group is also hard for the following reasons:

- career progression could be irreversibly interrupted with unemployment;
- family maintenance becomes difficult to afford (due to children still living at home);
- people in this age class no longer feel young enough to reinvent their lives and are not old enough to retire.

Younger unemployed individuals could be less worried about being unemployed because they think they could have several working chances in the future. In their view, the future has a long perspective and lasts a long time.

TABLE 7

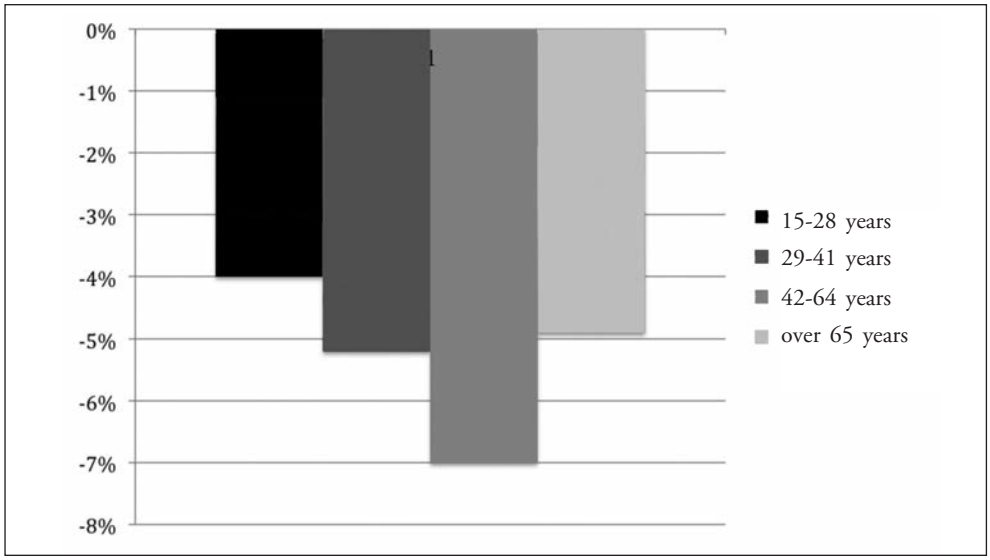
LIFE SATISFACTION EQUATIONS FOR EUROPE, ORDERED LOGIT

Life Satisfaction	**(1)**	
	1973-2002	*T*-statistic
Unemployed	-0.280	-2.16
Self-employed	0.216	1.26
Retired	0.107	1.28
Student	0.392	6.45
Male	-0.078	-1.43
Age	-0.051	-7.16
Age^2	0.001	8.48
Middle education	0.145	3.24
Higher education	0.266	4.10
Married	0.207	5.70
Separated	-0.456	-12.41
Widowed	-0.212	-4.09
Income	0.100	14.82
Unemployed*aged 15-28	**-0.109**	**-0.43**
Unemployed*aged 29-41	**-0.059**	**-0.94**
Unemployed*aged 42-65	**-0.795**	**-4.65**
Observations	427,082	
Pseudo R^2	0.092	

Note: Regressions are ordered Logit with standard errors adjusted for cluster effects at the country level. The dependent variable is self declared life satisfaction ranging from 1 ("not at all satisfied") to 4 ("very satisfied"). Year and country dummy variables are omitted for problems of space.

GRAPH 7

PROBABILITY OF DECLARING HIGH LEVELS OF LIFE SATISFACTION



Moreover, they could benefit from economic and psychological support provided by their families, which weakens the impact of unemployment.

Younger individuals are less demoralised when unemployed: they feel they have more resources, aspirations, projects and above all they think they have enough time to accomplish them. Moreover, they do not have the "social and cultural pressure" that affects older people.

People belonging to the oldest age group (over 65) may suffer less when unemployed because they see the retirement very near and therefore do not worry about future working conditions.

To sum up, the results presented in this section show that being unemployed has a strong negative effect on individual well-being. In addition, the cost of being unemployed increased in the last few decades of the 20th century.

Reasons may be found in the increasing cost of living as well as in the fact that unemployment is now more often associated with a "social stigma", which brings high psychological costs in terms of well-being.

Our results show that the cost of being unemployed in terms of life satisfaction weighs more heavily on males than on females.

We can hypothesize that men are influenced by a form of cultural and social pressure which subjects them to a stereotyped model of the successful and performing working man.

Lastly, we have shown that the individuals who suffer most are those belonging to the 42-64 age group, suggesting that, together with other factors, the difficulty of re-entering the labour market plays an important role.

This result supports the Italian proposal for a Single Contract (*contratto unico a tutela crescente)* made by Professors Tito Boeri and Pietro Garibaldi.[9]

The Single Contract proposal has been made in response to the problem of massive unemployment and to counter the duality of the labour market in Italy between temporary and permanent workers.

The proposal aims to reconcile flexibility with job protection and consists in a permanent working contract, with firing costs and employment protection increasing with job seniority.

The new contract structure could guarantee a higher degree of job protection to those workers (42-64 years old) who, according to our results, seem to suffer most when unemployed.

[9] There are several Single Contract proposals that differ in their details but have a common structure. See for example ANDRÉS J. *et* AL. (2009) for Spain and BLANCHARD O. and TIROLE J. (2003) for France.

5. - Conclusions

Research on well-being has questioned the approach to utility of standard economics and has identified two important aspects of unemployment that have traditionally not been considered with attention in the economic literature:

- unemployment is not only an underutilization of resources and does not only reflect individual decision between being employed at given wage level or being unemployed;
- the negative influence of unemployment goes beyond unemployed individuals: it also affects employed individuals, thus increasing the sense of economic insecurity.

Using the data coming from the Eurobarometer Survey for 15 European countries, we perform an analysis of the non-pecuniary costs of unemployment and find that the life satisfaction costs of being unemployed are high and increased between 1973 and 2002.

We can put forward some possible explanations for this result:

- increased living costs in Europe in the period considered;
- a "social stigma" cost that is particularly high in those countries where work defines one's own position in the society;
- the impossibility of fulfilling one's personal motivations (*e.g.* ambition, self realisation, etc).

The increasingly high social costs of unemployment in Europe in the last few years have their micro-foundation in the increasing social disease of unemployed individuals. The latter are no longer able to satisfy their social needs and therefore feel unhappier.

Another result of the analysis is that females are less distressed by unemployment. In many European countries men are still the only sources of income within the family. Moreover, men are often subject to cultural and social pressure, which impose the stereotyped model of the successful and performing working man. Being unemployed causes psychological pressure, which brings distress and gives a feeling of uneasiness and discomfort.

Lastly, the analysis shows how being unemployed weighs more heavily on people aged from 42-65, emphasizing the difficulty of re-entering the labour market, especially in countries with "weak" employment policies.

Our results support the Italian proposal for a Single Contract (made by Professors Tito Boeri and Pietro Garibaldi), which consists in a permanent working contract with firing costs and employment protection increasing with job seniority.

The recent dramatic rise in unemployment in Europe hides large cross-country differences in the way people perceive this economic "ill". However, our results show that when unemployment is associated with a high cost in terms of individual well-being, employment-generating policies may be more important than redistributive policies designed to mitigate only the income effects of unemployment exclusively.

Our results suggest also that policy makers should give renewed emphasis to active labour policies aiming to reduce long-term unemployment, including educational support, labour retraining, professional requalification and job matching programmes.

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Profile of the 2012 Winners

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The Winners of the XIII Edition (2009)

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The Winners of the XII Edition (2008)

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worked at the research centre of the Bank of Italy where she studied the effects of the expansion of higher education provision in Italy. The paper produced is part of a wide research project on "gender equality" of the Bank of Italy. Her current research instead focuses on higher education and networks' formation. She is expected to finish her Ph.D. in spring 2013.

The Winners of the XI Edition (2007)

GIULIO TARDITI (*giuliotarditi@yahoo.it*). In 2009 he concluded the Ph.D. thesis entitled "Affine Structure Hypothesis for Euribor Rates" under the supervision of Prof. Pieraccini at the Doctoral School in Economics and Quantitative Methods at the Department of Economics in "Roma Tre" University of Rome. His current scientific interests are related to econometric forecasting models, especially regarding time series with arbitrage restrictions, as with interest rates data.

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The Winners of the X Edition (2006)

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The Winners of the IX Edition (2005)

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The Winners of the VIII Edition (2004)

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The Winners of the VII Edition (2003)

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Publications 2011:

«The Effects of Social Spending on Economic Activity: Empirical Evidence from Panel of OECD Countries», with ZDZIENICKA A., *Fiscal Studies*, vol. 32(4), 2011, pages 1-25; «Exchange Rate Volatility and Macroeconomic Performance in Central and Eastern European EU Member States», with ARRATIBEL O., MARTIN R., ZDIENICKA A., *Economic Systems*, vol. 35(2), 2011, pages 261-277; «Average Tax Rates Cyclicality in OECD Countries: A Test of Three Fiscal Policy Theories», with KARRAS G., *Southern Economic Journal*, vol. 19(1), 2011, pages 1-25; «Tax Design in the OECD Countries: A Test of the Hines-Summers Hypothesis», with KARRAS G., *Eastern Economic Journal*, vol. 37(2), 2011, pages 239-247; «Assessing Long-Term Fiscal Developments: A New Approach», with AFONSO A., AGNELLO L.,

SOUSA R., *Journal of International Money and Finance*, vol. 30 (1), 2011, pages 130-146; «The Real Effects of Financial Crises in the European Transition Economies»", with ZDZIENICKA A., *Economics of Transition*, 19 (1), 2011, pages 1-25; «The Impact of Government Spending on the Private Sector: Crowding-Out versus Crowding-In Effects», with SOUSA R., *Kyklos*, vol. 64(4), 2011, pages 516-533.

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Publications (2011):

BEE M., RICCABONI M. and SCHIAVO S., «Pareto versus Lognormal: A Maximum Entropy Test», *Physical Review E*, vol. 84, no. 026104, 2011, - doi: 10.1103/PhysRevE.84.026104; BELLONE F., NESTA L., MUSSO P. and SCHIAVO S., «L'impact des contraintes financières sur les performances à l'exportation des entreprises françaises», *Economie et Statistique*, no. 435-436, 2011, pp. 65-83.

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Publications:

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Publications:

«Un'analisi sulla gestione dei rifiuti urbani nei comuni capoluogo di provincia (Waste Management in Italy: An Analysis of City-Level Data)», *Economia delle Fonti d'Energia e dell'Ambiente*, vol. 52, no. 1, 2009, pages 161-180.

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Publications 2010:

BALDASSARRE G., MIROLLI M., «What Are the Key Open Challenges for Understanding the Autonomous Cumulative Learning of Skills?», *The Newsletters of the Autonomous Mental Development Technical Committee* (IEEE CIS AMD Newsletters), vol. 7 (1), 2010, page 11; BALDASSARRE G., MIROLLI M., «Reply and Summary: On the Open Challenges for Understanding Cumulative Learning», *The Newsletters of the Autonomous Mental Development Technical Committee* (IEEE CIS AMD Newsletters), vol. 7 (2), 2010, pages 8-9; CALIGIORE D., MIROLLI M., PARISI D., BALDASSARRE G., «A Bioinspired Hierarchical Reinforcement Learning Architecture for Modeling Learning of Multiple Skills with Continuous State and Actions», in JOHANSSON B., SAHIN E., BALKENIUS C. (eds.), *Proceedings of the Tenth International Conference on Epigenetic Robotics (EpiRob2010)*, Lund University Cognitive Studies, no. 149, 2010, pages 27-34; CALIGIORE D., GUGLIELMELLI E., PARISI D., BALDASSARRE G., «A Reinforcement Learning Model of Reaching Integrating Kinematic and Dynamic Control in a Simulated Arm Robot», in KUIPERS B., SHULTZ T., STOYTCHEN V.A., YU C. (eds.), *IEEE International Conference on Development and Learning* (ICDL2010), Piscataway, NJ, IEEE, 2010, pages 211-218; CALIGIORE D., BORGHI A., PARISI D., BALDASSARRE G., «TRoPICALS: A Computational Embodied Neuroscience Model of Compatibility Effects», *Psycological Review*, vol. 117, issue 4, 2010, pages 1188-1228; CHERSI F., MIROLLI M., GURNEY K., REDGRAVE P., BALDASSARRE G., *Goal-Directed Motor Sequence Learning Based on Multiple Basal Ganglia-Cortical Loops*, Soc. Neurosci. Abs., 380, Abstract at the 40th Annual Meeting of the Society for Neuroscience (Neuroscience 2010), San Diego, US, 13-17 November 2010; FIORE V.G., MANNELLA F., MIROLLI M., CABIB S., PUGLISI-ALLEGRA S., BALDASSARRE G., *A Computational Model of Dopamine and Norepinephrine Dynamics in Rats Exposed to Prolonged, Inescapable Stress*, Abstract at the 40th Annual Meeting of the Society for Neuroscience (Neuroscience 2010), San Diego, US, 13-17 November 2010; MANNELLA F., MIROLLI M., BALDASSARRE G., «The Interplay of Pavlovian and Instrumental Processes in Devaluation Experiments: A Computational Embodied Neuroscience Model Tested with a Simulated Rat», in TOSH C., RUXTON G. (eds.), *Modelling Perception With Artificial Neural Net-*

works, Cambridge University Press, 2010, pages 93-113; Mirolli M., Mannella F., Baldassarre G., «The Roles of the Amygdala in the Affective Regulation of Body, Brain and Behaviour», in Ziemke T., Low R. (eds.), *Connection Science*, Special Issue, vol. 22(3), 2010, pages 215-245; Ognibene D., Pezzullo G., Baldassarre G., «How Can Bottom-Up Information Shape Learning of Top-Down Attention-Control Skills?», in Kuipers B., Shultz T., Stoytchev A., Yu C. (eds.), *IEEE International Conference on Development and Learning* (ICDL2010), Piscataway, NJ, IEEE, 2010, pages 231-237; Ognibene D., Pezzullo G., Baldassarre G., «Learning to Look in Different Enviroments: An Active-Vision Model which Learns and Readapts Visual Routines», in Doncieux S., Girard B., Guillot A., Hallam J., Meyer J.-A., Mouret J.-B. (eds.), *From Animals to Animats 11* - Proceedings of the 11th International Conference on Simulation of Adaptive Behavior (SAB 2010), 2010; Santucci V.G., Baldassarre G., Mirolli M., «Biological Cumulative Learning Through Intrinsic Motivations: A Simulated Robotic Study on Development of Visually-Guided Reaching», in Johansson B., Sahin E., Balkenius C. (eds.), *Proceedings of the Tenth International Conference on Epigenetic Robotics (EpiRob2010)*, Lund University Cognitive Studies, 2010, pages 121-128.

Stefano D'Ambrosio (*dambrosios@27 degrees.co.uk*) has been working since the year 1999 in the company "Europe Economics", an economic consultancy based in London where he reached the position of Principle in 2006. Stefano has an extensive experience in the telecoms sector and in particular of cost modelling, access pricing, universal service obligation and regulatory accounting. He is now based in Geneva, and since 2007 he is a freelancer specializing in the field of economic regulation telecommunications, in particular deals with the verification of the records regulatory and development of cost models of fixed and mobile operators with significant market power in Europe.

Luca Flabbi (*lf74@georgetown.edu*) is Assistant Professor in the Department of Economics at Georgetown University in Washington, DC. He is a labor economist and applied econometrician working on labor market dynamics, bargaining, gender discrimination, inequality and schooling. Recent publications include: «Gender Discrimination Estimation in a Search Model with Matching and Bargaining», *International Economic Review*, vol. 51(3), 2011, pages 745-783; «The Effect of Job Flexibility on Women Labor Market Outcomes Estimates from a Search and Bargaining Model», *Journal of Econometrics,* 2011 (con A. Moro).

Anita Guelfi (*aguelfi@luiss.it*) starting from January 2009 Anita is also a Ph.D. student in History and Theory of Economic Development at the "LUISS Guido Carli" University in Rome.

Paola Rampone (*prampone@kpmg.it*) during 2011 has been continuing the experience in KPMG Advisory with the role of manager. In 2011 she contributed to a project devoted to the implementation of the information system for a major automotive corporation in North America.

Michele Trova (*michele.trova@venetobanca.it*), along the year 2011, consolidated his activity in the field of pricing of structured financial products and the parameterization of the front office systems currently in use by the Financial Department of Veneto Banca S.C.p.A., where he acted as Head of the Analysis & Financial Controlling unit. He has been appointed to study the implementation of the ALMO activity at the banking group level. He continued his research activity at the University of Venice where he has been confirmed instructor for the course of Investments at the IMEF Master and professor of Economics and Econometrics of the International Finance.

The Awarding Ceremony of the 2012 «Angelo Costa» Prize Winners

Prof. John Vickers congratulates Maddalena Cavicchioli.

Prof. Massimo Egidi, Rector of "LUISS Guido Carli" University of Rome, congratulates Francesca Brusa.

Emma Marcegaglia, President of "LUISS Guido Carli" University of Rome, congratulates Giorgio Chiovelli.

Dr. Angelo Costa congratulates Marco Giovanni Nieddu.

Our Referees for the Year 2010 - 2011

The papers submitted for publication in the Rivista di Politica Economica are evaluated by two anonymous referees who do not know the identity of the authors. The role of these experts is fundamental to ensure the quality of the papers that will then be published in the journal.
Our particular thanks go to all the referees who – in a cooperative spirit – helped us selecting the works submitted to the editorial office of the Rivista di Politica Economica in the year 2009:

Alessandro Acquisti
Gian Luigi Albano
Torben M. Andersen
Mario Anolli
Cristiano Antonelli
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Andrea Presbitero
Giovanni Putrella
Salvatore Rizziello
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Michele Ruta
Gilberto Turati
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2012 ANNUAL INDEX

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KEY WORDS

BOOKS REVIEWS

RIVISTA DI POLITICA ECONOMICA

CONFINDUSTRIA

ANNOUNCEMENT OF THE 2013

Economics Undergraduate Theses Prize «Angelo Costa»

XVIth Edition

1 *Rivista di Politica Economica* (*RPE*) announces the XVIth competition for the publication of the five most deserving papers taken from undergraduate theses in Economics (two-year M.Sc.) by students graduated in an Italian university. The Prize consists in the publication of the winning papers in the October-December 2013 issue of *RPE*, which will be published in English.

The initiative has two targets:

- to renew the commitment to make promising Italian graduates in Economics known, awarding them with the publication of their paper so as to encourage the continuation of their studies and their chances of admission to Master and/or Ph.D. programs;
- to promote the publication of excellent studies which too often remain as mimeos and cannot be appreciated by a larger audience.

2 The *RPE* editorial board will evaluate all papers taken from undergraduate theses in Economics defended by students graduated in an Italian university between May 1st, 2010 and October 30th, 2012 to be delivered to the editorial board within the deadline of January 10th, 2013. The papers presented must be independent and self-sufficient with respect to the theses they are taken from and they shall in no way exceed a length of 30 pages (of 30 lines each) plus tables, graphs and appendix for a maximum of 10 additional pages. The papers submitted in the previous editions of the Prize will not be accepted.

3 The candidate shall send an e-mail with the following statements:

a) the candidate's surname, name, place and date of birth and contact details for notifications about the Prize, as well as the name of the advisor for the thesis;

b) a declaration that the paper has not been published and will not be submitted and/or published in any other scientific journal unless *RPE* rejects it;

The candidate shall enclose the following documents:

(i) the candidate's degree certification (two-year M.Sc.) indicating final grade and title of the thesis;

(ii) two pdf copies of the paper in English of length as specified at point 2), of which:

– one copy of the paper indicating candidate's name on the front page and an up-to-100-words length abstract;

– one copy of the paper including the abstract but without any reference to the candidate's name or data.

It is recommended that the English version be checked by a mother-tongue speaker. Bibliographic references shall be detailed and shall only refer to the works mentioned in the paper.

The documents must be sent by mail at the address: *rpe@confindustria.it* within January 10th, 2013.

4 The Editorial Board of the Prize is composed by:

Dr. Marcella Panucci
Director General of Confindustria and Editor of RPE;
Dr. Luca Paolazzi
Director of Confindustria Research Department;
Prof. Gustavo Piga
Managing Editor of RPE.

The Editorial Board of the Prize will evaluate the papers sent and the selected papers will then be submitted to an Italian referee expert in the subject dealt with in the paper. The 10/15 works rating the highest marks will be evaluated by the Members of the International Scientific Committee whose task is to choose the five final winners whose papers deserve publication.

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Prof. Stephen A. Ross	*(Massachusetts Institute of Technology)*
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Prof. Jean Tirole	*(Université des Sciences Sociales de Toulouse)*

5 The winners will receive the anonymous Italian and international referee reports on their papers by June 30th, 2013. The authors will then prepare a final version to be delivered for publication within a month, which takes into account the referees' comments. The *RPE* retains the right not to publish a paper that has not satisfied the referees' requests of amendments. Any reproduction of the winning papers or of basic parts of them is forbidden without prior consent by the *RPE* Editorial Board.

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The first page of the paper submitted for publication must include: full title; name of the authors which shall appear in alphabetical order and their affiliation. The email of each author shall appear in a footnote in the first page. Apart, the indication of the author who will be responsible for correspondence and correcting of proofs shall be provided to the editorial office together with full address, telephone and fax numbers of all the authors. Acknowledgements should appear in a footnote of the first page and it is good practice to thank the anonymous referees of Rivista di Politica Economica and quote the usual disclaimer.

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RIVISTA DI POLITICA ECONOMICA

Founded in 1911

The journal Rivista di Politica Economica – quarterly since the year 2009 – was founded in 1911 as «Rivista delle Società Commerciali» and assumed its present name in January 1921. It is one of the oldest Italian publications in Economics offering its pages to analyses and research studies of various schools of thought. The papers published in the journal are quoted in Econlit, e-JEL, JEL ON-CD, in the International Bibliography of the Social Sciences and in RePEC at: http://econpapers.repec.org/article/rporipoec/.

The journal publishes two ordinary issues with papers in Italian or English; one monographic issue and the special issue dedicated to the «Angelo Costa» Lecture and to the winning papers of the Undergraduate Economics Theses Prize.

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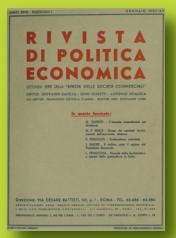

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