Essays in Welfare Growth and the Gender Wage Gap

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Abstract

Στην διατριβή εξετάζονται τρία ξεχωριστά θέματα: το μισθολογικό χάσμα μεταξύ ανδρών και γυναικών στην Ευρωπαϊκή Ένωση, οι παράγοντες που επηρεάζουν τον διορθωμένο ως προς την ευημερία δείκτη του ακαθάριστου εγχώριου προϊόντος, και οι παράγοντες που επηρεάζουν την υγεία, όπως αυτή αντικατοπτρίζεται στην προσδοκώμενη διάρκεια ζωής στη γέννηση χρησιμοποιώντας την μπεϋζιανή οικονομετρική μεθοδολογία. Το πρώτο κεφάλαιο περιλαμβάνει μια συνοπτική ανασκόπηση των αποτελεσμάτων που προέκυψαν από την εξέταση των τριών θεμάτων.

Στο δεύτερο κεφάλαιο εξετάζεται το μισθολογικό χάσμα ανδρών και γυναικών που παρατηρείται σε εικοσιτέσσερις χώρες μέλη της Ευρωπαϊκής Ένωσης (ΕΕ). Με βάση τα αποτελέσματα καταλήγουμε στο συμπέρασμα ότι το μέγεθος του μισθολογικού χάσματος διαφέρει σημαντικά μεταξύ χωρών. Το μεγαλύτερο μέρος του χάσματος δεν μπορεί να εξηγηθεί από τα μετρήσιμα χαρακτηριστικά των ατόμων στο δείγμα. Στην συνέχεια εξετάζεται η ύπαρξη των φαινομένων της "γυάλινης οροφής" και "κολλώδους πατώματος" στις χώρες της ΕΕ. Παρατηρούμε ότι το φαινόμενο της "γυάλινης οροφής" παρουσιάζεται στην πλειοψηφία των χωρών της ΕΕ σε αντίθεση με το φαινόμενο του "κολλώδους πατώματος" που παρουσιάζεται σε ένα μικρό αριθμό χωρών. Ακολούθως, εξετάζεται αν το μέρος του μισθολογικού χάσματος που δεν μπορεί να εξηγηθεί από μετρήσιμα χαρακτηριστικά συσχετίζεται με πολιτικές που εφαρμόζονται στις χώρες της ΕΕ. Συμπεραίνουμε ότι πολιτικές που έχουν ως σκοπό να συμφιλιώσουν την εργασία και την προσωπική ζωή των ατόμων και οι πολιτικές που σχετίζονται με το σχηματισμό των μισθών σε κάθε χώρα παρουσιάζουν αρνητική σχέση με το μισθολογικό χάσμα.

Στο τρίτο κεφάλαιο συγκρίνεται η επίδραση που έχουν ένας αριθμός μεταβλητών στο "διορθωμένο" ως προς την ευημερία δείκτη του ακαθάριστου εγχώριου προϊόντος (ΑΕΠ) κάθε χώρας χρησιμοποιώντας την μεταβλητή που εισηγήθηκαν οι Becker, Philipson and Soares (2005). Στην μεταβλητή αυτή λαμβάνεται υπόψη η βελτίωση στην ευημερία κάθε χώρας όπως αυτή αντικατοπτρίζεται στην βελτίωση που παρατηρήθηκε στην προσδοκώμενη διάρκεια ζωής

στη γέννηση κάθε ατόμου σε μεγάλο αριθμό χωρών. Σκοπός του κεφαλαίου είναι να εντοπιστούν παράγοντες που επηρεάζουν με διαφορετικό τρόπο το δείκτη του ΑΕΠ και του "διορθωμένου" δείκτη του ΑΕΠ. Βρίσκουμε ότι η εκπαίδευση και οι θεσμοί κάθε χώρας διαδραματίζουν μεγαλύτερο ρόλο στον καθορισμό του "διορθωμένου" δείκτη του ΑΕΠ. Επιπλέον παρατηρούμε χώρες με χαμηλό εισόδημα παρουσίασαν μεγαλύτερο ρυθμό σύγκλισης σε χώρες με ψηλότερα εισοδήματα αν λάβουμε υπόψη τον ρυθμό αύξησης του "διορθωμένου" δείκτη του ΑΕΠ.

Στο τελευταίο κεφάλαιο εξετάζονται οι παράγοντες που επηρεάζουν την υγεία σε κάθε χώρα όπως αυτή αντικατοπτρίζεται στην προσδοκώμενη διάρκεια ζωής στη γέννηση (μακροβιότητα) χρησιμοποιώντας μια Μπεϋζιανή οικονομετρική μεθοδολογία. Οι μεταβλητές που χρησιμοποιούνται ως παράγοντες που πιθανώς να επηρεάζουν την μακροβιότητα των ατόμων κάθε χώρας είναι το επίπεδο του συστήματος υγείας, οι θεσμοί, η γεωγραφική θέση, η θρησκεία κτλ. Συμπερασματικά, καταλήξαμε στο αποτέλεσμα ότι η διατροφή του πληθυσμού και η ποιότητα του συστήματος υγείας κάθε χώρας είναι σημαντικοί παράγοντες που επηρεάζουν την μακροβιότητα του πληθυσμού. Επιπλέον εξετάζεται η σχέση του κατά κεφαλή εισοδήματος κάθε χώρας και του μέσου όρου ζωής του πληθυσμού λαμβάνοντας υπόψη την πιθανή ενδογένεια της σχέσης αυτής. Τα αποτελέσματα παρουσιάζουν ότι χώρες με ψηλότερο μέσο όρο ζωής έχουν μεγαλύτερο κατά κεφαλή εισόδημα.

Three different issues are examined in the thesis: the gender wage gap across the European Union (EU) member states; the determinants of a welfare “corrected” gross domestic product (GDP) and the determinants of health as they are captured by life expectancy at birth using the Bayesian Model Averaging Methodology. The first chapter includes a summary of the results that we get from the study of the above issues.

The second chapter describes our attempt to understand the gender wage gap across twenty-four EU member states. We found that the size of the gender wage gap varies considerably across countries. Most of the gap cannot be explained by the characteristics available in this data set. Next, we examine the presence of the “glass ceilings” and “sticky floors” effects. Our results showed that in most countries “glass ceilings” effect are present and “sticky floors” effects are found in a small number of countries. Moreover, we examine if the unexplained part of wage gap is related to features are related to country-specific policies and institutions across EU countries and we reached to the conclusion that policies and institutions are systematically inversely related to unexplained gender wage gaps.

In the third chapter we explore the effect of different determinants of a welfare corrected measure of income growth. In order to achieve that we use the measure proposed by Becker, Philipson, and Soares (2005) that takes into account health improvements as they are captured by life expectancy. When we compare the determinants of economic growth, we found that education and institutions have a greater effect on welfare growth compared to their impact on economic growth. Also, initial income has a greater impact on welfare growth than on real income per capita growth, implying even faster convergence than in Becker, Philipson, and Soares (2005).

The last chapter evaluates the determinants of life expectancy considering a large number of economic theories using the Bayesian Model Averaging methodology. The theories examined are health related inputs, health risk factors, institutions, religion etc. Health institutions and average nutrition are the most significant determinants of life expectancy. Both factors have a positive effect over life expectancy. Also, countries with lower life expectancy in 1960 exhibited larger increases in life expectancy. We also explore the relationship between average life expectancy and income, correcting for endogeneity, using a Bayesian Model Averaging instrumental variable approach. We find evidence of a positive and significant effect of life expectancy on income.

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Chapter 1

Introduction

In the second chapter we consider and attempt to understand the gender wage gap across 24 EU member states, all of which share the objective of gender equality, using 2007 data from the European Union Statistics on Income and Living Conditions. The size of the gender wage gap varies considerably across countries and selection corrections affect the offered gap, sometimes substantially. Most of the gap cannot be explained by the characteristics available in this data set. Quantile regressions show that, in most countries, the wage gap is wider at the top of the wage distribution ('glass ceilings') and, in fewer countries, it is wider at the bottom of the wage distribution ('sticky floors'). These features are related to country-specific characteristics that cannot be evaluated at the member state level. We use the cross-country variation in this large sample of member states to explore the influence of (i) policies concerned with reconciling work and family life and (ii) wage-setting institutions. We find that policies and institutions are systematically related to unexplained gender wage gaps.

In the third chapter we compare the determinants of economic growth and welfare growth. Our main result is that determinants may differ or have different impact on welfare outcomes as compared to economic outcomes. Human capital plays a bigger role in determining the former, so that policies targeting human capital can have a greater effect on the welfare of societies than one would think by looking at their impact on economic growth alone. Institutions also have a greater effect on welfare growth compared to their impact on economic growth, consistent with the importance of government stability for the uninterrupted provision of health-related inputs and information. Finally, initial income has a greater impact on welfare growth than on real income per capita growth, implying even faster convergence than in Becker, Philipson, and Soares (2005) after adding a number of economic, health-related, institutions-related, and geographic variables. We conclude that there exist systematic differences for the impact of a number of factors on economic relative to welfare outcomes.

In the fourth chapter we attempt to examine the determinants of life expectancy considering a large number of economic theories using the Bayesian Model Averaging methodology. The theories examined are health related inputs, health risk factors, neoclassical/Solow variables, institutions, fractionalization, religion and regional heterogeneity. We also examine the effect of these large number of theories on income growth rate. Our findings show that health inputs matter for life expectancy in 2005 and life expectancy growth rate from 1960 to 2005. We find that health institutions and average nutrition have a positive effect over these health outcomes. Furthermore, we find that countries with lower life expectancy in 1960 exhibited larger increases in life expectancy. These effects are robust in the use of different prior structures. The analysis of the determinants of income growth show that health variables affect income. Finally, we control for endogeneity using a Bayesian Model Averaging instrumental variable approach we find evidence of a positive and significant effect of of life expectancy on income. Our work serve as the basis for further examination of the relationship between life expectancy and its determinants as well as the relationship between income and average life expectancy.

Chapter 2

The Gender Wage Gaps, 'Sticky Floors' and 'Glass Ceilings' of the European Union

2.1 Introduction

The reduction of labour market gender disparities has attracted considerable political and legislative attention in the European Union. Two different directives, the Racial Equality Directive and the Employment Framework Directive, define a set of principles that offer legal protection against discrimination. The EU Employment Guidelines, 2003/58/EC of July 22, 2003, indicate that "Member States will, through an integrated approach combining gender mainstreaming and specific policy actions, encourage female labour market participation and achieve a substantial reduction in gender gaps in employment rates, unemployment rates and pay by 2010". In this chapter we examine the gender pay gap across the EU countries, all of which share the principles referred to above.

While a number of important studies have addressed some of these issues for some EU countries (see, inter alia, Arulamplam et al. (2006), Olivetti and Petrongolo (2008), and Nicodemo (2009)), this chapter focuses on the unexplained gaps, 'sticky floors' and 'glass ceilings' that can be discerned in all member states (MSs) and attempts to relate them to country-specific wage-setting institutions and to policies that reconcile work and family life. In order to do this effectively, it is necessary to use the maximum number of MSs available so as to achieve the maximum variability in institutional and policy settings. The 2007 EU Statistics on Income and Living Conditions (EU-SILC) dataset includes information on 24 of the 2007 MSs (all except Malta). This information is available on a consistent basis across MSs, thereby making it possible to implement a common protocol to measure the various gaps. We explore the degree of success of the conditioning set of common variables available in explaining the MS wage gaps, using the benchmark Oaxaca and Ransom (1994) decomposition, with and without Heckman (1979, 1974b) corrections. The methodology of Olivetti and Petrongolo (2008) is also used to explore the impact of differential employment rates on the observed wage distributions and some noteworthy differences between the corrected wage gaps and those that emerge through the Heckman (1979, 1974b) corrections are discerned. The variation in the gender-wage gap across the wage distribution is examined using quantile regression analysis, following the methodology proposed by Melly (2005). This allows us to search for possible 'sticky floor' and 'glass ceiling' effects - see Albrecht et al (2003). With these gaps and effects established on a consistent basis across the 24 MSs, we consider the extent to which they are related to various country features. The OECD (2001) work-family reconciliation index, initially covering 14 EU and OECD countries, is recreated for the 24 EU countries in our sample and is used, along with the unionization rate, to examine the relationship between gaps and effects on the one hand and country features on the other. We find that the gender wage gap is positive and significant in all 24 EU MSs. Consistent with Nicodemo (2009), Arulamplam et al. (2006), and other studies, the bulk of the observed wage differences cannot be explained by observed characteristics. When the Heckman (1979, 1974b)corrections are carried out, wage gaps are still positive and significant in almost all countries. When the different imputation methodologies proposed by Olivetti and Petrongolo (2008) are used to correct for the possible sample selection created by divergent patterns of non-employment across countries, the median wage gap increases substantially for almost all countries. The quantile-based wage decompositions reveal the presence of 'glass ceiling' effects in the majority of countries and 'sticky floor' effects in a significant number of countries. Looking across the 24 MSs, the general unexplained part of the wage gap, as well as the glass ceiling and sticky floor effects appear to be systematically related to features of MS work-family reconciliation policies and their wage-setting institutions.

The objective in this literature has largely been to ensure that gender-specific features of wage distributions, especially among countries that share and promote the objective of gender equality, cannot be attributed to unobservable characteristics and that unexplained effects relate truly to female disadvantage. In single-country explorations, country-specific policies must remain an unobservable, captured only by intercept differences among gender-specific wage equations. Some hope of narrowing down the unexplained effects exists when several country experiences can be compared. This likelihood is clearly enhanced when the number of countries studied is increased. Yet, international explorations run the risk of muddling possible gender disadvantage with data consistency problems and country differences in institutions and policies. By focusing on a set of countries with similar values[1] and the same data, we hope to contribute to this important area.

[1] It is conceivable that gender policies and attitudes may not be homogeneous across all MSs. For instance, the countries joining on May 1, 2004 may have not adjusted fully. Also, countries in the former USSR may have a different set of values and practices. We comment on these issues below.

Section 2.2 notes briefly the literature that also follows a broad sweep across countries and provides background information on the gender wage gap in the EU. Section 2.3 describes the EU-SILC data and Section 2.4 the econometric methodology used and the results obtained. Section 2.5 considers the work-family reconciliation index and unionization rates and their relation to the wage gap. Section 2.6 concludes.

2.2 The gender wage gap in the EU: A brief survey of the literature

The literature on the gender gap is, of course, enormous. A number of papers adopt a cross-country perspective. Plantenga and Remery (2006) examine, for the European Commission, the unconditional gender wage gap for 24 EU states (except Malta) plus Iceland, Liechtenstein and Norway and survey policies that aim to reduce this gap. Rubery (2002), examines these policies and targets, concludes that concrete objectives and time frames are needed. Brainerd (2000) examines the gender wage gap in ex USSR MSs, while Newell and Reilly (2001) note that the gap in east European countries has not exhibited an upward trend during the transition. Weichselbaumer and Winter-Ebmer (2005), based on a meta-analysis of international gender wage gaps, conclude that between the 1960s and the 1990s unconditional differentials fell. They attributed this to the improved education and training for women. Blau and Kahn (1996), using the Juhn et al. (1991) decomposition, show that eight European countries have a lower gender gap than the US and attribute this to higher female wages in Europe for low earners. Blau and Kahn (2003) argue that institutional settings affect the gender wage gap.

Olivetti and Petrongolo (2008) examine the non-randomness of selection into work and how this might affect international comparisons of gender wage gaps. They estimate median wage gaps in a sample of employed workers and also in a sample enlarged with the non-employed - for whom wages were imputed. They find that, for most countries, the median wage gaps in imputed wage distributions are higher than those in the actual wage distributions, suggesting that in those countries female high earners are overrepresented in the workforce. They find a negative correlation between the gender wage gap and gender employment gap, thus resolving the paradox that countries, such as Greece, have a lower wage gap than Anglo-Saxon countries.

Nicodemo (2009) examines the extent of the wage gap in a sample of five Mediterranean EU countries (France, Greece, Italy, Portugal and Spain) in 2001 and 2006, using the EU-SILC and the European Community Household Panel Survey (ECHPS) datasets. She finds a positive wage gap in all countries, in both time periods, the greater part of which cannot be explained by observed characteristics. The gender gap is larger at the bottom of the distribution and smaller at the top of the distribution in most countries in 2006.

Arulamplam et al. (2006) examine the gender wage gap in 11 European countries using the ECHPS for the years 1995-2001. The gap widens toward the top of the wage distribution in most of countries and, in a few cases, it also widens at the bottom of the distribution. The authors use the OECD (2001) work-family reconciliation index to examine the possible factors that affect the extent of the wage gap. They conclude that differences in family and work reconciliation policies and wage setting institutions (proxied by union membership rates) across EU countries may account for the variation in the wage gap. Child care provision is an important factor that affects the decision of women to enter the labour market. Viitanen (2005), examining UK data, finds that the price of childcare has a significant, negative, effect on the probability of working as well as on using formal childcare. Boca and Vuri (2007), using data for Italy, find that policies that reduce the cost of child care and expand the child care system can have a positive impact on female employment. Gustafsson and Stafford (1992) find that the high quality of public child care in Sweden encourages women with small children to enter paid employment.

Despite the wealth of information and methodologies contained in these studies, a gap remains. No study has investigated the conditional gap across a large number of countries, that share similar declared policies, and examined the extent to which the unexplained gender gap may be related to country-specific policies and institutions.

2.3 Data

The data used for the econometric analysis, available since 2004, is the 2007 EU-SILC prepared by the statistical services of MSs on behalf of Eurostat. EU-SILC collects comparable cross sectional data on income, poverty, and social exclusion. Information is available for all EU countries except Malta; Norway and Iceland are also included but these countries are excluded from our EU sample.

The EU-SILC data set reports a wealth of information on the personal characteristics of each individual. These include age, education, marital status, number of children, and child care details. Also, it reports information on working status, whether an individual was working full time or part time, the industry of employment and his or her occupation and years of working experience (not available for all countries). In addition, information on annual earnings (the variable analyzed here) is available - we use the terms earnings and wages interchangeably.

Beginning with the original-data base sample, in the working sample we include individuals who (i) are aged between 25 and 54, (ii) work as employees (employers and the self-employed are excluded), (iii) work full time (students and the handicapped are excluded) for the whole of the previous year, worked at least one hour during the week prior to the interview and do not have a second job, and (iv) received an annual wage larger than €1000. These restrictions bypass complications involving further education, preparation for retirement, part-time status and the truthful reporting of incomes and they produce a more homogeneous sample. In our main results, age is used as a proxy for experience. However, some direct-experience information is also available for all countries except Denmark, Finland, Greece, Hungary, Sweden, and the UK. Experience is reported for all individuals in Cyprus, the Czech Republic and Italy. For other countries apart from Slovenia, the number of observations lost is very small. It varies from 0.08% (1 individual) for the female Estonian sample, to 2.24% (24 individuals) for the Irish male sample. In Slovenia, if we exclude individuals who do not report their experience, the male sample decreases by 63.32% and the female sample by 63.5%. Table 2.4.1 in Appendix A provides further details.

Table 2.1 presents the average unconditional ln-annual earnings and the employment rate[2], by gender, for each country. The wage gap is defined as the difference between the male and female average ln-wage earnings. The highest male and female earnings are received in Denmark and Luxembourg, while the lowest are received in Latvia and the Slovak Republic. The highest differences between male and female earnings are observed in Cyprus and Estonia, with 0.502 and 0.423 ln-earning units, respectively, while the lowest differences are observed in Slovenia and Hungary, with 0.087 and 0.100 ln-earning units respectively. The highest male employment rates are observed in Denmark and Cyprus (95% and 94%, respectively) and the lowest male employment rates in Finland and Poland (81% and 80% respectively). The highest female employment rates are observed in the Slovak Republic and Estonia (83% and 80%, respectively) while the lowest employment rates are observed in The Netherlands and Greece (30% and 41%, respectively). Figure 2.2 presents the wage gap by country. The countries with the highest gender wage gap are new MSs (Cyprus, Estonia, the Czech Republic, Latvia, Lithuania and the Slovak Republic). The lowest gender wage gap is observed in Slovenia and Hungary. Thus, of the nine new MSs in the sample, six have the highest and two the lowest unconditional gender wage gaps, with Poland being closer to the middle of the pack. The Scandinavian countries in the sample (Denmark, Finland and Sweden) have middling gender gaps, while Greece, Italy and Spain have relatively low gaps - a fact that motivated the Olivetti and Petrongolo (2008) study. The average gender wage gap across the EU24 is 0.381 ln-wage points and the average employment gap is 27%.

The unconditional correlation between the gender earnings and employment gap is negative though it is quite weak and not statistically significant[3]. Olivetti and Petrongolo (2008),

[2]The 'employment' rate is calculated as the number of individuals included in the working sample over the number of individuals in the base sample.

[3]The correlation is -0.23. The estimated coefficient from the regression of the gender wage gap on the gender employment gap is -0.015 and the associated p-value for the hypothesis that the regression coefficient is equal

Table 2.1: Ln-earnings and employment rate by country

	Ln-earnings				Employment Rate (%)			
	Male	Female	Difference	Rank	Male	Female	Difference	Rank
Austria	10.381	10.156	0.225	10	92	55	37	8
Belgium	10.474	10.347	0.127	21	88	54	34	9
Cyprus	10.067	9.564	0.502	1	94	64	30	10
Czech Republic	9.056	8.732	0.323	3	94	72	21	13
Denmark	10.854	10.657	0.198	13	95	76	20	16
Estonia	8.918	8.495	0.423	2	90	80	10	20
Finland	10.514	10.269	0.245	8	80	61	19	17
France	10.233	10.031	0.202	11	91	70	21	14
Germany	10.507	10.311	0.196	14	89	50	39	6
Greece	9.900	9.714	0.186	15	88	41	46	2
Hungary	8.677	8.576	0.100	23	85	68	17	18
Ireland	10.698	10.462	0.236	9	84	46	38	7
Italy	10.156	9.991	0.164	19	84	42	42	3
Latvia	8.616	8.311	0.305	4	85	75	10	21
Lithuania	8.687	8.400	0.286	5	86	80	6	24
Luxembourg	10.672	10.496	0.176	18	92	51	41	4
Netherlands, The	10.613	10.434	0.178	17	94	30	64	1
Poland	8.801	8.619	0.181	16	81	56	25	12
Portugal	9.401	9.279	0.122	22	87	67	20	15
Slovak Republic	8.646	8.378	0.268	6	91	82	8	23
Slovenia	9.598	9.512	0.087	24	88	79	9	22
Spain	9.897	9.744	0.153	20	88	48	40	5
Sweden	10.352	10.155	0.198	12	91	77	14	19
United Kingdom	10.672	10.419	0.253	7	93	67	26	11

using a different set of countries and data, also found a negative correlation coefficient between the two measures[4]. They attach importance to this correlation because they believe that the low gender wage gap in countries such as Greece and Italy is indicative of positive selection into the working sample, suggesting that the observed wage gap in these countries is not representative.

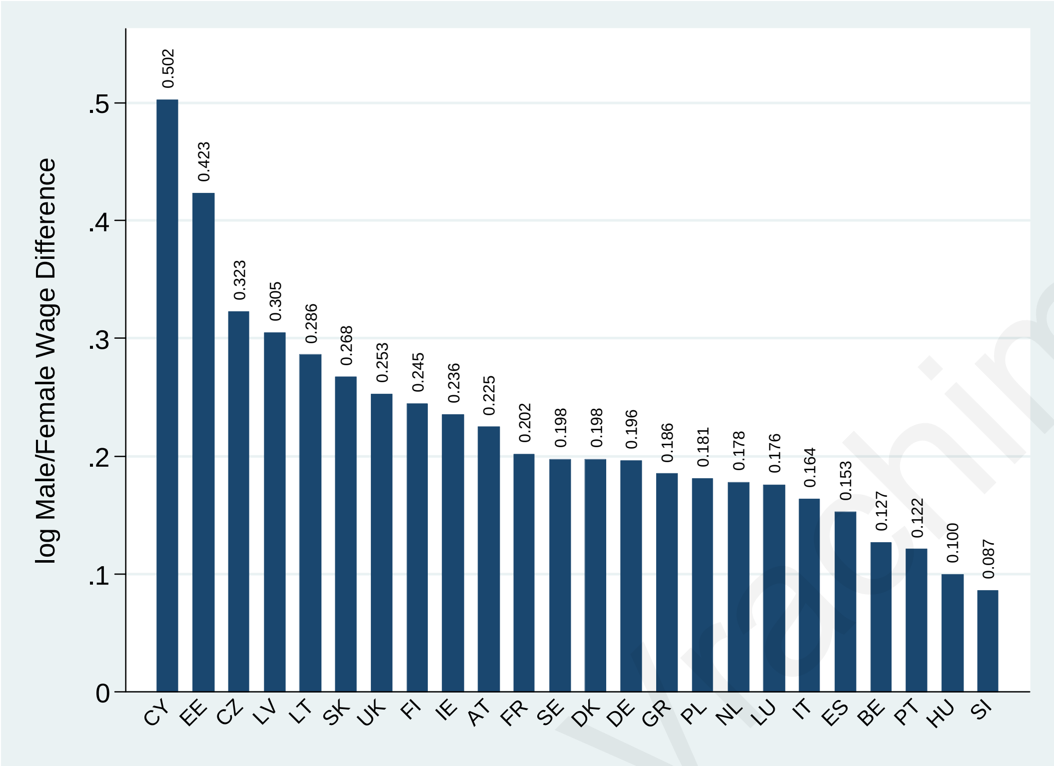
2.4 Econometric Model

All analysis is conducted separately for each gender. We begin by estimating Ordinary Least Squares (OLS) ln-earnings equations which take account of all relevant characteristics avail-

to zero is 0.15.

[4]The database used was the ECHPS and the Michigan Panel Study of Income Dynamics (PSID). The countries included were Austria, Belgium, Denmark, Ireland, Italy, Finland, France, Germany, Greece, The Netherlands, Portugal, Spain, United Kingdom and the United States. The correlation coefficient in the Olivetti and Petrongolo (2008) dataset was -0.474.

Figure 2.1: Relative wage gap in European countries



able in the EU-SILC data. When the Heckman (1974b, 1979) corrections are implemented in the context of the Probit model, we use additional variables which account for membership in the selected sample. Given this information and following Oaxaca and Ransom (1994), we proceed to decompose the mean difference between the male and female earnings into a portion attributable to characteristics and portions attributable to the 'male advantage' and the 'female disadvantage'. In a second set of decompositions and following Melly (2005), we consider decompositions along the entire wage distribution, not just at the mean, allowing us to establish possible 'sticky floors' and 'glass ceilings'. Following Olivetti and Petrongolo (2008), we impute wages for the observations in the base sample that were not included in the working sample and consider the median wage gap and its relation to employment rates[5]. In Section 2.5, various gaps are examined under the prism of the work-family and wage setting institutions in the 24 MSs.

2.4.1 The Oaxaca-Ransom decompositions

The Oaxaca and Ransom (1994) decomposition is given by:

[5]Kunze (2005) summarizes the major econometric methodologies used in the literature.

$$\bar{W}^M - \bar{W}^F = (\bar{X}^M - \bar{X}^F)\hat{\beta}_N + \bar{X}^M(\hat{\beta}^M - \hat{\beta}^N) + \bar{X}^F(\hat{\beta}^N - \hat{\beta}^F) \tag{2.1}$$

where $\bar{W}^M$ and $\bar{W}^F$ are the average values of ln earnings for males and females, $\bar{X}^M$ and $\bar{X}^F$ are vectors with the average characteristics for the two genders and $\hat{\beta}^M$ and $\hat{\beta}^F$ are the OLS estimates of relevant coefficients. $\hat{\beta}^N$ is a non-discriminatory coefficient structure obtained from the pooled regression of males and females. The first term in Eq. (2.1) measures the explained part, the second the male advantage (i.e., the extent to which the male characteristics are valued above the non-discriminatory coefficient structure) and the third the female disadvantage (i.e., the extent to which the female characteristics are valued below the non-discriminatory coefficient structure). Only the earnings of the individuals who are working are observed and, as a result, the sample may not be random. To deal with this selection problem, we use the Heckman (1974a,b) model.

Table 2.2 provides the decomposition results with age used as a proxy for experience. In Eq. (2.1), the actual value of experience is used instead of age in a sample where this information in available. In both tables, the set of explanatory variables in the wage equations includes education, firm size, marital status, industry of employment and occupation. The Probit equations include education, marital status, the number of children, income from property rents, financial assets and other allowances, mortgage expenses, child-care provisions and occupation; the additional variables, as well as the non-linearity of the Probit equation, aid in identification.

By a property of OLS, the predicted total gap in column 1, Table 2.2, is equal the actual gap appearing in Figure 2.1, so that Cyprus has the highest average predicted gender pay gap and Slovenia the lowest. Column 5, Table 2.2, reports the pay gap that is predicted to prevail once selection into the base sample is taken into account (the 'offered' gap) and, in some cases (Austria, Belgium, Estonia, France, Germany, Greece, Ireland, Latvia, Poland, Portugal, Spain, and the EU) the selection-adjusted gap is even higher, suggesting that positive selection is at work. The explained part of the decompositions is smaller than the unexplained part (male and female disadvantage combined) for almost all cases, regardless of whether selection corrections have been made. This suggests that the data available do not fully account for the behavior of earnings and/or that a substantial amount of female disadvantage may exist. Interestingly, Scandinavian countries but also Cyprus (which has the highest gap) have the highest proportion of the gap explained by characteristics, while Greece, Italy, Hungary, Poland, Portugal, Slovenia and Spain have very low proportions of the wage gap explained. In some cases, the explained gap is negative, suggesting that female characteristics are superior to male ones. For the vast majority of countries, the female disadvantage is larger than the male advantage, likely because the non-discriminatory structure is weighted towards the numerically dominant males.

Table 2.2: Decompositions using age as a proxy for experience

	Oaxaca-Ransom decomposition				Heckman-corrected Oaxaca-Ransom decomposition			
	Total	Explained	Unexplained		Total	Explained	Unexplained	
		Endowments	Male Advantage	Female Disadvantage		Endowments	Male Advantage	Female Disadvantage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Austria	0.225***	0.060***	0.051***	0.114***	0.334***	0.024*	0.072**	0.239***
Belgium	0.127***	0.038***	0.029***	0.060***	0.135***	0.025**	0.027***	0.082***
Cyprus	0.502***	0.225***	0.124***	0.153***	0.478***	0.186***	-0.037	0.328***
Czech Republic	0.323***	0.088***	0.107***	0.128***	0.277***	0.062***	0.027***	0.189***
Denmark	0.198***	0.065**	0.055***	0.077***	0.182***	0.037	0.026*	0.119***
Estonia	0.423***	0.200***	0.109***	0.114***	0.602***	0.181***	0.171***	0.250***
Finland	0.245***	0.116***	0.060***	0.069***	0.216***	0.093***	0.029**	0.094***
France	0.202***	0.079***	0.047***	0.076***	0.238***	0.061***	0.030**	0.147***
Germany	0.196***	0.060***	0.043***	0.094***	0.336***	0.037***	0.122***	0.176***
Greece	0.186***	0.003	0.070***	0.113***	0.204***	-0.037**	0.016	0.225***
Hungary	0.100***	-0.031***	0.063***	0.069***	0.042	-0.036***	-0.044	0.122***
Ireland	0.236***	0.053***	0.066***	0.117***	0.281***	0.038**	0.042*	0.201***
Italy	0.164***	-0.007	0.058***	0.112***	0.150***	-0.031***	0.041***	0.141***
Latvia	0.305***	0.099***	0.106***	0.100***	0.392***	0.091***	0.114*	0.186***
Lithuania	0.286***	0.081***	0.102***	0.103***	0.204***	0.076***	-0.076*	0.204***
Luxembourg	0.176***	0.049**	0.039***	0.088***	0.141***	0.019	0.042***	0.080***
Netherlands, The	0.178***	0.068***	0.024***	0.086***	0.159***	0.043***	0.030***	0.086***
Poland	0.181***	0.004	0.079***	0.098***	0.390***	-0.024***	0.155***	0.259***
Portugal	0.122***	-0.069***	0.089***	0.101***	0.125**	-0.111***	0.015	0.220***
Slovak Republic	0.268***	0.072***	0.098***	0.098***	0.223***	0.064***	-0.066***	0.224***
Slovenia	0.087***	-0.063***	0.074***	0.076***	0.059**	-0.106***	0.015*	0.151***
Spain	0.153***	0.001	0.057***	0.095***	0.238***	-0.026***	0.095***	0.168***
Sweden	0.198***	0.086***	0.046***	0.066***	0.178***	0.051***	0.033**	0.094***
United Kingdom	0.253***	0.081***	0.068***	0.104***	0.236***	0.066***	0.026***	0.144***
European Union	*0.381****	*0.194****	*0.077****	*0.110****	*0.461****	*0.168****	*0.053****	*0.240****

Note: Columns 1-4 report the results of the Oaxaca-Ransom decomposition and columns 7-8 the Heckman-corrected Oaxaca-Ransom decomposition. The explained part (the first term of Eq. (2.1)) measures the part of the predicted average wage difference that can be explained by the difference between the male and female characteristics. The unexplained part (the second and third terms of Eq. (2.1)) corresponds to the male advantage and female disadvantage. Three stars indicate significance at the 1%, two stars at the 5% and one star at the 10% level.

Table 2.3: Decompositions using experience for the countries where this is available

	Oaxaca-Ransom decomposition				Heckman-corrected Oaxaca-Ransom decomposition			
	Total	Explained	Unexplained		Total	Explained	Unexplained	
		Endowments	Male Advantage	Female Disadvantage		Endowments	Male Advantage	Female Disadvantage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Austria	0.226***	0.070***	0.048***	0.108***	0.333***	0.033**	0.069**	0.231***
Belgium	0.126***	0.037***	0.029***	0.060***	0.136***	0.026**	0.023***	0.087***
Cyprus	0.502***	0.246***	0.115***	0.142***	0.498***	0.211***	-0.018	0.305***
Czech Republic	0.323***	0.094***	0.104***	0.125***	0.277***	0.065***	0.028***	0.184***
Denmark	-	-	-	-	-	-	-	-
Estonia	0.424***	0.201***	0.109***	0.114***	0.588***	0.179***	0.164***	0.246***
Finland	-	-	-	-	-	-	-	-
France	0.202***	0.084***	0.045***	0.073***	0.240***	0.067***	0.031**	0.142***
Germany	0.198***	0.062***	0.042***	0.093***	0.338***	0.040***	0.122***	0.176***
Greece	-	-	-	-	-	-	-	-
Hungary	-	-	-	-	-	-	-	-
Ireland	0.234***	0.060***	0.063***	0.110***	0.271***	0.045**	0.040*	0.186***
Italy	0.164***	0.001	0.056***	0.108***	0.149***	-0.024***	0.036***	0.136***
Latvia	0.308***	0.103***	0.106***	0.099***	0.390***	0.095***	0.115*	0.180***
Lithuania	0.286***	0.080***	0.102***	0.104***	0.203***	0.075***	-0.075*	0.203***
Luxembourg	0.177***	0.066***	0.034***	0.077***	0.149***	0.038*	0.038***	0.074***
Netherlands, The	0.180***	0.070***	0.024***	0.085***	0.167***	0.047***	0.027***	0.093***
Poland	0.184***	0.011	0.077***	0.095***	0.404***	-0.017**	0.167***	0.253***
Portugal	0.121***	-0.061***	0.085***	0.097***	0.117*	-0.104***	0.009	0.212***
Slovak Republic	0.268***	0.073***	0.097***	0.098***	0.228***	0.065***	-0.059***	0.222***
Slovenia	0.076***	-0.068***	0.075***	0.070***	0.172***	-0.113***	-0.012	0.298***
Spain	0.153***	0.017*	0.051***	0.085***	0.250***	-0.011	0.089***	0.171***
Sweden	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-

Note: Columns 1-4 report the results of the Oaxaca-Ransom decomposition and columns 7-8 the Heckman-corrected Oaxaca-Ransom decomposition. The explained part (the first term of Eq. (2.1)) measures the part of the predicted average wage difference that can be explained by the difference between the male and female characteristics. The unexplained part (the second and third terms of Eq. (2.1)) corresponds to the male advantage and female disadvantage. Three stars indicate significance at the 1%, two stars at the 5% and one star at the 10% level.

In Table 2.3 experience is used instead of age in the wage and Probit equations. Allowing for the fact that a number of countries do not have experience data, most of the statements made in the previous paragraph continue to hold and so we do not pursue the experience/age issue any further.

Arguably education, occupation and industry effects are endogenous. These problems are often handled in the literature by using instrumental variables methodologies or by exploiting certain features of the datasets used. For example, Kim and Polachek (1994) and Kunze (2001) used panel estimation methodologies to correct for potential endogeneity of the explanatory variables using the generalized method of moments methodologies proposed by Arellano and Bond (1991) and Blundell and Bond (1998). Unfortunately, the EU-SILC dataset does not provide information on parents' education or occupation, which could provide appropriate instruments to correct for endogeneity; in addition, the dataset we use is in a pure cross-section form. We include occupation and industry dummies as in Albrecht et al. (2003), page 162, who note that "as an accounting exercise, it is useful to know the extent to which the gender gap at different percentiles can be "explained"" by these and other variables. Education is "universally" used in participation and wage estimations and cannot be left out even if we cannot correct for endogeneity. We also estimate the wage and probit equations without the occupation and industry dummies. When tables parallel to Table 2.2 and Table 2.3 but without the industry and occupation effects in the wage and Probit equations (as appropriate), are constructed, the explained parts are significantly smaller, suggesting the importance of industry and occupation effects in explaining the gender wage gap - see Polachek (1981).

2.4.2 Quantile decompositions of the gender wage gap

The quantile regression methodology (see Koenker and Bassett (1978)) allows the characteristics of individuals to have different impacts at different points of the wage distribution; it consequently affects the implied decompositions at each point. This approach allows examination of 'glass ceiling' and 'sticky floor' phenomena. In the case of the former, a larger unexplained gender wage gap is observed at the top of the wage distribution, suggesting that, as women advance to top positions, their pay may not increase pari pasu. In the case of the latter, a larger unexplained earnings gap at the lower end of the wage distribution may suggest that females enter occupations and industries with low pay and few advancement opportunities. Decomposition procedures based on quantile regression have been proposed by Melly (2005), Machado and Mata (2005) and Gosling et al. (2000). We follow Melly (2005).

One of the first studies to use quantile regression to study these phenomena is Albrecht et al. (2003). The authors examine the gender wage gap in Sweden, using data for 1998, and find noteworthy glass ceiling effects. Arulamplam et al. (2006) analyze the gender wage gap for eleven European Union countries over the period 1994-2001 and find glass ceiling effects for the majority of the countries in their sample and, in a few cases, signs of sticky floor phenomena.

Melly (2005)decomposes the difference between male and female wages (the left hand side of Eq. (2.2)) into the three factors that appear on the right hand side of Eq. (2.2), namely the effect of differences in residuals, in (median) coefficients, and in covariates:

$$\begin{aligned} \hat{q}(\hat{\beta}^{M}, X^{M}) - \hat{q}(\hat{\beta}^{F}, X^{F}) &= \left[\hat{q}(\hat{\beta}^{M}, X^{M}) - \hat{q}(\hat{\beta}^{mM,rF}, X^{M})\right] + \\ &\quad \left[\hat{q}(\hat{\beta}^{mM,rF}, X^{M}) - \hat{q}(\hat{\beta}^{F}, X^{M})\right] + \\ &\quad \left[\hat{q}(\hat{\beta}^{F}, X^{M}) - \hat{q}(\hat{\beta}^{F}, X^{F})\right] \end{aligned} \tag{2.2}$$

where X^{M} and X^{F} are vectors with male and female characteristics, $\hat{\beta}^{M}$ and $\hat{\beta}^{F}$ are the estimated median coefficients on characteristics, $\hat{q}\left(\hat{\beta}, X\right)$ is the counterfactual earnings distribution of individuals with characteristics$X$ and return on characteristics $\hat{\beta}$, and $\widehat{q}\left(\hat{\beta}^{mM,rF}, x^{M}\right)$ is the distribution that would have prevailed if the median coefficients were the same for males and females but the residuals were distributed as in the female distribution. The set of personal characteristics included are the same as in Appendix A.1[6]. The decomposition results appear in Table 2.4 and our findings on sticky floor and glass ceiling effects are summarized in Table 2.5. Figure 2.2 presents, by country, decompositions over the male and female earnings distribution.

Table 2.4 reports the quantile regression decompositions obtained for five quantiles (10%, 25%, 50%, 75%, and 90%). The part of the observed wage gap (not adjusted for selection) that is not explained by observed characteristics (the third term in Eq. (2.2)) is shown in square brackets. The last two columns of Table 2.4 repeat the total and the unexplained part (the sum of the male advantage and the female disadvantage) from Table 2.2 to facilitate the comparison between the quantile and Oaxaca and Ransom (1994) decomposition results.

When the total and the unexplained gaps at the 50th percentile of the quantile regression decompositions are compared to the mean values in the Oaxaca and Ransom (1994)

[6]Some of the industries and occupations were merged because participation in these was very low for some of the countries and the decompositions could not have been performed if these near-singleton dummy variables where included in the estimation. More specifically armed forces employees were joined with professionals for Austria, Belgium, Germany, Denmark, France, Finland, Ireland, Italy, Lithuania, Luxembourg, Latvia, The Netherlands, Poland, Portugal, Slovak Republic, Slovenia, Sweden and United Kingdom. Agriculture, fishing and mining employees were combined with craft workers for Belgium, Finland, France, Luxembourg, The Netherlands and Poland. Agriculture and the construction sector were merged for France and The Netherlands.

decompositions, the results in the quantile decompositions show that many more countries have unexplained components that exceed the total wage gaps. This suggests that, at the median of the wage distribution, females tend to have higher qualifications than men. Indeed, this is generally the case for lower quantiles[7]. By the 75th percentile, this is true for only 13 countries and by the 90th percentile it is true for only 10 countries. Thus, the quantile results reinforce the conclusion in the Oaxaca-Ransom decompositions that a substantial portion of the earnings gap remains unexplained and offer the additional insight that this is more true at the lower than at the higher end of the earnings distribution. As in the Oaxaca and Ransom (1994) results, the quantile decompositions continue to show the six new MSs with the highest unconditional gender gaps (Cyprus, the Czech Republic, Estonia, Latvia, Lithuania, and the Slovak Republic) at the top of the unexplained gap list, while the new MSs at the bottom of the unconditional gap list (Slovenia and Hungary) are now placed 15th and 18th respectively.

We define a sticky floor and a glass ceiling as existing if the 10th percentile and the 90th percentile respectively exceed other reference points of the wage distribution (see Table 2.5) by at least two percentage points. The results are summarized in Table 2.5. There is evidence of sticky floors in 10 out of the 24 countries in the sample using the 10-25 difference and 11 countries when using the 10-50 difference. The strongest evidence for sticky floors is found in Cyprus, Luxembourg, Slovenia, and Spain, where differences for all three reference points can be seen. This phenomenon for Cyprus and Luxembourg can be partly attributed to the high segregation of women in low-paying industries and occupations[8].

A number of countries exhibit significant signs of glass ceiling effects. In Table 2.5, 14 countries satisfy all three reference standards and a number of other countries meet one or two of the three criteria. Only 6 countries do not exhibit these effects based on any of the three measures used. These countries are Cyprus, Greece, Latvia, Lithuania, Portugal, and Spain and it is surprising that this list does not include the Scandinavian countries. The results for Greece and Spain are very interesting and conform with the motivation of Olivetti and Petrongolo (2008) who argue for an extreme form of positive selection in these countries, i.e. that only the most highly qualified and paid women enter the labour market. Table 2.5 also summarizes the general shape of the total ln earnings distributions in the 24 countries studied.

[7]In Hungary, Italy, Portugal, and Slovenia the unexplained part is larger than the total effect throughout the wage distribution. By contrast, in Estonia, the unexplained part is lower than the total difference throughout the wage distribution.

[8]In Appendix Table A.7, the industry and occupation segregation index is provided for all EU countries.

Table 2.4: Quantile regression decompositions

	Quantile decompositions										Oaxaca-Ransom decompositions	
	10%		25%		50%		75%		90%			
Austria	0.240	[0.267]	0.205	[0.229]	0.200	[0.222]	0.212	[0.230]	0.269	[0.265]	0.225	[0.165]
Belgium	0.131	[0.189]	0.114	[0.168]	0.101	[0.130]	0.114	[0.101]	0.167	[0.109]	0.127	[0.089]
Cyprus	1.012	[0.512]	0.539	[0.491]	0.423	[0.439]	0.309	[0.353]	0.279	[0.299]	0.502	[0.277]
Czech Republic	0.337	[0.347]	0.346	[0.370]	0.299	[0.357]	0.287	[0.300]	0.341	[0.302]	0.323	[0.235]
Denmark	0.153	[0.329]	0.133	[0.204]	0.147	[0.158]	0.215	[0.197]	0.322	[0.260]	0.198	[0.132]
Estonia	0.349	[0.264]	0.402	[0.327]	0.442	[0.387]	0.454	[0.425]	0.479	[0.430]	0.423	[0.223]
Finland	0.128	[0.192]	0.181	[0.199]	0.253	[0.225]	0.316	[0.214]	0.325	[0.192]	0.245	[0.129]
France	0.152	[0.169]	0.137	[0.165]	0.159	[0.167]	0.217	[0.174]	0.275	[0.198]	0.202	[0.123]
Germany	0.224	[0.334]	0.156	[0.303]	0.154	[0.212]	0.190	[0.181]	0.240	[0.185]	0.196	[0.137]
Greece	0.159	[0.240]	0.178	[0.270]	0.194	[0.318]	0.184	[0.335]	0.193	[0.318]	0.186	[0.183]
Hungary	0.027	[0.101]	0.086	[0.179]	0.108	[0.217]	0.105	[0.208]	0.157	[0.213]	0.100	[0.132]
Ireland	0.197	[0.234]	0.193	[0.218]	0.208	[0.194]	0.248	[0.218]	0.288	[0.280]	0.236	[0.183]
Italy	0.165	[0.225]	0.136	[0.198]	0.132	[0.199]	0.167	[0.215]	0.225	[0.242]	0.164	[0.170]
Latvia	0.224	[0.255]	0.339	[0.372]	0.353	[0.391]	0.295	[0.325]	0.305	[0.303]	0.305	[0.206]
Lithuania	0.221	[0.168]	0.309	[0.262]	0.343	[0.380]	0.282	[0.358]	0.248	[0.310]	0.286	[0.205]
Luxembourg	0.213	[0.366]	0.177	[0.320]	0.123	[0.236]	0.156	[0.148]	0.188	[0.134]	0.176	[0.127]
Netherlands, The	0.160	[0.211]	0.127	[0.191]	0.141	[0.164]	0.193	[0.160]	0.238	[0.181]	0.178	[0.110]
Poland	0.131	[0.193]	0.177	[0.273]	0.191	[0.311]	0.191	[0.326]	0.218	[0.344]	0.181	[0.177]
Portugal	0.136	[0.167]	0.173	[0.254]	0.190	[0.355]	0.072	[0.387]	-0.005	[0.275]	0.122	[0.190]
Slovak Republic	0.281	[0.343]	0.250	[0.330]	0.252	[0.329]	0.263	[0.338]	0.301	[0.331]	0.268	[0.196]
Slovenia	0.150	[0.264]	0.121	[0.223]	0.062	[0.224]	-0.005	[0.179]	0.045	[0.147]	0.087	[0.150]
Spain	0.197	[0.238]	0.170	[0.250]	0.149	[0.260]	0.127	[0.233]	0.106	[0.185]	0.153	[0.152]
Sweden	0.223	[0.263]	0.163	[0.157]	0.160	[0.119]	0.212	[0.144]	0.252	[0.168]	0.198	[0.112]
United Kingdom	0.201	[0.255]	0.220	[0.289]	0.235	[0.263]	0.246	[0.226]	0.325	[0.270]	0.253	[0.172]

Note: The decomposition methodology is described in 2.4.2. The decompositions are estimated at the 10th, 25th, 50th, 75th and 90th quantile. For each of the reported quantiles, the difference between the actual ln earnings for the two genders is reported first, followed by the portion which is not explained by the quantile regressions in square brackets. The last two columns provide the (no selection) total and unexplained wage gaps from Table 2.2. The male advantage and female disadvantage are summed up to produce the unexplained part of the Oaxaca-Ransom decomposition.

Table 2.5: Summary of quantile evidence on sticky floors and glass ceilings

	Sticky floor measured by†:			Glass ceiling measured by‡:			
	10 - all gaps	10-25 Difference	10-50 Difference	10 - all gaps	10-25 Difference	10-50 Difference	Shape of actual earnings distribution
	(1)	(2)	(3)	(4)	(5)	(6)	
Austria		Yes	Yes	Yes	Yes	Yes	U-Shaped
Belgium			Yes	Yes	Yes	Yes	U-Shaped
Cyprus	Yes	Yes	Yes				Decreasing
Czech Republic			Yes		Yes	Yes	Complex
Denmark				Yes	Yes	Yes	Increasing
Estonia				Yes	Yes	Yes	Increasing
Finland						Yes	Increasing
France				Yes	Yes	Yes	U-Shaped
Germany		Yes	Yes	Yes	Yes	Yes	U-Shaped
Greece							Flat
Hungary				Yes	Yes	Yes	S-shaped
Ireland				Yes	Yes	Yes	U-Shaped
Italy		Yes	Yes	Yes	Yes	Yes	U-Shaped
Latvia							Reverse U
Lithuania							Reverse-U
Luxembourg	Yes	Yes	Yes		Yes	Yes	U-Shaped
Netherlands, The		Yes		Yes	Yes	Yes	U-Shaped
Poland				Yes	Yes	Yes	Increasing
Portugal							Reverse U
Slovak Republic		Yes	Yes	Yes	Yes	Yes	Complex
Slovenia	Yes	Yes	Yes		Yes		U-Shaped
Spain	Yes	Yes	Yes				Decreasing
Sweden		Yes	Yes	Yes	Yes	Yes	U-Shaped
United Kingdom				Yes	Yes	Yes	Increasing

Note: †A "glass ceiling" effect is defined to exist if the 90^{th} percentile wage gap exceeds the reference gap by at least two percentage points. ‡ A "sticky floor" effect is defined to exist if the 10^{th} percentile wage gap exceeds the reference gap by at least two percentage points.

Figure 2.2: Quantile regression decomposition

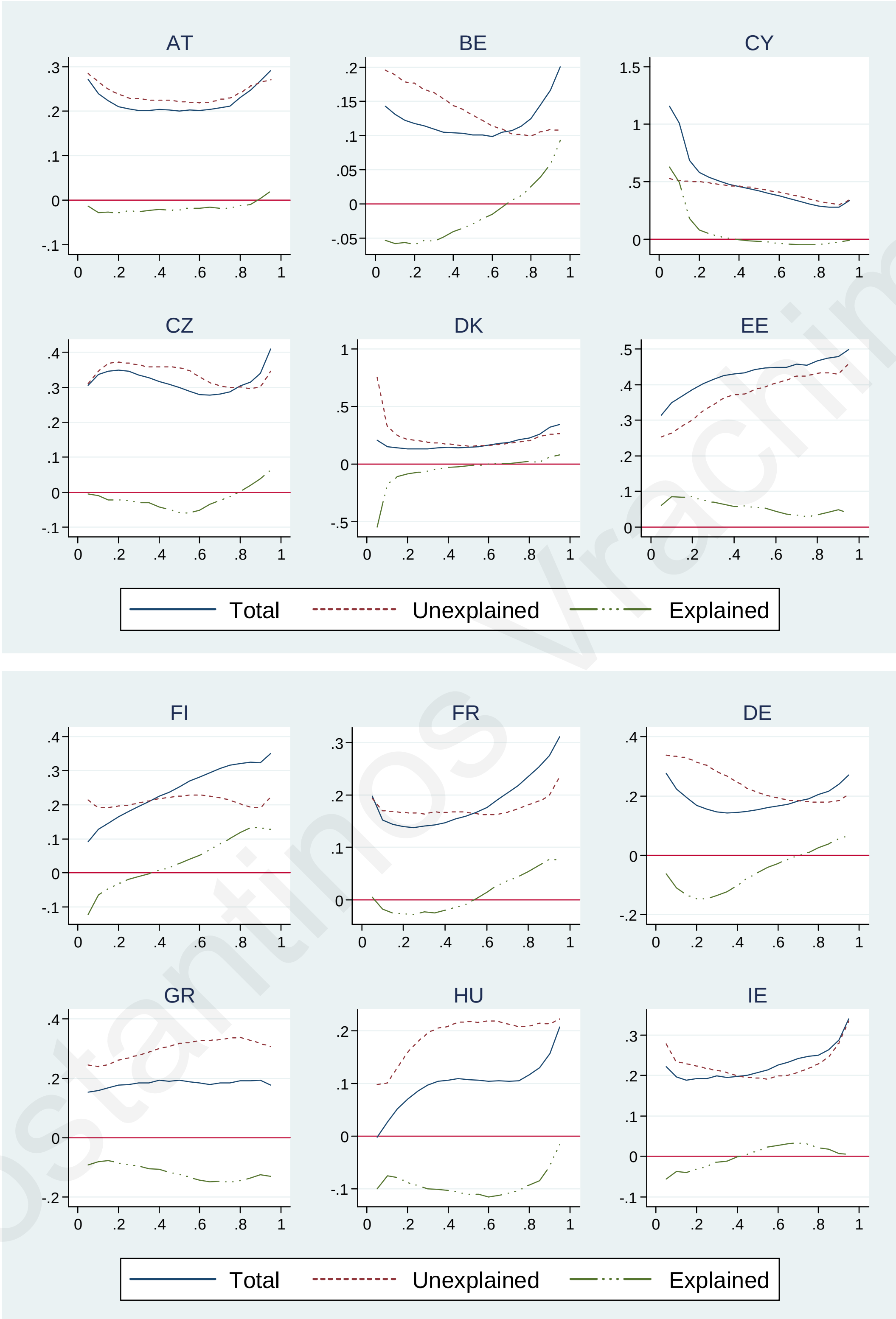
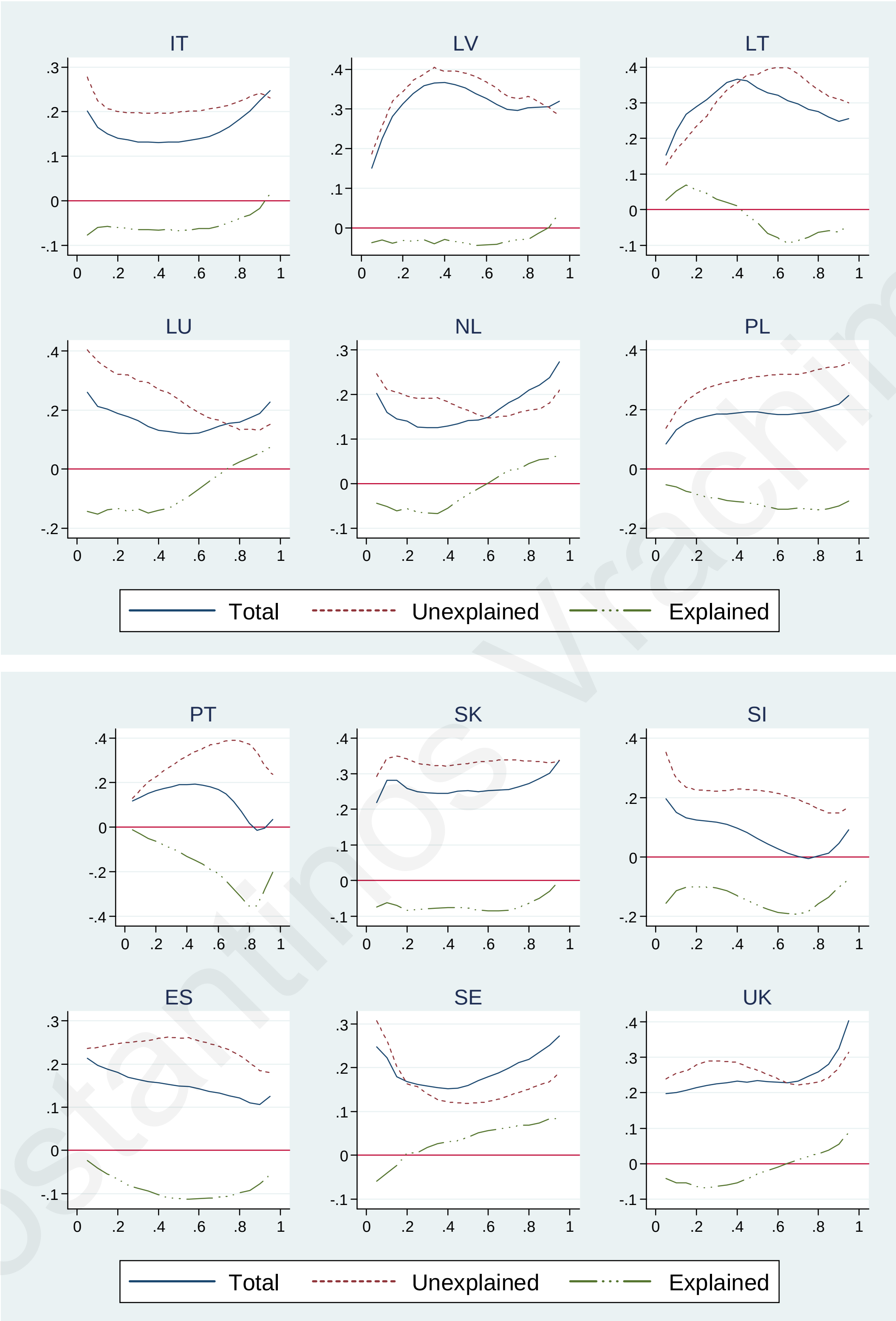


Figure 2.2: (continued) Quantile Regression Decomposition



This feature of our results is examined more conveniently in Figure 2.2. The blue solid lines plot the actual wage distribution, the red dotted lines show the unexplained component and the blue dashed/dotted lines indicate the explained component. The unexplained gap distribution follows five broad patterns. It is U-shaped (the unexplained component is high at the extreme ends of the distribution, suggesting sticky floor and glass ceiling effects) in Austria, France, Ireland, Italy, The Netherlands, and Sweden. The unexplained gap follows an inverse U-shape (no evidence of sticky floor or glass ceiling effects) in Latvia, Lithuania, Portugal, and Spain. It follows a decreasing pattern (sticky floor effects only) in Belgium, Cyprus, Denmark, Germany, Luxembourg, and Slovenia. The unexplained portion follows an increasing pattern (glass ceiling effects only) in Estonia, Greece, Hungary, and Poland. The Czech Republic, Finland, the Slovak Republic and the United Kingdom display more complex patterns.

2.4.3 Estimation of a selection-corrected median wage gap

Building on Johnson et al. (2000) and Neal (2004), Olivetti and Petrongolo (2008) note that some countries (e.g. Greece, Italy and Spain) have a surprisingly low gender wage gap (particularly when compared to the UK and US). Since these countries tend to also have low female employment rates, they speculate that selection affects the observed gender wage gap. They impute the wages for the non-participants and the unemployed and confirm that the difference between the actual and imputed gaps is small for the UK, the US and most central and northern European countries but is larger for Greece, Italy and Spain. This suggests that selection by women into the labour markets of the latter three countries is not random[9]. The imputation procedure for those not in the working sample requires only that a missing wage be placed below or above the median. Two approaches are used: The first, imputes the unobserved wage based on educated assumptions about the relative position of the wage of each individual with respect to the median wage in each country. The second, uses probability models to assign individuals to either side of the median wage. We follow this approach, describing first the imputation approaches used.

2.4.3.1 Imputation of wage using educated assumptions

In the first approach and based on the known characteristics of the non-employed, a wage is assigned to them. The wage $w_{i,c}$, assigned for each individual i in country c by gender takes one of the values $\underline{w}^c$ and $\bar{w}^c$ where $\underline{w}^c$ is the minimum wage in country and $\bar{w}^c$ is the maximum wage in country c. At least four alternatives are possible in our cross-sectional data: (i) Set $w_{i,c} = \underline{w}^c$ if an individual is non-employed, (ii) Set $w_{i,c} = \underline{w}^c$ if an individual is unemployed, (iii) Set $w_{i,c} = \underline{w}^c$ if an individual is non-employed and has education less than upper secondary and less than ten year's experience and set $w_{i,c} = \bar{w}^c$ if education is greater than upper secondary and the individual has more than ten years of experience (observations that do not meet these

[9]The sample used in their study includes individuals aged 25-54 and excludes the self-employed, individuals working in the military and full-time students.

conditions are lost), and (iv) Based on assortative matching, set $w_{i,c} = \underline{w}^c$ if the non-employed spouse's wage income belongs to the bottom income quartile of the wage distribution; observations where the spouse's income belonged at the top of the distribution were left out.

Column 1, Table 2.6, reports the median wage gap for the samples used in sections 2.4.1 and 2.4.2, once the number of observations is modified as suggested above. The correction based on alternative (i) assigns the minimum value of each gender distribution to non-employed individuals, increasing the median wage gap for all countries; the gap is not imputed for countries where the female employment rate is lower than 50%. The increase is more significant for countries with low female employment rates like Austria, Belgium, Germany, and Luxembourg. The correction based on alternative (ii), assigns the minimum value of each gender distribution to unemployed individuals, increasing the median wage gap in countries such as Belgium, Germany, Greece, Slovenia, and Spain. The change in the median wage gap is negligible or negative in Latvia, Luxembourg, United Kingdom, Lithuania, Finland, Sweden, Estonia and Ireland. The correction based on alternative (iii) assigns the minimum value of each gender distribution to low experience and education individuals, increasing the median wage gap substantially in countries such as Austria, Cyprus, Ireland, Italy, Poland, and Spain. It also increases in Greece. The median wage gap decreases or increases only slightly in countries such as Lithuania, Estonia, the Slovak Republic, and Latvia. The correction based on alternative (iv) assigns the minimum value of each gender distribution only if the non-employed spouse's wage income belongs to the bottom income quartile of the wage distribution. This is the least stringent assumption and the median wage gap remains unchanged in many countries.

2.4.3.2 Imputation of wage using the Probit model

The second methodology consists of two steps. In the first step, a Probit model is used, for each gender, to determine the probability of an individual receiving a wage below the median of the wage distribution. The set of explanatory variables includes the variables used in the first-step Probit equation in the Heckman (1974a,b) -corrected Oaxaca and Ransom (1994) decompositions. In the second step, the predicted probabilities are used as follows: the employed are included with their observed wage and the non-employed with the minimum wage in the gender distribution with probability and the maximum wage in a gender distribution with probability . The median gender wage gap is then estimated for the imputed sample for males and females. The gender difference appears in column 6, 2.6.

The median wage gap increases in most countries. It increases considerably in Ireland, Luxembourg, Spain, and The Netherlands, countries with low female employment rates. On the other hand, the median wage gap is reduced in Slovenia and Greece. It remains almost unchanged in Estonia and the Czech Republic.

2.4.3.3 Discussion

Our results based on the first imputation method are consistent with Olivetti and Petrongolo (2008) in that the revised wage gaps are higher in Greece, Italy and Spain. This is also true for Italy and Spain in the Probit imputation approach. Selection issues are clearly important. The selection adjustments in Olivetti and Petrongolo (2008) result in generally higher imputed wage gender gaps than is the case in the Heckman (1974, 1978) approach. This is likely because of the more conservative approach followed in assigning the missing wages.

2.5 The role of institutions and work-family reconciliation policies

Labour-market policies are likely to affect the extent of the wage gap both at the mean or median and across the whole wage distribution[10]. In this section, the relationship between the unexplained part of the wage gap (columns 3 plus 4, Table 2.2 of the Oaxaca and Ransom (1994) approach and column 5, Table 2.4 of the quantile decomposition approach), the sticky floor (column 3, Table 2.5) and the glass ceiling (column 6, Table 2.5) effects on the one hand and, on the other hand, the institutions and gender-specific policies prevailing in the MSs is examined. The trade union membership rate is used as a proxy for the wage-setting environment in each MS[11]. The OECD (2001) Work-family Reconciliation Index is a convenient summary of the policies prevailing in MSs on work-family issues. The original measure used five variables which are not all available for our 24 MSs and so we have constructed a close substitute based on information which is, in fact, available. The new summary measure relies on (i) the availability of formal child care for children under 3 for more than 30 hours a week, (ii) maternity pay entitlement (product of length and generosity), (iii) the extent to which part-time employment for family, children and other reasons is possible, (iv) the extent to which working times can be adjusted for family reasons and (v) the extent to which whole days of leave can be obtained

[10]Family policies may have a positive or negative effect on the wage gap. Extended parental leave may increase out-of-work time and, as a result, employees returning to employment may receive reduced wage growth, resulting in a higher wage gap. On the other hand, parental leave may help preserve the ties of employees with their firms, increasing firms' incentive to invest in human capital, implying a lower wage gap. Such effects may hold with different force at different points of the wage distribution. Child-care policies may have an overall positive effect because they increase attachment to work and the incentive to acquire human capital and because they ease the economic burden of child-care.

[11]Countries with higher unionization rates tend to have lower wage dispersion (Blau and Kahn (1992) and Blau and Kahn (1996)), possibly lowering the wage gap. Trade unions may be less likely to represent the interests of their female electorate because they may be perceived as having less attachment to the labour market - Booth and Francesconi (2003). They may also be less sensitive to the interests of members at the low end of the wage distribution - see also Arulamplam et al. (2006).

Table 2.6: Gender wage gap based on the Olivetti and Petrongolo (2008) selection procedures

	Median wage gap	Imputation based on four alternative assumptions				Probability-based imputation
		(i)	(ii)	(iii)	(iv)	
Austria	0.199	0.496	0.224	0.331	0.245	0.356
Belgium	0.111	0.314	0.169	0.199	0.125	0.195
Cyprus	0.419	0.698	0.436	0.539	0.427	0.538
Czech Republic	0.310	0.426	0.325	0.367	0.308	0.319
Denmark	0.138	0.168	0.145	-	0.139	0.164
Estonia	0.439	0.507	0.397	0.439	0.439	0.443
Finland	0.254	0.311	0.243	-	0.257	0.301
France	0.152	0.236	0.173	0.203	0.164	0.209
Germany	0.139	0.445	0.212	0.158	0.156	0.232
Greece	0.231	-	0.320	-	0.247	0.035
Hungary	0.116	0.288	0.130	-	0.143	0.199
Ireland	0.224	-	0.179	0.340	0.245	0.553
Italy	0.137	-	0.182	0.410	0.177	0.186
Latvia	0.366	0.436	0.375	0.395	0.378	0.398
Lithuania	0.346	0.444	0.344	0.338	0.348	0.366
Luxembourg	0.127	0.781	0.130	0.386	0.189	0.332
Netherlands, The	0.134		0.149	0.228	0.156	0.440
Poland	0.214	0.417	0.292	0.321	0.223	0.318
Portugal	0.187	0.345	0.205	0.267	0.200	0.230
Slovak Republic	0.283	0.307	0.321	0.297	0.285	0.297
Slovenia	0.069	0.120	0.112	0.077	0.073	0.062
Spain	0.145	-	0.215	0.392	0.187	0.299
Sweden	0.164	0.173	0.155	-	0.164	0.172
United Kingdom	0.244	0.461	0.245	-	0.270	0.368

Note: The first column provides the difference between the median ln wage for males and females. In column: (i) min wage assigned if non-employed, (ii) min wage assigned if unemployed, (iii) min wage assigned if education less than upper secondary and less than a ten years of experience and max wage assigned if education greater than upper secondary and more than ten years experience, (iv) min wage assigned if non-employed and spouse's wage income belongs to the bottom income quartile of wage distribution. In the sixth column, the imputation is based on the Probit model. In the column headed (i), the imputation is not estimated for some countries because we assume ex ante positive self selection and, in these countries, more than 50% of the female population is not working. In the column headed (iii), experience is not reported for six countries and the imputation cannot be performed.

without loss of holiday entitlement for family reasons. The data actually used to produce our composite index (similar to the OECD data[12]), the index itself and the trade union membership rate date appear in Table 2.7.

Figure 2.3 presents the relationship between (i) the mean gender wage gap, (ii) the median gender wage gap, (iii) the glass-ceiling effect, and (iv) the sticky floor effect and our family reconciliation index. The first two graphs within Figure 2.3 show that, across the 24 countries, the unexplained parts of the mean and median wage gap are negatively related to the work-family reconciliation index. That is, countries with generous work-families policies (e.g. Denmark and The Netherlands) tend to have a lower unexplained wage gap compared to countries with less generous policies (e.g. Cyprus, Poland and the Slovak Republic). The index is positively and significantly (at the 10% level) related to glass ceiling effects and it is positively and significantly related to sticky floor effects at the 1% level. That is, in countries with more generous family-work policies, the gender pay gap tends to be higher at the extremes of the wage distribution. At the low end of the distribution (graph 4, Figure 2.3), this may be caused by an increase in the participation of low-paid female employees who may be responding to better child-care arrangements. At the high end of the wage distribution (graph 3, Figure 2.3) this may be due to professional women increasing out-of-work time (given more generous maternity leave provisions) and paying a cost for doing so.

[12]The correlation coefficient between the fourteen EU countries included in the OECD (2001) and in our composite index is 59% and it is significant at the 5% level.

Table 2.7: Summary indicators of work-family policies among the EU countries; unionization rates

	Formal Child-care coverage for under three†	Maternity pay entitlement†	Voluntary part-time working†	Adjust working day for family reasons†	Take leave for family reasons†	Composite Index‡	Union membership rate †
Austria	-1.01	0.02	1.50	0.88	1.55	2.94	31.7
Belgium	0.46	-1.63	1.22	0.76	1.06	1.86	52.9
Cyprus	-0.08	-0.81	-0.71	-1.16	-1.85	-4.62	-
Czech Republic	-1.01	1.26	-0.71	-0.38	0.01	-0.84	21.0
Denmark	3.62	0.84	0.00	1.36	1.71	7.53	69.1
Estonia	-0.32	1.67	-0.50	-0.62	-0.07	0.16	36.1
Finland	0.46	0.02	-0.70	1.06	0.09	0.92	70.3
France	0.23	-1.63	0.18	-0.50	-0.96	-2.69	7.8
Germany	-0.39	-0.81	1.22	-0.98	-0.48	-1.44	19.9
Greece	-0.70	0.02	-0.83	-0.68	-0.39	-2.59	23.0
Hungary	-0.62	0.43	-0.83	-0.68	-0.56	-2.27	16.9
Ireland⋆	-0.55	2.08	0.00	0.00	0.00	1.54	31.7
Italy	0.23	0.43	0.04	-0.68	-0.72	-0.71	33.3
Latvia	0.23	0.02	-0.82	-0.32	0.01	-0.89	-
Lithuania	-0.32	0.84	-0.63	-1.34	-0.96	-2.40	-
Luxembourg	-0.39	0.02	1.12	1.36	-0.31	1.79	41.8
Netherlands, The	-0.70	0.02	2.78	2.61	1.88	6.59	19.8
Poland	-0.86	0.02	-0.81	-1.28	-1.21	-4.14	14.4
Portugal	1.00	0.43	-0.85	-0.32	-0.80	-0.54	18.7
Slovak Republic	-0.78	-0.39	-0.83	-0.92	-1.12	-4.05	23.6
Slovenia⋆	0.69	0.00	-0.84	0.16	0.82	0.83	-
Spain	0.07	0.43	-0.51	0.52	0.90	1.41	14.6
Sweden	1.38	-1.63	0.32	0.64	1.23	1.93	70.8
United Kingdom	-0.62	-1.63	1.19	0.58	0.17	-0.31	28.0

Sources: †Data for the first five columns are drawn from Eurostat (2009). †Data for union membership rates are taken from OECD (2009) for all countries but Estonia for which data are taken from ILO (1997). Notes: §All indicators in the first five columns are scaled in order to have a zero mean and standard deviation equal to unity. So, a value of zero implies that the country concerned is at the average value for the countries in the table.‡The composite index is the sum of the first five columns in the table. ⋆ Maternity pay entitlement is missing for Slovenia and Voluntary part-time working, Adjust working day for family reasons and Take leave for family reasons are missing for Ireland. Missing values are replaced with the mean value of the rest of the sample.

Table 2.8: Relationship between the Oaxaca-Ransom unexplained gender gap part and the work-family reconciliation index and its constituent indices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Child Care	-0.014**						-0.007
	(0.006)						(0.007)
Maternity		0.018**					0.013**
		(0.008)					(0.006)
Vol. part-time			-0.024***				-0.008
			(0.007)				(0.009)
Adjust work day				-0.027***			-0.012
				(0.007)			(0.012)
Family days off					-0.025***		-0.008
					(0.008)		(0.015)
Composite index						-0.008***	
						(0.002)	
Constant	0.166***	0.166***	0.166***	0.166***	0.166***	0.166***	0.166***
	(0.009)	(0.009)	(0.008)	(0.007)	(0.008)	(0.008)	(0.0070
Observations	24	24	24	24	24	24	24
R^2 Adjusted	0.053	0.119	0.259	0.348	0.284	0.258	0.401

OLS regression equations; robust standard errors in parentheses. Three stars indicate significance at the 1%, two stars at the 5% and one star at the 10% level.

Figure 2.3: Relation between the wage gap and the work-family reconciliation index

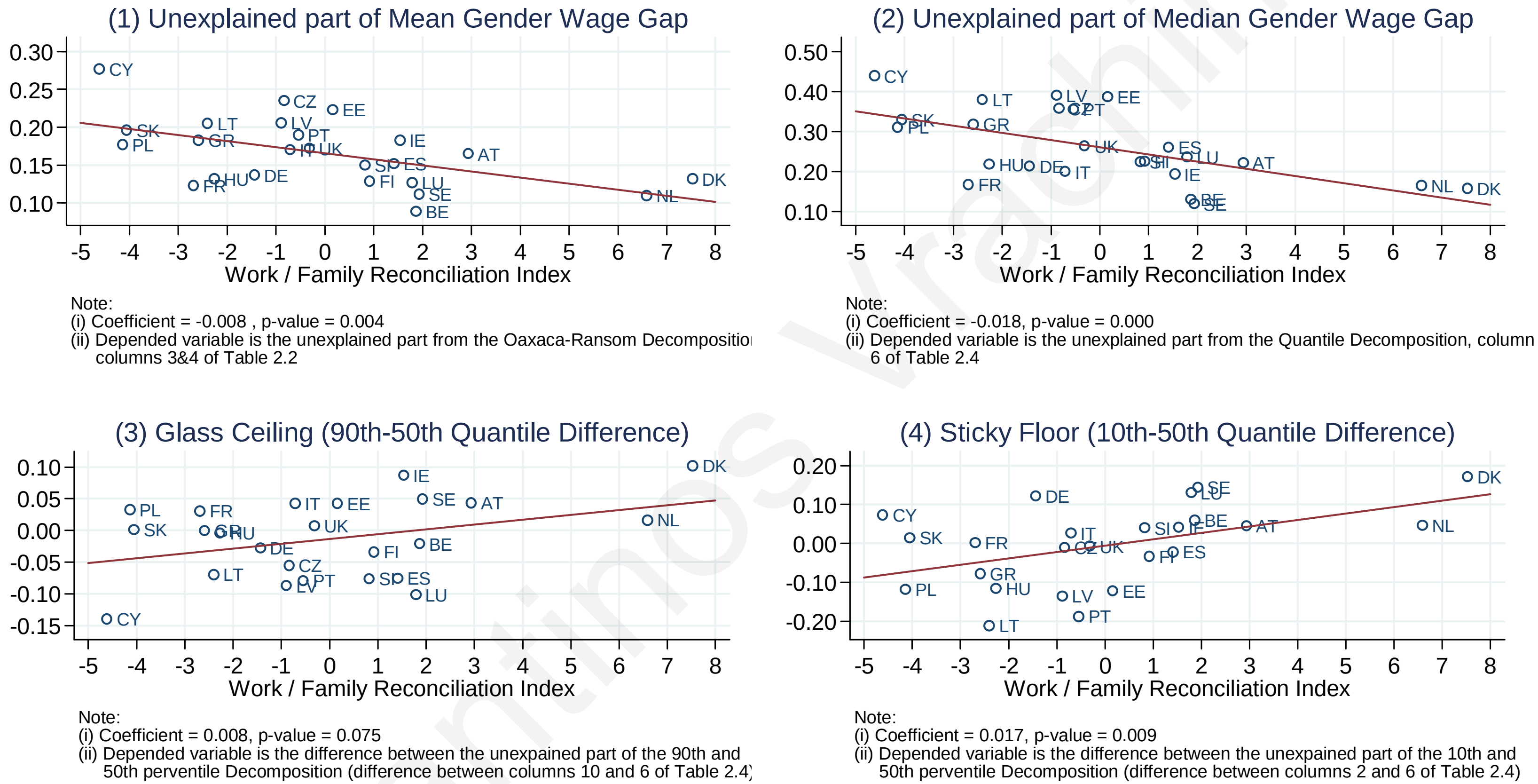
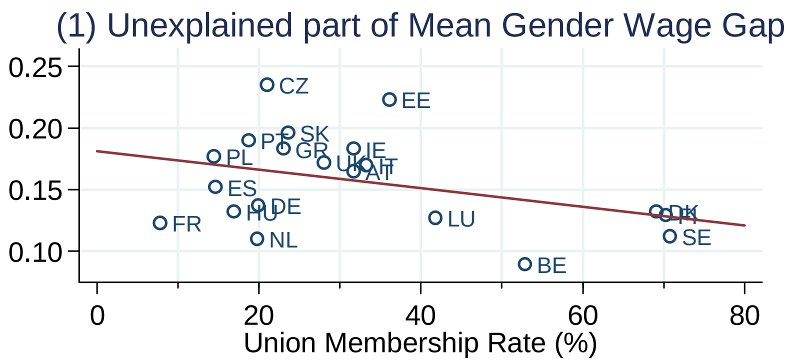
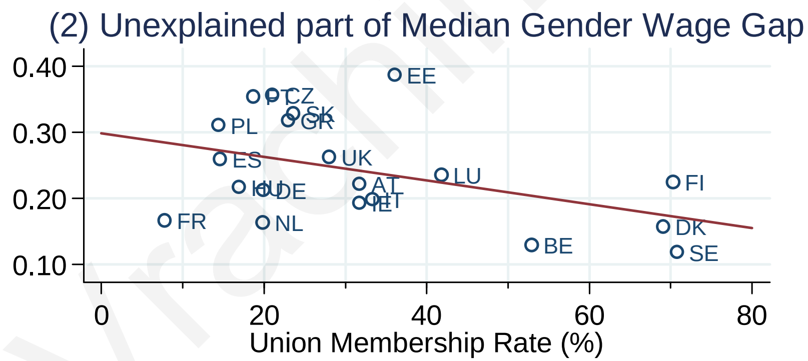


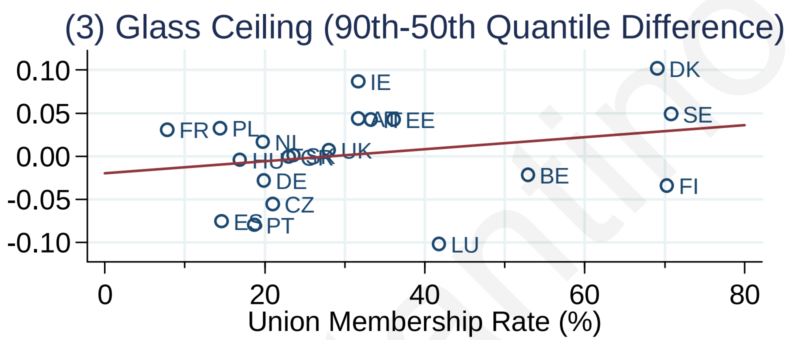
Figure 2.4: Relation between the wage gap and the union membership rate



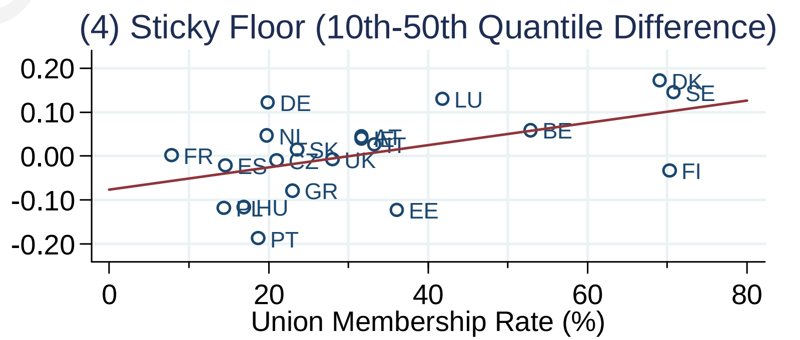
Note:
(i) Coefficient = -0.008 , p-value = 0.039
(ii) Depended variable is the unexplained part from the Oaxaca-Ransor
Decomposition, columns 3&4 of Table 2.2



Note:
(i) Coefficient = -0.018, p-value = 0.030
(ii) Depended variable is the unexplained part from the Quantile
Decomposition, column 6 of Table 2.4



Note:
(i) Coefficient = 0.008, p-value = 0.306
(ii) Depended variable is the difference between the unexpained part o
the 90th and 50th perventile Decomposition (difference between
columns 10 and 6 of Table 2.4)



Note:
(i) Coefficient = 0.017, p-value = 0.030
(ii) Depended variable is the difference between the unexpained part of
the 10th and 50th perventile Decomposition (difference between
columns 2 and 6 of Table 2.4)

Table 2.8 presents the results of the regression of the unexplained part from the Oaxaca and Ransom (1994) decomposition on the constituent indices as well as the composite family-work reconciliation index. Given that Figure 2.3 suggests that the Oaxaca and Ransom (1994) average and the Melly (2005) median gender gap behave similarly relative to the family reconciliation index, we present results for the former. The relationship between the unexplained gap and the composite index (this is what appeared in graph 1, Figure 2.3) is negative and statistically significant at the 1% level (column 6, Table 2.8). The relationship for the constituent indices is individually negative and significant at least at the 5% level except for the maternity leave variable which is positive and significant at the 5% level. When all indices are entered in the regression equation, only the maternity leave variable maintains its significance. Thus, it would appear that very generous and extended maternity leaves may have an unintended impact on the mean gender gap, just as the composite index appears to do at the extremes of the wage distribution. Ruhm (1998) using a sample of nine European countries indicated that although parental leave is associated with increases in female employment rates, if it is taken over extended periods it may reduce the relative wage of female employees. This negative effect can be attributed to different reasons. Female labour supply increases in the period prior to childbirth in order to be eligible for parental leave. This is likely to reduce female earnings. Also, women having multiple births over a short period of time may be away from their job for several years causing substantial depreciation of human capital. Beblo and Wolf (2002) find evidence that discontinuous employment caused by maternal leave reduces the wage for females. Gutierrez-Domenech (2005) indicate that an extended period of maternity leave is counterproductive since it postpones return to work, reduces skills and might cause a further disincentive to re-entry.

Figure 2.4 presents the relationship between the two unexplained wage gaps, the glass ceiling and sticky floor effects on the one hand and the union membership rate on the other. The relationship of the unexplained part of the mean and median wage gap, in Graphs 1 and 2, Figure 2.4, is negative and statistically significant at the 5% level. Thus, unionism appears to be associated with reductions in the wage gap at the center of the wage distribution. Graphs 3 and 4, Figure 2.4, reveal a positive relation between the gender gap at the top and bottom of the wage distribution and the union membership rate but this is not significant at the top and significant at the 5% level at the bottom of the distribution. This latter effect may arise if unions pay less attention to the interests of female and (so they may feel) more marginally attached members.

2.6 Conclusion

Using data from the 2007 EU-SILC, the gender wage gap is examined for a set of 24 EU member countries. The gender wage gap varies considerably between countries, ranging from

0.502 ln wage points in Cyprus to 0.087 ln wage points in Slovenia.

The empirical results show that a large part of the wage gap is not explained by characteristics and, indeed, in several countries the unexplained gap is larger than the total, suggesting that female characteristics are superior to the male ones. When the decomposition is performed across the wage distribution using quantile regression, the unexplained gender wage gap widens at the top of the distribution (glass ceiling effect) in most countries and, in some cases, it also widens at the bottom of the distribution (sticky floor effect). The wage gap is wider when non-random selection into work is taken into account; this suggests that women in the selected samples are more highly qualified than in the population at large.

The unexplained gender wage may not be due to female disadvantage because data limitations may preclude study of important forces. Such forces may include country-specific institutions and policies which would not show up in individual (or even in a small group of) country studies. To explore these it is necessary to study a large number of countries where the variability is due to policies and not other forces, such as the proclivity to discrimination. Focusing on EU member states is useful in that they all, at least nominally, espouse non-discriminatory attitudes and practices. We find that the trade union membership rate is negatively related to the average and median unexplained wage gaps. Generous policies concerning the reconciliation of work and family life also reduce the mean and median unexplained wage gaps. These effects are rather different at the tails of the unexplained gender wage gaps. There is some evidence that countries with more generous work-family reconciliation policies tend to have stronger glass ceiling and sticky floor effects and regression analysis suggests that, at the mean, this may be due to maternity policies. It is conceivable that, if these are long and generous, they may encourage absences from the labour market which, in the end, have unintended effects as returning female workers are only able to command lower wages. Such effects, if confirmed by further study, would suggest that care should be taken in the design of work-family reconciliation policies.

Chapter 3

A Contribution to the Empirics of Welfare Growth

3.1 Introduction

The macroeconomic growth literature has typically used real per capita income as a proxy for economic conditions and quality of life across countries. This fails to capture other aspects of welfare. For example, recent improvements in health and life expectancy are not taken into account. Becker et al. (2005) introduce a welfare-corrected 'full' income measure that incorporates the value of gains in life expectancy in addition to real income per capita. In this chapter, we look at the determinants of the growth rate of this welfare measure. Our purpose is to compare the impact of economic, geographic, institutional, and health-related variables on 'full' income growth versus income per capita growth, and identify factors that have differential impact on these two measures of growth. Such differential impact would then suggest that greater use of some existing policies or the use of different policies might be appropriate if the target is to improve welfare rather than the income component of welfare alone.

A number of papers have asked whether international health outcomes are a by-product of economic growth or whether non-income factors are in part responsible. The latter argument is made by Preston (1975, 1980, 1996) and more recently by Becker et al. (2005), Soares (2007b,a), Papageorgiou et al. (2007), and Ricci and Zachariadis (2010). Our work is in line with this body of work. It is precisely when there are non-income determinants of health outcomes, that one can consider health as a separate component of welfare. If income was the sole determinant of health, then studying economic growth across countries would suffice to characterize the path of cross-country health outcomes and broader welfare growth. In contrast, if there are non-income determinants of health then factors driving welfare growth might well be different from those relevant for economic growth, with important policy implications.

Our benchmark is the empirical model from Mankiw et al. (1992). To this basic framework, we add institutions, health-related, and geography-related variables in addition to purely economic explanatory variables. Using a cross-section of 74 countries for the period from 1960 to 2003, our main result is that determinants may differ or have different impact on welfare outcomes as compared to economic outcomes.

We find that human capital in the form of secondary educational attainment, plays a more significant role in determining welfare growth than in determining economic growth. This suggests that policies targeting human capital might have a much greater effect on the welfare of societies than one would think by looking at their impact on economic growth alone. Moreover, measures of institutions like government stability have a larger effect on 'full' income growth compared to their impact on economic growth suggesting that continuity in governance is conducive to the long-run maximization of welfare, likely through the uninterrupted provision of health-related inputs, public infrastructure, and public health-related information. The quality of health institutions also has a greater and significant effect on welfare growth that is statistically different than the smaller and typically insignificant effect of health institutions on economic growth. Based on panel estimation, the same finding about the relative impact on welfare versus economic growth holds for nutrition and physical investment. Finally, the finding from Becker et al. (2005) regarding convergence in a bivariate setting, is confirmed and shown to be robust and implied convergence much faster in the presence of a variety of economic, geographic, institutions-related, and health-related variables.

In the next section we describe and justify the empirical concepts utilized in this application, and the data used to construct these. In section 3.3, we motivate our empirical specification, describe the estimation, and present our results. The last section briefly concludes.

3.2 Empirical Concepts

The methodology used to construct the welfare measure is proposed by Becker et al. (2005). The authors calculated the value of increases in life expectancy and add this to real GDP per capita. The value of life expectancy improvements is calculated by using an indirect utility function. We consider a representative individual who receives the country's income per capita in all years of life and lives to the age corresponding to the country's life expectancy at birth. We consider this representative individual at two points in time, with lifetime income and life expectancy denoted by Y and T, and Y' and T' respectively. We are interested in the infra-marginal income $w(T,T')$ that would give a person the same utility level observed in the second period, but with the life expectancy observed in the first period:

$$V\left(Y' + w\left(T, T'\right), T\right) = V\left(Y', T'\right) \tag{3.1}$$

Becker et al (2005) consider the following functional form for the indirect utility function $V(Y,T)$:

$$\begin{aligned} V(Y,T) &= \max_{\{c(t)\}} \int_o^T e^{-\rho t} u(c(t))\,dt \\ subject\ to\ Y &= \int_o^T e^{-rt} y(t)\,dt = \int_o^T e^{-rt} c(t)\,dt \end{aligned} \tag{3.2}$$

where $y(t)$ is income at age t, $c(t)$ consumption at t, r is the interest rate, and ρ is the subjective discount factor. Based on certain assumptions we are able we obtain a closed form solution for w:

$$w\left(T, T'\right) = \left[y'^{1-\frac{1}{\gamma}} \times \left(\frac{1 - e^{rT'}}{1 - e^{rT}} \right) + a\left(1 - \frac{1}{\gamma}\right) \times \left(\frac{e^{rT} - e^{rT'}}{1 - e^{rT}} \right)^{\frac{\gamma}{1-\gamma}} \right] - y' \tag{3.3}$$

The set of parameters (α, γ, r) needed to compute $w\left(T, T^1\right)$ are calibrated from other parameters more commonly estimated in the "value of life" and consumption literature's[1]. The growth rate in 'full' lifetime income that values gains in longevity in addition to gains in material income is then given by: $G = \frac{Y' + w(T,T')}{Y} - 1$[2].

Table 3.1 presents the value of the longevity gains observed between 1960 and 2003. In columns 1-4 of the Table 1 we present life expectancy and income per capita in 1960 and 2003. The next column present the annual value of life expectancy gains, $w\left(T^{1960}, T^{2003}\right)$. In the last two columns we present the growth rate of income and "full" income. Results are presented for the regions of the world according to World Bank classification.

[1]The parameters a and ε are estimated from the expressions: $a = c^{1-\frac{1}{\gamma}} \left(\frac{1}{\varepsilon} - \frac{1}{1-\frac{1}{\gamma}} \right)$, where $\varepsilon = \frac{u'(c)c}{u(c)}$ is the elasticity of the instantaneous utility function. We employ the same parameter values suggested by Becker et al. (2005), where $\gamma = 1.25$ and $a = -16.2$. The annual interest rate r is assumed to be 0.03.

[2]It should be noted that although this accounts for improvements in home-produced or nonmarket health, it still leaves out other factors that can affect welfare like the value of leisure and other non-market goods, much like real GDP per capita.

The average value of life expectancy gains in the whole sample in terms of annual income is \$2.059. These gains are significant if we compare them to the initial value of income per capita. These gains reached the 67 percent of the initial income per capita. The average growth rate for "full" income is 3.9 percent as opposed to 3.1 percent for income per capita.

Europe and Central Asia and North America had the highest life expectancy level in 1960 with 68 and 70 years respectivly. Until 2003 the increase in these two regions was small. In other regions of the world these changes were enormous. Life expectancy in East Asia and Pacific, Middle East and North Africa and Latin America and the Carribean increased considerable. Life expectancy in these regions converged to the levels of the developed regions of the world. The values of gains in longevity also reflect this trent. If we compare them to the initial income per capita these gains reach 323, 127 and 98 percent for the East Asia and Pacific, Middle East and North america and the South Asia region respectivelly. In therms of yearly growth rates East Asia and Pacific and South Asia are the top performers.The region with the worst performance is Sub-Saharan Africa. Life expectancy increased only by five years. The value of life expectancy gains correspond to a meer \$57. When we estimate the growth rate of "full" income it is on average equal to the growth rate of income.This indicate that unlike income changes longevity changes reduced the welfare differences across countries.

Table 3.1: Value of Life Expectancy gains by region of the world, 1960-2003

	1960		2003		Value of life exp. gains in annual income	Yearly Growth Rate	
	Life Exp.	GDP pc	Life Exp.	GDP pc		Income	Welfare
Europe & Central Asia	68	7.223	73	15.864	1.629	2.6	2.9
East Asia & Pacific	43	1.115	71	6.812	3.610	5.0	6.3
Latin Am. & Carib.	56	3.733	72	7.281	1.505	1.6	2.1
Middle East & N. Africa	48	2.343	70	6.720	2.972	2.2	2.4
North America	70	12.962	77	34.344	2.972	2.2	2.4
South Asia	44	892	64	2.857	877	2.7	3.4
Sub-Saharan Africa	41	1.457	46	1.769	57	0.1	0.1
World	50	3.085	67	8.096	2.059	3.1	3.9

The measure proposed by Becker et al. (2005) is not the only welfare corrected GDP measure. Jones and Klenow (2010) introduce a GDP growth measure that incorporates appart from improvements in health (life expectancy at birth), consumption, leisure and inequality of consumption. The welfare function used by Jones and Klenow (2010) is given by:

$$V(e,c,l,\sigma) = e \times \left(\bar{u} + logc + v(l) - \frac{1}{2}\sigma^2\right)$$

where e is life expectanvy at birth, c is consumption, l stand for leisure and σ^2 is the inequality of consumption. The measure of welfare is estimated as the geometric mean of the Compensating and Equivalent variation measures. The Compensating Variation (CV) measure is estimated as follow: by which factor λ_i must we adjust consumption in the Unites States in order to make an individua being indifferent between living in the United States and another country i? The welfare mformula become:

$$log\lambda_i^{CV} = \frac{e_i - e_{US}}{e_{US}} \times \left(\bar{u} + logc_i + v(l_i) - \frac{1}{2}\sigma_i^2\right) +$$

$$\begin{aligned} &+logc_i - logc_{US} \\ &+v(l_i) - v(l_{us}) \\ &-\tfrac{1}{2}\left(\sigma_I^2 - \sigma_{US}^2\right) \end{aligned}$$

The Equivalent Variation (EV) measure is estimated as follow: by which factor λ_i we must increase consumption in country i to raise welfare there to the Unites States level? The welfare formula become:

$$log\lambda_i^{EV} = \frac{e_i - e_{US}}{e_{US}} \times \left(\bar{u} + logc_{US} + v(l_{US}) - \frac{1}{2}\sigma_{US}^2\right) +$$

$$\begin{aligned} &+logc_i - logc_{US} \\ &+v(l_i) - v(l_{us}) \\ &-\tfrac{1}{2}\left(\sigma_I^2 - \sigma_{US}^2\right) \end{aligned}$$

In a related paper, Fleurbaey and Gaulier (2009) construct a full-income measure for 24 OECD member countries. Like Jones and Klenow (2010) they incorporate into income life expectancy gains, leisure, and inequality of consumption but their contribution differs both theoretical and empirical to Jones and Klenow (2010) measure. We use the measure of Becker et al. (2005) because we are able to use the code provided by the authors to reconstruct the 'full' income growth rate at different time periods. Jones and Klenow (2010) and Fleurbaey and

Gaulier (2009) provide information about their welfare measure but they have not published their code that will enable us to reconstruct their measure in different time periods.

For the cross-sectional applications, the 'full' income growth rate is constructed for 93 countries using real GDP per capita in 1960 and 2003 taken from the Penn World Tables volume 6.2 (PWT), and life expectancy for 1960 and 2003 taken from the World Development Indicators (WDI). The life expectancy variable is reported sporadically in the following pattern: 1960, 1962, 1967, 1970, 1972... up until 2002, for 175 countries. Thus, based on the availability of the life expectancy data, the welfare and income variables are constructed in four intervals: 1962-1970, 1972-1980, 1982-1990 and 1992-2000, for panel estimation purposes.

The standard Solow model explanatory variables considered include initial income per capita and the investment share in GDP both taken from the PWT, and population size data used to construct population growth rates obtained from the WDI. Our primary measure of human capital is the percentage of population with completed secondary education aged 15 and over, taken from the Barro and Lee (2001) dataset. These data are reported every five years starting from 1960 until 2000. Increased educational status affects economic outcomes but can also affect health improvements by two separate channels, consistent with Becker (2007). First, increases in education lead to an increase in expected wealth and thus in health spending which as a result increases survival rates. Second, educated individuals can make more efficient use of given health inputs by acquiring better health information and health related habits, thus increasing their survival probability. Kenkel (1991) emphasizes better information on health, and Grossman (1972) better decision-making by more educated individuals. In line with this, the aggregate level of education in the economy can be thought of as improving the quality of health services offered within a country, consistent with greater absorptive capacity for health-related technology and ideas[3].

Health-related variables are obvious candidates as determinants of the life expectancy component of our measure of 'full' income, and are also possible determinants of economic growth to the extent that life expectancy affects economic growth consistent with Arora (2001) and Weil (2007). The health-related variables being considered include the number of physicians per thousand people, a health institutions quality index, and the number of AIDS cases per 100,000 people. The number of physicians is taken from the WDI database and data are available for the whole period under consideration[4]. The health institutions quality index is taken

[3]Soares (2007b)states that "[*t*]echnologies related to individual-level inputs used in the production of health seem to be subject to the effectiveness with which individuals can use these inputs" so that "more educated individuals have higher survival advantage in diseases for which medical progress has been important." Similarly, Cutler, Deaton and Lleras-Muney (2006, p. 115) write that "the differential use of health knowledge and technology [*is*] almost certainly [*an*] important part of the explanation" as to why "[*t*]here is most likely a direct positive effect of education on health."

[4]For most countries this is reported on a five or ten year interval basis.

from the World Health Organization's (WHO) World Health Report (2000). Finally, the AIDS variable is taken from the WHO's Global Health Atlas (2007) and covers the period between 1979 and 2001[5]. These three variables are likely to be important determinants of the general health status of each country.

Physicians act as a rival input into the health production function but are also associated with the spread of new non-rival medical-related ideas and are complementary to the use of new medical technology. The number of physicians per thousand persons is highly correlated with other health indicators so that it appears to capture well the overall availability of health care in each country[6]. It is also positively associated with the education level in each country. The correlation coefficient between average years of secondary education and physicians is 81 percent. This is plausible, since if education participation is higher then the number of health care professionals completing their studies should also be higher. This collinearity should then affect the estimated coefficient for education and its interpretation when physicians availability is added in the regression specifications along with education attainment rates.

The Health Institutions Quality Index is a measure of efficiency of National Health Systems. The index is used to assess the performance of countries in terms of achieving a broad set of health outcomes[7].The index takes into account the level of health (using Disability Adjusted Life Expectancies[8]), health inequality, responsiveness[9], responsiveness inequality, and fairness of financial contribution[10]. The resulting composite index is a weighted average of these five categories, i.e., health with weight 25%, health inequality with weight 25%, level of responsiveness with weight 12.5%, distribution of responsiveness with weight 12.5% , and fairness of financing with weight 25%. A more detailed description of this index as well as its subcomponents can be found in WHO (2000) and Evans et al. (2001).

[5]The earliest observation available for the AIDS variable is in 1979 while regular observations for most countries start from the mid-1980's.

[6]The correlation coefficient of the number of physicians with the number of hospital beds per thousand persons is 73 percent, 88 percent with improved water conditions and -77 percent with malaria prevalence.

[7]The construction of the index is described in detail in Evans et al. (2001) and in a publication by the WHO in 2000.

[8]The number of disability days is estimated using three pieces of information, birth and death rates, the prevalence of each type of disability at each age, and the weight assigned to each type of disability. These days are used to adjust the Life Expectancy for each country and provide a more accurate view of health because people live part of their lives in less than full health.

[9]The responsiveness measure assesses "how the system performs relative to non-health aspects, meeting or not meeting a population's expectations of how it should be treated by providers of prevention, care or non-personal services." (WHO 2000 p.31). The measure takes into account two broad categories of variables. The first is related to the respect that the system pays to persons (includes respect for the dignity of the person, confidentiality etc), and the second the system client orientation (includes prompt attention, amenities of adequate quality etc).

[10]This measure assesses the ability of the health system to distribute fairly across households the burden of health financing. Under this metric, the "health system is perfectly fair if the ratio of total health contribution to total non-food spending is identical for all households, independently of their income, their health status or their use of the health system" (WHO 2000 p.26).

Inclusion of AIDS is needed to capture the devastating effect of this pandemic during the last twenty-five years. It should be noted that the effect is greater in Sub-Saharan Africa where a steady reduction in life expectancy has been observed over the past decade or so. Due to its prevalence in Sub-Saharan Africa which faces a broader range of economic problems and diseases, AIDS can have a more general interpretation proxying for a number of bio-geographic factors affecting health outcomes. Moreover, the effect of AIDS is associated with the failure of public institutions and the lack of proper education to react and take measures to reduce it.

Another factor that relates to health but is likely to affect both income and health status, is nutrition (average dietary energy consumption.) A student which is well fed is more able to acquire knowledge and train herself to become a productive worker. A worker with a better diet is more likely to work harder and longer, and as a result produce more output. More importantly an individual with a balanced diet has an increased probability of survival. These facts are stressed in the work of Fogel (1994). The nutrition variable is taken from the World Food Organization (FAO) Statistical Yearbooks. It is reported as an average for 1969-71, 1979-81, 1990-92, 1995-97, and 2001-03. These data are generally available for 141 countries.[11]

The measures used as proxies for the institution status in each country are government stability and contract variability/risk of expropriation. Woodruff (2006) argues for the use of variables measuring both formal and informal institutions, and suggests that government stability and risk of expropriation serve this dual goal. It should thus be noted that the measures of government stability and risk of expropriation we use in this application capture both differences in formal but also informal institutions between countries, unlike measures of the type of electoral rule, legal system structure, and judicial independence which capture only formal institutional structure.

Government stability captures "government's ability to stay in office and carry out its declared programs depending upon such factors as the type of governance, cohesion of the government and governing parties, approach of an election, and command of the legislature. It is created from three subcomponents: government unity, legislative strength and popular support. This index is taken from the International Country Risk Guide (2008) dataset made available by the Political Risk Service (PRS) group, and is reported on a monthly basis from 1984 to 2003 for at least 140 countries in any one month. This index is given on a scale between zero and 12, with 12 amounting to very high degree of Government stability. The minimum and maximum values across countries in our sample are 3.5 and 11.2 respectively. In our estimation exercise, we consider the natural log of this variable.

[11] This is the case for all sub-periods except for the last when the data become available for 173 countries, including 29 countries that used to belong to the Warsaw Pact or came about from the dissolution of the USSR, Yugoslavia, and Czechoslovakia.

Contract variability/risk of expropriation assesses the factors affecting the risk in investment and broad property rights. It is used as a proxy for the quality of institutions in a given time period. It is made available by the PRS database on a monthly basis from 2001 to 2003 for at least 90 countries on a scale between zero and 4. These data are used in conjunction with the series previously used by Knack and Keefer (1997) and more recently by Acemoglu et al. (2001) covering the earlier period between 1985 and 1995. A high value amounts to very high Risk of Expropriation. In the regressions, we utilize the natural logarithm of these values plus unity[12].

The last group of variables utilized here as potential determinants of income and full income relates to geography, including climate and natural resources. For example, countries with adverse weather conditions might be less productive than countries where workers face better weather conditions. Climate might also influence health status in a country. For example, tropical climates are conducive to the development of diseases like malaria or tuberculosis. Following Acemoglu et al. (2001), four different groups of geography variables are identified: namely temperature, humidity, soil quality and natural resources. These data are obtained from Parker (1997) and were assembled in the early 1990's.

Temperature variables include: average temperature, minimum "monthly high", maximum "monthly high", minimum "monthly low"[13], and maximum "monthly low", all of them in degrees Fahrenheit. In the regressions, we include two of these variables: maximum "monthly high" and minimum "monthly low" that are meant to capture the effect of extreme temperatures on final output and on health. Humidity variables include: morning minimum, morning maximum, afternoon minimum, and afternoon maximum in percentage points. Among these, we consider afternoon maximum humidity as the one most likely to have an effect on economic and health outcomes. Soil quality variables include: dummies for steppe low latitude, steppe middle latitude, desert middle latitude, desert low latitude, dry steppe wasteland, desert dry winter, and highland. We construct a variable that sums up all of these adverse soil characteristics, which is then expected to have an adverse effect on economic and health outcomes. National resources variables include: number of minerals present in a country (ranging between zero and 37 for the countries in our sample), oil resources in thousands of barrels per capita, and percent of world reserves of gold, iron, and zinc. Each of these three natural resources variables is expected to have a positive impact on economic and health outcomes. Overall, we consider seven geography-related variables in natural logs. Namely, these are: maximum "monthly high" and minimum "monthly low" temperature, afternoon maximum humidity, a variable capturing

[12]The Knack and Keefer (1995) data are available on a 0-10 scale. For estimations reported in Tables 3.2 and 3.3, data from both sources are first rescaled in the 0-100 interval and the average of the two periods is constructed. For Table 3.3, the natural log of the Risk of Expropriation for 1985-95 from Knack and Keefer (1995) is used.

[13]Minimum monthly low has negative values for 12 countries. Thus, before taking the natural log, we add to all observations the absolute value of the minimum observation plus one.

adverse soil characteristics related to desert-type, steppe-type and highland morphology, and natural resources in the form of oil, number of minerals, and percent of world reserves of gold, iron and zinc.[14]

Our sample includes 74 countries, appearing in Table B.1, with data averaged over the period 1960-2003[15] or the earlier period from 1960 to 1979, subject to availability of each variable. Since we need a data set that includes sufficient variation, it is desirable to consider developing countries as well as industrialized economies. This comes at the cost of the time dimension of the sample since quite a few of the variables we consider are exceedingly sparse over time, especially so for developing countries. Focusing on long-run time averages in levels seems more appropriate due to the inherent long-run nature of the relation under study. Moreover, averaging over long periods helps alleviate potential measurement error problems. This greatly improves the reliability of the education data used as shown in previous work by Topel (1999) and Krueger and Lindahl (2001).

We also exploit the panel dimension of the data, considering changes over each decade for the dependent variables as described earlier, and decade-averages for the explanatory variables as described below. Investment, physicians, and the population growth rate $(h+g+\delta)$ are constructed by averaging over the periods 1960-1968, 1970-1978, 1980-1988, and 1990-1998. The initial income variable for the income equation is estimated using the log income in the start of each interval of the dependent variable, that is: 1962, 1972, 1982, and 1992. For explaining welfare growth, the log welfare income is used for 1972, 1982 and 1992. For 1962, log income is used due to lack of availability of welfare income in the beginning of the sample. To construct the education variable, the observations for 1960 and 1965 are used to calculate the mean for the first interval, 1970 and 1975 for the second, and similarly 1980 and 1985, and 1990 and 1995 are used for the third and fourth intervals respectively. For AIDS, since this is first observed in 1979, we assume zero incidence for all countries prior to that date. The nutrition variable is constructed using the 1969-71 survey for the first panel interval, the 1979-81 survey for the second, the 1990-1992 survey for the third, and the 1993-95 and 1995-97 surveys for the last interval of our panel. Finally, we note that certain variables cannot be included in the panel estimation framework, since they are not available over time. For example, government stability is reported only after 1984. Similarly, risk of expropriation is available only as an overage for the period 1985-1995 and annually for 2001 to 2003.

[14]Alternatively, we considered the full set of 21 geography-related variables used in Acemoglu et al. (2001) pertaining to temperature, humidity, soil quality, and natural resources as listed above. The estimates for the other variables were qualitatively unchanged after including these mostly insignificant geography-related variables, relative to the estimates obtained using the shorter set of seven sometimes significant geography variables.

[15]The period over which we construct the dependent variables is somewhat different for three of the countries. For Canada and Israel we consider the available data from 1960 to 2002, and for Tunisia from 1962 to 2003.

3.3 Empirical Estimation and Results

3.3.1 Motivation for Empirical Specification

The benchmark regression model used here is based on the framework proposed in the seminal paper of Mankiw et al. (1992). Starting from the basic Solow (1956) growth model, they provide an estimable equation which relates income per capita with investment, education, and population growth. As the Solow model implies a capital share of about 0.6 which is higher than the conventional value of about one third, Mankiw et al. (1992) considered an augmented version of the Solow model where human capital enters as a factor in the production function. The estimation of this augmented model yielded results closer to the actual value of the income share of investment. The Cobb-Douglas production function assumed is:

$$Y_t = K_t^a H_t^b (A_t L_t)^{1-a-b}, L_t = L_0 e^{\eta t}, A_t = A_0 e^{gt}, \dot{K} = sY_t - \delta K_t \tag{3.4}$$

where H is the stock of human capital, Y is output, L is labor, A is the level of technology, and (a,b) are the share of capital and labor. Solving for the steady-state income per capita one obtains:

$$\ln\left(\frac{Y}{L}\right) = \ln A_0 + gt + \frac{a}{1-a-b}\ln s_k + \frac{a+b}{1-a-b}\ln(\eta+g+\delta) - \frac{b}{1-a-b}\ln s_h \tag{3.5}$$

Technology varies across countries and it is assumed to equal $\ln A_0 = c + \varepsilon_i$, with c a constant and ε_i a white noise random error. The term $g+\delta$ is assumed constant across nations and set equal to 0.05. The term gt is eliminated because the equation is estimated on a cross section of countries. The estimable equation is:

$$\ln\left(\frac{Y}{L}\right)_i = \beta_0 + \beta_1 \ln s_i + \beta_2 \ln(\eta+g+\delta)_i + \beta_3 \ln h_i + \varepsilon_i \tag{3.6}$$

where $\frac{Y}{L}$is income per capita, s_i is investment, η is the population growth rate, g is the rate of technological growth, and δ is the depreciation rate of capital.

We use this formulation because it is parsimonious and can easily be extended to include additional sets of explanatory variables like health inputs which can be thought of as yet an other dimension of human capital. Bernanke and Gurkaynak (2001) show that the framework proposed by Mankiw et al. (1992) is not just specific to the Solow growth model but to all models that admit a balanced growth path.

Additional inputs that might be expected to affect the determination of income can be included to the basic specification described by Eq. (3.6). For example, *health* could play an important role in determining income. Countries experiencing high levels of investment in health are expected to have a healthier labor force with increased longevity and as a result produce more output. Possible factors that determine the level of health in each country and can be used to analyze its impact on income and welfare, include the number of medical staff and nutritional levels. Another important factor likely to affect income and welfare is the quality of *institutions*. For instance, the presence of strong institutions in a country is conducive to government and broader stability which can have a positive impact on long-term economic and broader welfare outcomes. Finally, *geography* can be expected to matter for economic and welfare growth independently or indirectly through its impact on health and institutions. The extended model that will be used to evaluate the importance of the additional factors affecting income is thus given by:

$$\begin{aligned}\Delta \ln\left(\frac{Y}{L}\right)_i &= \ln\left(\frac{Y}{L}\right)_i - \ln\left(\frac{Y}{L}\right)_0 = \beta_0 - \ln\left(\frac{Y}{L}\right)_{i,0} + \beta_1 \ln s_i \\ &\quad + \beta_2 \ln(\eta + g + \delta)_i + \beta_3 \ln h_i + \underline{\gamma} X_i + \underline{\zeta}\Omega_i + \underline{\lambda}\Phi_i + \varepsilon_i\end{aligned} \tag{3.7}$$

In addition to the usual Solow variables, the set of health-related variables X will be included, followed by the set of institutions-related variables Ω, and geography-related variables Φ. In each of the last three cases, we estimate a number of coefficient estimates $\underline{\gamma}$, $\underline{\zeta}$, and $\underline{\lambda}$ that relate to the impact of individual health-related, institutions-related, and geography-related variables respectively.

One of the assumption in cross-section growth regressions that the unobserved growth terms ε_i are uncorrelated with other hand side variables and more imporantly initial income. If we do not include country specific effects we will have ommited variables bias[16]. These countries characthersitics may capture differences in counties production function, for example technology. The panel data framework allow for differences in country “unobserved” characteristics. We extend the empirical estimation framework of Mankiw et al. (1992), following Islam (1995) and Caselli et al. (1996). The panel estimation model that will be used is given by:

$$\begin{aligned}\Delta \ln\left(\frac{Y}{L}\right)_{i,t} &= \ln\left(\frac{Y}{L}\right)_{i,t} - \ln\left(\frac{Y}{L}\right)_{i,t-1} = \beta_0 - \ln\left(\frac{Y}{L}\right)_{i,t-1} + \beta_1 \ln s_{i,t} \\ &\quad + \beta_2 \ln(\eta + g + \delta)_{i,t} + \beta_3 \ln h_{i,t} + \underline{\gamma} X_{i,t} + \underline{\lambda}\Phi_i + \xi_t + v_i + \varepsilon_{i,t}\end{aligned} \tag{3.8}$$

[16]In the cross section estimation we assume that such effects are uncorrelated with other right-hand side variables.

3.3.2 Results

3.3.2.1 Cross-Section Estimation

Table 3.2 presents results for the case in which all explanatory variables are averaged over the whole period under study i.e. from 1960 to 2003, subject to availability of each variable over time.[17] We present estimates with real income per capita growth as the dependent variable in odd-numbered columns and estimates with welfare growth as the dependent variable in even-numbered columns. In columns (1) and (2), the basic empirical model given in Eq. (3.7) is estimated without the additional explanatory variables (i.e. $\underline{\gamma} = \underline{\zeta} = \underline{\lambda} = 0$). In columns (3) and (4), we add health inputs in the form of AIDS and physicians imposing $\underline{\zeta} = \underline{\lambda} = 0$, and in columns (5) and (6) we consider an additional health-related variable regarding nutrition status. In columns (7) and (8), we allow for institutions-related variables in the form of government stability and risk of expropriation, imposing $\underline{\lambda} = 0$ on Eq. (3.7). Finally, in columns (9) and (10), we relax all constraints and allow for geography-related variables in addition to economic, health-related, and institutions-related explanatory variables. All variables utilized in the specifications presented in Table 3.2 are in natural logarithms so that our estimates can be interpreted as elasticities.

In general, the main variables have the expected effect. Initial income has a negative impact, and education, physicians, and government stability have a positive impact on both the rate of economic growth and welfare growth. We note, however, that the magnitude of the impact of these explanatory variables typically differs across the two measures of growth.

The estimated impact of initial income on the growth rate of real income per capita ranges from -0.51 in column (1) to about -0.7 in column (7). This impact is always lower in absolute terms than that on the growth rate of ‘full’ income which ranges from about -0.6 in column (2) to -0.77 in column (8). This difference suggests faster convergence for ‘full’ income than for real income per capita, consistent with life expectancy catching up faster than income in less developed countries relative to developed countries. This resembles the main empirical finding in Becker et al. (2005). In that paper, a bivariate regression of each of the two income measures growth rate on initial income was used to show that convergence has been much more rapid for ‘full’ income relative to income growth rates, a finding that can be attributed in part to the relatively fast technology diffusion for medical knowledge documented in Papageorgiou et al. (2007). The coefficients of the regression of income and full income to initial income in Becker et al. (2005) are -0.13 and -0.26 respectively (shown in their Table 3) and statistically

[17] For example, the institution measures are available only since 1984, geography measures typically have no time variation, and AIDS prevalence is not relevant prior to the late 1970’s.

significant in both cases.[18] Here, this relative convergence finding based on a bivariate relation, is confirmed and found to be robust to adding a number of additional economic, health-related, institutions-related, and geographic variables. A test of the hypothesis that the coefficient of initial income for each regression pair is equal, is overwhelmingly rejected at the one percent level of statistical significance. Furthermore, the implied convergence rate is found to become faster as more explanatory variables are added. The absolute impact of initial income and the implied convergence rate increase monotonically as we control for additional groups of variables going from left to right in Table 3.2, except for the last two columns at which point we include an additional seven geography-related variables.

Turning our attention to secondary education attainment, this also appears to be more important for 'full' income than for real income per capita growth. The elasticity of income per capita with respect to education ranges from as high as 0.29 in column (1) to a low of 0.10 and statistically insignificant in column (9). The elasticity of 'full' income with respect to education ranges from a high of 0.36 in column (2) to a low of 0.12 and marginally insignificant (p-value equal to 10.2 percent) in column (10). Excluding the observation for Zambia which appears to be an outlier in this case[19], the estimate for the impact of education on welfare growth for the specification in column (10) changes to 0.16 and significant with p-value equal to 0.037 (0.14 with p-value 0.056 for economic growth.) We also note the insignificant impact of physicians on both economic and welfare growth, controlling for secondary education. Since the two variables are closely related conceptually (countries with higher secondary educational attainment would be expected to also have a greater number of graduates out of medical school) and highly correlated empirically, it is to be expected that including both in the same regression somewhat weakens the individual significance of each of these variables, rendering the impact of physicians insignificant in this case.

The conclusion is that human capital in the form of secondary education attainment has a greater effect on welfare growth than on economic growth. This conclusion holds for every single pair of specifications comparing the impact on income versus 'full' income growth. Testing the null hypothesis that the coefficient of education in each regression pair is equal, the null is rejected at the one percent level for columns (1) and (2), at the five percent level for columns (5) and (6), at the ten percent in columns (3) and (4) and columns (7) and (8). For columns (9) and (10) the associated p-value is 0.125 (or 0.102 once the Zambia outlier is excluded). We note that the effect of education is reduced as we add additional groups of variables. This is the case since education might matter in part indirectly through some of the

[18] Their sample consist of 96 countries. Our sample is quite smaller because some observations are not available for all the explanatory variables that we use.

[19] This is the most influential observation in terms of affecting the estimated coefficient for each of our main explanatory variables: education, health institutions quality index, and government stability, for the specifications estimated for columns (9) and (10) of Table 3.2.

other included variables or because of the associated collinearity problem between education and other included variables. For example, a more educated person is less likely to contact AIDS[20] and countries with a good educational system are more likely to provide education, training, and information on health issues.

Similarly to secondary education, the health institutions quality index has a positive effect that differs in magnitude for income and 'full' income. The estimated income elasticity of the health institutions variable ranges from 0.44 and statistically insignificant in column (7) to 0.61 in column (9). The estimated 'full' income elasticity of health institutions is as high as 0.73 in column (10) and as low as 0.56 in column (8). Moreover, the estimated impact of the health institutions quality index on welfare growth is always statistically significant, even when we include an additional seven geography variables in column (10). The quality of health institutions has a greater effect on welfare growth than on economic growth. This conclusion holds for every single pair of specifications in columns (3) to (10) comparing the impact on income versus 'full' income growth. Testing the null hypothesis that the coefficient of health institutions quality in each regression pair is equal, the null is rejected at the one percent level for columns (9) and (10), and at the five percent level in columns (3) and (4), columns (5) and (6) and columns (7) and (8).

From the discussion in the above three paragraphs, we infer that human capital and health institutions have a usefulness for the welfare of nations that is not captured in standard economic growth regressions. The same can be said for a number of other factors. Notably, this is the case with the institutions-related variable of government stability. While conducive to a good economic environment, the stability and continuity of governance has an even bigger effect on welfare when one accounts for its impact on life expectancy. It appears that the willingness and ability of governments to provide an uninterrupted flow of health-related inputs and information pertaining to long-run maximization of society's overall welfare, is related to the absence of discontinuities in governance that may distract the provision of health-related services and the planning and construction of public infrastructure in the long-run. The estimated impact of the stability of government on 'full' income growth is equal to 1.01 in column (8) while its impact on economic growth is 0.85 and insignificant as shown in column (7). Once we include geography variables, the impact of government stability on 'full' income growth in column (10) is now 1.17, while its impact on economic growth in column (9) is 0.99. For both comparisons, the null that the impact of government stability on welfare growth is equal to its impact on economic growth can be rejected with p-values that are below ten percent in the first case and below five percent in the second case.

[20] The unconditional correlation of education with AIDS is -32.7 percent.

Table 3.2: Explaining period-averages of income and full income.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Income	Welfare	Income	Welfare	Income	Welfare	Income	Welfare	Income	Welfare
Income	-0.508***	-0.595***	-0.638***	-0.718***	-0.694***	-0.770***	-0.697***	-0.771***	-0.688***	-0.768***
	(0.067)	(0.084)	(0.096)	(0.101)	(0.092)	(0.101)	(0.089)	(0.097)	(0.091)	(0.101)
$\eta + g + \delta$	-0.481***	-0.453***	-0.407***	-0.368***	-0.284***	-0.254**	-0.225**	-0.201*	-0.229*	-0.194
	(0.099)	(0.107)	(0.090)	(0.093)	(0.099)	(0.105)	(0.107)	(0.111)	(0.131)	(0.125)
Investment	0.250*	0.218	0.194	0.166	0.175	0.149	0.212	0.190	0.186	0.145
	(0.143)	(0.154)	(0.141)	(0.148)	(0.145)	(0.153)	(0.134)	(0.142)	(0.131)	(0.142)
Education	0.289***	0.364***	0.174**	0.196**	0.176***	0.198***	0.151**	0.171**	0.102	0.120
	(0.059)	(0.064)	(0.072)	(0.074)	(0.065)	(0.067)	(0.064)	(0.065)	(0.070)	(0.072)
Physicians			0.111	0.123	0.050	0.066	0.088	0.109	0.065	0.104
			(0.073)	(0.079)	(0.075)	(0.081)	(0.079)	(0.085)	(0.073)	(0.083)
AIDS			-0.003	-0.026	0.008	-0.015	0.005	-0.018	0.002	-0.018
			(0.023)	(0.024)	(0.022)	(0.023)	(0.024)	(0.025)	(0.021)	(0.022)
Health Institutions Index			0.590	0.722**	0.520	0.657*	0.435	0.561*	0.610**	0.729**
			(0.368)	(0.360)	(0.339)	(0.335)	(0.316)	(0.305)	(0.273)	(0.281)
Nutrition					1.366***	1.272***	0.904*	0.740	0.923*	0.714
					(0.442)	(0.464)	(0.479)	(0.492)	(0.542)	(0.563)
Government Stability							0.852	1.007*	0.992*	1.173**
							(0.527)	(0.563)	(0.517)	(0.556)
Risk of Expropriation							-0.046	-0.038	0.045	0.048
							(0.047)	(0.049)	(0.055)	(0.054)
Temperature (Max Monthly High)									0.082	0.250
									(0.438)	(0.449)
Temperature (Min Monthly Low)									0.024	0.036
									(0.046)	(0.048)
Afternoon Max Humidity									0.249	0.494
									(0.306)	(0.308)
Metals (Gold, Iron Ore, Zinc)									4.099*	3.395
									(2.223)	(2.247)
Oil									0.005	0.008
									(0.010)	(0.011)
Number of Minerals									0.111*	0.118*
									(0.058)	(0.062)
Soil (Dessert, Steppe or Highland)									-0.259**	-0.212*
									(0.112)	(0.122)
Constant	4.359***	5.054***	3.145**	3.329**	-6.924*	-6.047	-4.494	-3.367	-7.429*	-7.758*
	(0.435)	(0.500)	(1.414)	(1.467)	(3.516)	(3.746)	(3.572)	(3.748)	(3.935)	(3.890)
Observations	74	74	74	74	74	74	74	74	74	74
Adjusted R^2	0.564	0.555	0.640	0.674	0.677	0.700	0.688	0.713	0.725	0.744
Test Income	[0.000]				[0.000]				[0.000]	
Test Education	[0.000]		[0.066]		[0.044]		[0.062]		[0.125]	
Test Health Institutions Quality Index			[0.029]		[0.015]		[0.015]		[0.010]	
Test Government Stability							[0.086]		[0.042]	

Notes: *** p-value < 0.01, ** < 0.05, * < 0.10. In the last four rows, we report p-values for the null that the estimated impact on income and welfare is the same.

Finally, we note that two of the seven geography-related variables included in the specifications for which results are reported in columns (9) and (10), have a significant impact on both income and 'full' income growth. The number of minerals found in a country is positively associated with income and welfare growth, while adverse soil quality characteristics related to the presence of desert-type, steppe-type, and highland morphological conditions in a country, are found to have statistically significant negative effects on both income and 'full' income growth. Furthermore, the presence of precious metals is found to have a positive impact which is significant at a ten percent level for income per capita growth.

3.3.2.2 Instrumental Variables estimation

Explanatory variables may be endogenous to the income variables we set out to explain so that the IV methodology might be called for. The use of predetermined values of explanatory variables could alleviate the endogeneity problem to the extent that future values of income variables do not affect previous values of explanatory variables, so that initial values of variables could be used as predetermined instruments for the value of explanatory variables during the whole period. As the evidence for endogeneity appears strong (the null hypothesis that the specified variables can be treated as exogenous is rejected in four out of five cases for the 'full' income variable and in two out of the five cases for the income variable), we use an instrumental variables approach to address this issue. The null hypothesis that our instruments have no impact in the endogenous variables is strongly rejected with p-values lower than the 0.01 level in the regressions of each endogenous variables on all predetermined or exogenous variables. The strong rejection of the hypothesis is important for the finite sample properties of the IV estimator, as indicated by Wooldridge (2002).

In Table 3.3, we present estimates based on Eq. (3.7), utilizing now averages of lagged values of the explanatory variables as instruments for the average of the whole period. The initial period average value for the explanatory variables is taken over the period 1960-1979 or the earliest available sample.[21] The variables considered as potentially endogenous in columns (1)-(4) are education, investment and $\eta + g + \delta$, in columns (5)-(6) the nutrition variable is added, and in columns (7)-(10) the government stability and risk of expropriation variables are included in the set of possible endogenous variables.

The estimated coefficients are qualitatively similar to those for Table 3.3. Once again, the main variables have the expected effect: initial income has a negative impact, and educa-

[21] The specific sample period for each lagged variable used as an instrument is as follows: investment, $\eta + g + \delta$, and physicians are averaged over 1960-1979, education is averaged for 1960, 1965, 1970, and 1975, nutrition is constructed using the 1969-1971 and 1979-1981 surveys, government stability is averaged over 1984-1995, and risk of expropriation over 1985-1995.

tion, health institutions quality, and government stability have a positive impact on the rate of economic growth and on the rate of welfare growth. Moreover, the magnitude of the impact of these variables typically differs across the two outcome measures, with the impact on welfare growth always statistically different and greater than the impact on economic growth.

The impact of initial income on the growth rate of real income per capita ranges from -0.5 in column (1) to -0.74 in column (7). This impact is lower in absolute terms in each comparison relative to the impact of initial income on the growth rate of 'full' income which ranges from -0.6 in column (2) to -0.79 in columns (9) and (10). This difference suggests faster convergence for 'full' income than for real income per capita. A test of the hypothesis that the coefficient of initial income for each regression pair is equal, is overwhelmingly rejected at the one percent level of statistical significance for all columns. Furthermore, the implied convergence rate of 'full' income is found to become faster as more explanatory variables are added.

Secondary educational attainment is again shown to be more important for 'full' income than for real income per capita growth. The elasticity of income per capita with respect to education ranges from 0.35 in column (1) to a low of 0.13 in column (9). The elasticity of 'full' income with respect to education ranges from a high of 0.45 in column (2) to a low of 0.18 in column (10). The estimated impact of education is significant in all cases. Moreover, the null hypothesis that the estimated impact of education on economic and welfare growth is equal, is rejected at the one percent level in all cases. The conclusion that human capital in the form of secondary education attainment or health institutions quality index has a greater effect on welfare growth than on economic growth, holds for every single pair of specifications being considered.

The estimated income elasticity of physicians ranges from 0.17 and statistically significant at the five percent level in column (9) down to 0.106 and statistically insignificant in column (5). Similarly, the estimated elasticity of physicians with respect to 'full' income ranges from 0.195 and statistically significant at the five percent level in column (10) down to 0.104 and statistically insignificant in column (6). The elasticity of 'full' income per capita with respect to the quality of health institutions ranges from a high of 0.64 in column (4) to a low of 0.49 in column (8), and remains statistically significant in all cases. The elasticity of income per capita with respect to the health institutions quality index is significant (at the ten percent level) only in column (9) where it equals 0.44, and is as low as 0.34 in column (7). The null hypothesis that the coefficient estimate for the impact of health institutions on economic and welfare growth is equal, is rejected for each regression pair at the one percent level in every case except for columns (3) and (4) where it is rejected at the five percent level (with p-value equal to 0.012).

Table 3.3: Explaining period-averages of income and full income using instrumental variables estimation.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Income	Welfare	Income	Welfare	Income	Welfare	Income	Welfare	Income	Welfare
Income	-0.501***	-0.596***	-0.679***	-0.756***	-0.724***	-0.781***	-0.743***	-0.793***	-0.735***	-0.794***
	(0.062)	(0.082)	(0.098)	(0.115)	(0.101)	(0.121)	(0.098)	(0.109)	(0.096)	(0.105)
$\eta+g+\delta$	-0.448***	-0.408***	-0.398***	-0.359***	-0.298**	-0.302**	-0.159	-0.191	-0.096	-0.124
	(0.119)	(0.131)	(0.102)	(0.106)	(0.119)	(0.129)	(0.187)	(0.199)	(0.213)	(0.216)
Investment	0.104	0.050	0.033	-0.015	0.023	-0.021	0.155	0.123	0.169	0.114
	(0.181)	(0.196)	(0.181)	(0.192)	(0.185)	(0.194)	(0.154)	(0.157)	(0.134)	(0.134)
Education	0.353***	0.446***	0.270***	0.328***	0.281***	0.334***	0.221**	0.278***	0.129*	0.183**
	(0.068)	(0.079)	(0.086)	(0.091)	(0.084)	(0.088)	(0.087)	(0.087)	(0.078)	(0.078)
Physicians			0.149*	0.129	0.106	0.104	0.144*	0.147*	0.170**	0.195**
			(0.083)	(0.094)	(0.080)	(0.092)	(0.077)	(0.081)	(0.080)	(0.085)
AIDS			0.023	0.002	0.033	0.008	0.028	0.005	0.030	0.016
			(0.028)	(0.029)	(0.027)	(0.030)	(0.028)	(0.030)	(0.024)	(0.025)
Health Institutions Index			0.482	0.640*	0.454	0.624*	0.343	0.489*	0.442*	0.600**
			(0.350)	(0.352)	(0.329)	(0.339)	(0.298)	(0.295)	(0.260)	(0.269)
Nutrition					0.940*	0.535	0.368	-0.163	0.325	-0.338
					(0.533)	(0.589)	(0.642)	(0.702)	(0.715)	(0.809)
Government Stability							1.180*	1.445**	1.340**	1.611**
							(0.640)	(0.656)	(0.613)	(0.638)
Risk of Expropriation							-0.107	-0.077	-0.074	-0.048
							(0.137)	(0.138)	(0.156)	(0.157)
Temperature (Max Monthly High)									0.561	0.845
									(0.529)	(0.550)
Temperature (Min Monthly Low)									0.080	0.073
									(0.055)	(0.060)
Afternoon Max Humidity									0.341	0.570**
									(0.278)	(0.280)
Metals (Gold, Iron Ore, Zinc)									3.327	2.877
									(2.313)	(2.293)
Oil									0.015	0.021*
									(0.011)	(0.011)
Number of Minerals									0.080	0.078
									(0.052)	(0.052)
Soil (Dessert, Steppe or Highland)									-0.219**	-0.168
									(0.097)	(0.106)
Constant	4.624***	5.408***	4.171***	4.208***	-2.809	0.230	0.029	3.465	-4.835	-2.580
	(0.530)	(0.624)	(1.381)	(1.550)	(4.344)	(4.795)	(4.578)	(5.002)	(4.470)	(4.828)
Observations	65	65	65	65	65	65	65	65	65	65
Adjusted R^2	0.533	0.532	0.587	0.622	0.613	0.633	0.634	0.663	0.677	0.707
Endogeneity Test	[0.051]	[0.026]	[0.114]	[0.037]	[0.055]	[0.009]	[0.157]	[0.094]	[0.347]	[0.210]
Test Income	[0.000]				[0.004]				[0.001]	
Test Education	[0.000]		[0.000]		[0.001]		[0.000]		[0.000]	
Test Health Institutions					[0.004]				[0.001]	
Test Government Stability							[0.021]		[0.015]	

Notes: *** p-value < 0.01, ** < 0.05, * < 0.10. In the last four rows, we report p-values for the null that the estimated impact on income and welfare is the same.

Stability and continuity of governance has a bigger effect on welfare than on economic growth. This effect is 1.45 in column (8) and 1.61 in column (10), while the corresponding effect on economic growth is 1.18 in column (7) and 1.34 in column (9). The null that the impact of government stability on welfare growth is equal to its impact on economic growth can be rejected with a p-value of 0.02 for columns (7) and (8),and with a p-value of 0.015 for the comparison between columns (9) and (10). Finally, geography matters. Adverse characteristics of soil quality have a significant negative effect on income as in Table 3.3 and a marginally insignificant negative effect on 'full' income (with p-value equal to 0.114). Moreover, oil reserves matter positively and significantly for 'full' income growth. Surprisingly, maximum afternoon humidity has a positive significant impact on welfare growth once we control for the impact of maximum "monthly high" temperature and minimum "monthly low" temperature.

3.3.2.3 Panel estimation

In Table 3.4, we present estimates based on a panel consisting of 66 countries[22] and four subperiods, as described in the data section. We estimate the relation between welfare growth or economic growth with a number of economic, health-related, and geographic variables as before. We present estimates based on pooling the data including only time dummies in columns (1)-(2), (5)-(6), (9)-(10) and (13)-(16), and estimates that account for both fixed country[23] and time effects in the remaining six columns of Table 3.4.

When pooling the data for the estimations reported in columns (5)-(6) and (9)-(10), we consider a single geography-related variable pertaining to adverse time invariant soil characteristics[24]. In columns (13)-(14), we replace soil characteristics with the presence of metals as measured by the percentage of world reserves of gold, iron, and zinc. Including these time invariant cross-sectional variables is a parsimonious alternative to including fixed country effects, allowing more degrees of freedom.[25] Nevertheless, the explanatory power for models with fixed country and time effects is greater than for the pooled models, as can be seen by comparing the

[22] 13 countries (China, Korea Republic, Belgium, Denmark, Finland, France, Ireland, Italy, Spain, Mexico, Egypt, Cameroon and Congo Republic) are excluded from the sample of 74 countries shown in Table B.1, because of lack of availability of the physicians and education variables over time. Five countries (Barbados, Benin, Lesotho, Mauritius and Rwanda) can now be added since the institutions-related variables are not included in the panel regressions.

[23] The null that the random and fixed effects estimates are the same was rejected in favor of the fixed effects alternative.

[24] This sums up adverse soil characteristics related to desert, steppe and highland-type morphology.

[25] We experimented with including (one-at-a-time) other geography-related variables such us maximum "monthly high" temperature, minimum "monthly low" temperature, humidity, and number of minerals found in the country. In each case, these were estimated to have an impact statistically indistinguishable from zero, while leaving the remaining estimates unchanged. Oil reserves was also used and it had a positive and significant effect on both income and welfare (at the five percent and ten percent level respectively), leaving other estimated coefficients unchanged.

adjusted R-squared. This suggests the presence of a number of omitted time invariant variables that are not accounted for in any of the pooled models. Finally, we opt to present estimates based on regression models that always control for the time dimension of the panel, in order to allow for the presence of a number of unobservable time-varying characteristics over these four decades. However, we note that estimates for the fixed effects model without time effects or the pooled model without time dummies are qualitatively similar to those presented in Table 3.4.

The qualitative results for initial income and education are remarkably similar to those for the cross-sectional analysis with both variables estimated to matter more for welfare growth than for economic growth. The estimated coefficients are now smaller in both cases as compared to the cross-sectional ones. On the other hand, the density of physicians considered in columns (9)-(12) and (15)-(16) of Table 3.4, does not appear to matter.[26] Finally, our inference regarding the investment and nutrition variables differs as compared to the cross-sectional results. These variables are estimated to have a significantly different and higher impact on welfare growth as compared to their impact on economic growth. A detailed description of the panel estimation results follows in the next couple of paragraphs.

The impact of initial income on welfare growth ranges from -0.49 in column (8) for the model with both time and country fixed effects, to -0.11 in column (13) for the pooled model with time dummies and a single cross-sectional geography variable. The impact of initial income on income per capita growth is also significant and negative in all cases but always smaller in absolute terms relative to its impact on welfare growth. The hypothesis that the impact of initial income on welfare and economic growth is the same, is rejected for all eight pairs of comparisons beyond the one percent level of statistical significance. Similarly, investment is now estimated to have a significantly greater impact on welfare growth as compared to economic growth. Its impact on welfare growth ranges from 0.14 in column (4) down to 0.096 in column (10). The same finding regarding relative impact on welfare growth as compared to economic growth appears to be the case for population growth and predictably so for AIDS prevalence, as shown in the second and fifth rows of Table 3.4 respectively, although the effect of AIDS is never significant.

[26]The health institutions quality index is not included in the analysis, because it is available only once during the period used in our study.

Table 3.4: Panel regressions for income and full income.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	Income	Welfare	Income	Welfare	Income	Welfare	Income	Welfare	Income	Welfare	Income	Welfare	Income	Welfare	Income	Welfare
Initial Income	-0.072***	-0.111***	-0.353***	-0.424***	-0.103***	-0.150***	-0.397***	-0.489***	-0.108***	-0.170***	-0.379***	-0.478***	-0.107***	-0.153***	-0.116***	-0.176***
	(0.023)	(0.025)	(0.062)	(0.066)	(0.023)	(0.028)	(0.061)	(0.070)	(0.030)	(0.036)	(0.057)	(0.069)	(0.023)	(0.028)	(0.030)	(0.036)
$\eta + g + \delta$	-0.096**	-0.142***	-0.034	-0.122**	-0.074*	-0.117***	-0.046	-0.139***	-0.075*	-0.122***	-0.052	-0.142***	-0.091**	-0.134***	-0.093**	-0.138***
	(0.042)	(0.028)	(0.088)	(0.054)	(0.040)	(0.025)	(0.081)	(0.046)	(0.041)	(0.026)	(0.077)	(0.045)	(0.040)	(0.026)	(0.040)	(0.027)
Investment	0.092***	0.117***	0.093	0.142**	0.079***	0.097***	0.075	0.117*	0.078***	0.093***	0.067	0.113*	0.084***	0.101***	0.082***	0.096***
	(0.024)	(0.027)	(0.061)	(0.063)	(0.025)	(0.028)	(0.060)	(0.061)	(0.026)	(0.030)	(0.061)	(0.062)	(0.025)	(0.028)	(0.026)	(0.030)
Education	0.050**	0.080***	0.067*	0.097**	0.045**	0.067***	0.053	0.075*	0.044**	0.063***	0.062*	0.080**	0.044**	0.067***	0.042*	0.062**
	(0.022)	(0.026)	(0.037)	(0.041)	(0.022)	(0.024)	(0.035)	(0.038)	(0.022)	(0.024)	(0.037)	(0.040)	(0.022)	(0.025)	(0.022)	(0.024)
AIDS					-0.004	-0.024	-0.013	-0.033	-0.003	-0.021	-0.020	-0.036	-0.007	-0.026	-0.006	-0.023
					(0.017)	(0.020)	(0.019)	(0.026)	(0.018)	(0.020)	(0.019)	(0.026)	(0.018)	(0.020)	(0.018)	(0.020)
Nutrition					0.309***	0.412***	0.392*	0.491**	0.304***	0.390***	0.431**	0.514**	0.285***	0.391***	0.278***	0.366***
					(0.105)	(0.119)	(0.197)	(0.215)	(0.106)	(0.118)	(0.199)	(0.216)	(0.103)	(0.118)	(0.104)	(0.117)
Soil (dessert, ...)					-0.025	-0.029			-0.024	-0.025						
					(0.024)	(0.024)			(0.024)	(0.024)						
Metals													0.478**	0.272	0.495**	0.322
													(0.214)	(0.304)	(0.221)	(0.310)
Physicians									0.006	0.022	-0.060	-0.035			0.009	0.026
									(0.019)	(0.022)	(0.044)	(0.051)			(0.019)	(0.022)
Time Affects	Yes				Yes		Yes		Yes		Yes		Yes		Yes	
Country Effects	No				No		Yes		No		Yes		No		No	
Constant	0.392***	0.611***	2.674***	2.982***	-1.697**	-2.180***	0.004	-0.266	-1.609**	-1.822**	-0.499	-0.565	-1.528**	-2.040**	-1.388*	-1.634*
	(0.127)	(0.146)	(0.512)	(0.549)	(0.719)	(0.800)	(1.532)	(1.669)	(0.769)	(0.836)	(1.546)	(1.690)	(0.721)	(0.803)	(0.767)	(0.842)
Observations	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264
Adjusted R^2	0.573	0.612	0.659	0.700	0.584	0.631	0.667	0.714	0.583	0.632	0.670	0.714	0.585	0.630	0.583	0.631
Test Income	[0.000]				[0.000]				[0.000]				[0.000]			
Test Investment	[0.000]		[0.000]		[0.000]		[0.000]		[0.000]		[0.000]		[0.000]		[0.000]	
Test Education	[0.000]		[0.000]		[0.000]		[0.000]		[0.000]		[0.000]		[0.000]		[0.000]	
Test Nutrition					[0.000]		[0.000]		[0.000]		[0.000]		[0.000]		[0.000]	

Notes: *** p-value < 0.01, ** < 0.05, * < 0.10. In the last four rows, we report p-values for the null that the estimated impact on income and welfare is the same.

The impact of education is again estimated to be greater for welfare growth as compared to economic growth. Its impact on welfare growth is as high as 0.097 in column (4) but down to 0.062 in column (16). This is significantly higher than the impact of education on economic growth, with p-values for the null that this impact is the same lying below the one percent level of significance. Finally, nutrition is found to be more important for welfare growth than for economic growth. Its impact on welfare growth ranges from 0.37 in column (16) to 0.51 in column (12). The null that this is similar to the impact of nutrition on economic growth is rejected with p-values much lower than one percent. Finally, the presence of precious metals appears to matter for economic but not welfare growth in this panel of countries for the period under study. Overall, the panel results suggest that policies encouraging education and nutrition are likely to have a greater impact on welfare than one would think by examining just their impact on economic growth. Moreover, the estimates presented in this section are consistent with the presence of systematic differences for the impact of a number of economic and other factors on economic growth as compared to welfare growth.

3.4 Conclusion

In this chapter, we have assessed the determinants of welfare growth as a concept closely related but distinct from economic growth, and offered empirical evidence about this being a potentially important distinction in terms of future policy and theoretical modeling alike. We considered a number of economic, health-related, geographic, and institutions-related potential determinants, and showed that determinants may differ or have different impact on welfare outcomes as compared to economic outcomes.

Human capital in the form of secondary educational attainment was shown to play a more important role in determining welfare growth than in determining economic growth, consistent with the notion that this factor is important for a broader concept of welfare growth that goes beyond the standard notion of economic growth. Thus, our work offers a new approach towards answering the "...significant open question ... whether the social returns to human capital investment substantially exceed the private return" (Topel, 1999, p. 2973), raised by economists going back to Becker (1975) and Heckman and Klenow (1997). Our work implies that when assessing social returns, health status should be treated as a separate component of welfare in addition to income.

We also show that initial income has a greater impact on 'full' income growth than on real income per capita growth, implying faster convergence in terms of welfare growth. These estimates are substantially greater than those in Becker et al. (2005). Moreover, based on estimation for a cross-section of countries, the quality of health institutions and political institutions were shown to have a greater effect on welfare growth compared to their impact on economic growth, consistent with the importance of government stability for the uninterrupted provision of health-related inputs and information. The same conclusion holds for nutrition as well as for physical investment, based on panel estimation.

Overall, we conclude that there exist systematic differences for the impact of a number of economic, health-related, institutions-related, and geographic factors on welfare outcomes as compared to their impact on economic outcomes. For example, human capital can be important for welfare even when it has been shown to matter less or not at all for real income per capita growth.[27] The same goes for informal institutions as measured by government stability. These are likely even more important for the process of development than previously thought.

The above conclusions have important policy implications for the welfare of societies. For instance, our findings suggest that investing in human capital and certain other factors might be crucial for welfare growth even if the effect on economic growth was small or non-existent. Clearly, our work suggests that there is further scope for studying the determinants of welfare growth, treating it as a potentially distinct concept than economic growth.

[27] In the same spirit, Acemoglu and Johnson (2007), acknowledge that "[health] interventions have considerably improved overall welfare" (p. 4) even though they "exclude any positive effects of life expectancy on GDP per capita" (p. 3).

Chapter 4

Health and Economic Growth: a Model Averaging Methodology

4.1 Introduction

Theory suggests that health can have both direct effects and indirect effects. Direct effects arise because healthier people are better workers or can work harder and more efficiently than others. Indirect effects can arise because health is growth enhancing due to diminishing returns to effective units of labor because land or physical capital are supplied inelastically[1]. Health can also stimulate learning abilities and strengthens education incentives as returns to education are enjoyed over a longer period. Furthermore, a healthier population increases retirement saving, which in turn increases average investment and capital stock. There are even Malthusian effects. While, in the short run, higher life expectancy raises the rate of population growth, which is bad for growth, in the long run, higher life expectancy may encourage families to reduce fertility, which is desirable for growth. Moreover, health may also have an effect via institutions. For instance, Acemoglu et al. (2001) argued that health environment in some countries was a crucial factor for the decision of some European colonizers to build local institutions, which had a persistent effect on income today.

The objective of this chapter is to revisit the relationship between health as measured by life expectancy and economic growth. Can differences in health explain the large cross-country differences in economic performance? A growing body of literature suggests that disease environments and health conditions can explain the large income differences across countries and

[1]In fact this is a generally equilibrium effect, which is not incorporated by micro-studies that study the effect of health; see for example Miguel and Kremer (2004) and Bleakley and Lange (2009). In this chapter we will focus on macro-studies.

therefore suggests that by improving health not only will lives be improved, but there will be positive effects on economic growth as well. Examples include Bloom et al. (1998); Gallup and Sachs (2001); Bloom and Canning (2005); Lorentzen et al. (2008). However, the existing body of empirical work is far from conclusive; see for instance, Acemoglu and Johnson (2007). More importantly, the literature suffers from many of the econometric problems that plague cross-country growth regressions. In particular, different studies employ different control variables; make different assumptions concerning the set of countries where health may matter, etc. Additionally, different econometric models might give rise to different conclusions. For instance, while Acemoglu and Johnson (2007) find a negative effect when they regress GDP per capita growth in life expectancy, Lorentzen et al. (2008) find a positive effect when they regress GDP per capita on initial or average level in life expectancy. Furthermore, conventional cross-country growth analysis generally assume that life expectancy is exogenous or predetermined. A notable exception is the study by Acemoglu and Johnson (2007) who instrument life expectancy using predicted mortality to exploit the international epidemiological transition that gave rise to exogenous differential changes in mortality from a number of major diseases across the world. In this paper we investigate the linkages between life expectancy and growth using a methodology, which is robust to different modeling assumptions that have appeared in previous studies and which clarifies the determinants of life expectancy and its role in the growth process.

Our contribution is threefold. Firstly, we identify robust determinants of life expectancy for a large cross-section of countries. The understanding of the determinants of life expectancy will elucidate the role of behavioral and policy variables - health global interventions - in explaining the cross-country variation in life expectancy. This is important since it is often the case that the reason for short life expectancy in some countries is the mere fact that they are poor or disadvantaged in other ways. Secondly, we examine if improvements in health have an effect on income. Thirdly, we evaluate the role of life expectancy in determining cross-country income differences accounting for the potential endogeneity of this relationship.

In answering these questions, we employ model averaging methods along the lines of Brock et al. (2003), i Martin et al. (2004), and Durlauf et al. (2008), and Durlauf et al. (2011) that allow assessment of the relative evidentiary support for a given empirical claim in the presence of various aspects of model uncertainty. Specifically, we construct estimates conditional not on a single model, but on a model space whose elements span an appropriate range of determinants. This problem is very important in economic growth due to theory uncertainty. As argued by Brock et al. (2003) growth theories are openended in the sense that the importance of one theory does not imply anything or precludes the importance of another.

Our findings show that health interventions counted for life expectancy in 2005 and life expectancy growth rate from 1960 to 2005. We find that health institutions and average nutrition have a positive effect over these health outcomes and that sub-Saharan African countries have lower health outcomes. Furthermore, we find that, countries with lower life expectancy in 1960 exhibited larger increases in life expectancy and started converging towards countries with higher life expectancies. When we examine the relationship between income and health determinants we find that a number of variables like nutrition, improved water resources and health expenditure are positively related to income growth. When we correct for potential endogeneity on the relationship of life expectancy and income we find that life expectancy have a positive and significant effect on income.

In the next section we describe and justify the empirical concepts utilized in this application. In section 4.3, we motivate our empirical specification and in section 4.4 we describe the data. Section 4.5 describe the estimation and present our results and the last section briefly concludes.

4.2 Determinants of Life Expectancy

The benchmark regression model used here is based on the standard framework for estimating cross-section growth regressions. We will be explaining life expectancy with a certain set of explanatory variables. The estimable equation is given by:

$$L_i = \mu_L + H_i\alpha_L + Z_i\beta_L + \varepsilon_{L,i} = X_i\theta_L + \varepsilon_{L,i} \tag{4.1}$$

where L is life expectancy of country i, H are health factors, Z are other determinants and ε is the error term. The set of health factors H include two sets of variables, health services and health risk factors. The set of other determinants Z include five sets of variables, neoclassical/Solow variables, institutions, religion, fractionalization and regional heterogeneity.

Health-related variables are obvious candidates as determinants of life expectancy. The health-related variables, being considered, include the number of physicians per 1,000 inhabitants, a health institutions quality index, the share of public expenditure over total health expenditure, the percentage of infant population immunized for measles, the percentage of population with access to improved water conditions, nutrition, and initial value of life expectancy. Anand and Bärnighausen (2004) and Kruk et al. (2009) suggest that the availability of physicians is a good proxy for the health system resources, capturing a large fraction of cross-country variation in infant and under-5 mortality rates. Castillo-Laborde (2011) suggest that a larger number of health workers, is negatively associated with disability-adjusted life-years (i.e. DALYs), thus, they reduce the burden of disease, especially the burden associated with communicable diseases. They find that this relationship is statistically significant for the number of doctors per 1,000 inhabitants and not significant for nurses or midwives. Next, we consider an index of effectiveness of health institutions in a country. Evans et al. (2001) indicate that increasing the resources and the effectiveness of health systems is critical to improving health. Infant population immunization rate is an important determinant of health. Bloom et al. (2005) and Bloom (2011) state that childhood vaccination programs reduce morbidity and mortality in a country and national economic growth and poverty reduction as well. Bloom (2011), page 5, indicate that "vaccinated children also tend to avoid the long-term sequels associated with certain childhood diseases, such as neurological impairments, hearing loss, and a variety of other physical disabilities". Deaton (2006) and Cutler and Miller (2005) emphasize on the effect of public health measures such as clean water and sanitation over health. Tangermann et al. (2007) indicate that immunization helped eradicating smallpox or poliomyelitis and eliminating neonatal tetanus to a large extend. Nutrition during certain periods in life (in uterus, in childhood, and in adulthood) influence individuals' health and a balanced diet increases the probability of survival, as indicated by Weil (2007). These facts are stressed in the work of Fogel (1994). Finally, the initial level of life expectancy reflects the health conditions prevailing in each country and are not captured by the other health variables, see Weil (2010).

A second possible determinant of longevity is the prevalence of infectious illnesses and the geographical conditions that may pose a threat to longevity in each country. We refer to this group of determinants as Health "Risk Factors". A number of papers examine the negative effect of illnesses not only on life but also on economic growth. Gallup and Sachs (2001) and Sachs and Malaney (2002) found evidence on the impact of malaria on economic growth. Bloom and Mahal (1997), Dixon et al. (2001) and McDonald and Roberts (2006) examined the effect of HIV/AIDS on growth and Delfino and Simons (2005) found a link between tuberculosis and economic growth. Weil (2010) examines the effect of epidemics on the growth of African. Geographical factors may also affect life. Exposure to tropical climates may increase the probability of an epidemic out-brake and help its more rapid expansion. Landlocked countries may face increased cost of delivery and access of health (and education) services to their population. The distribution of health services may be logistically difficult in such environments.

Another factor that relates to health is education and income. We refer to these variables as neoclassical/Solow determinants. Education is a measure of human capital that can determine longevity in a country. Increased educational status can affect health improvements by two separate channels, consistent with Becker (2007). First, advances in education leads to an increment in expected wealth and, thus, in health spending, which as a result increases survival rates and life expectancy. Second, educated individuals can make more efficient use of given health inputs by acquiring better health information and health related habits, thus increasing their survival probability. Kenkel (1991) emphasizes better information on health created by schooling, because more educated people choose healthier life-styles by improving their knowledge of the relationships between health behaviors and health outcomes. Grossman (1972) emphasize that more educated individuals make better decision regarding health, increase their demand for health services. In line with this, Soares (2007b) and Cutler et al. (2006) emphasize that the aggregate level of education in the economy can be thought of as improving the quality of health services offered within a country, consistent with greater absorptive capacity for health-related technology and ideas. Ricci and Zachariadis (2010)) find positive external effects of education on longevity even after controlling for other possible determinants of longevity. Income (GDP per capita) is an obvious determinant of health status. A country with greater resources may devote a large part of its wealth in improving health although the relationship of health and income is may be characterized by long lags (Easterly (1999)). Countries with higher incomes are likely to experience better health outcomes through better nutrition, housing and sanitation (Filmer and Pritchett (1999)) and the relative cost of sending children to school is also lower for those with higher incomes (Gupta et al. (1999)), which may indirectly affect health.

Political institutions may affect health outcomes, since the presence of strong institutions in a country is conducive to government and broader stability that can have a positive impact on long-term economic and broader welfare outcomes. Knowles and Owen (2010) examined the effect of formal and informal institutions on life expectancy, consistent with Woodruff (2006) who discusses the use of variables measuring both formal and informal institutions. Their results suggest that improving informal institutions has positive effects on life expectancy that are statistically significant for most countries and stronger than the effects of improving formal institutions.

Culture is another potential determinant of health. The influences of cultural perceptions on life can occur through two separate channels. The first is through psychosocial factors that may affect perceptions and emotions that are significant for health outcomes, see Lynch et al. (2001) and Marmot and Wilkinson (2001). The second channel is through the creation attributes and perceptions that help the creation of culture of inequality within a society which may lead also to the creation of inequality in the provision of health services see, see Eckersley (2006). Religion is an important determinant of culture. Religion may affect affecting personal traits such as honesty and work ethic, the creation of social capital or the form of a communal culture, see Barro and McCleary (2003) and McCleary and Barro (2006).

The last group of variables utilized here as potential determinants of longevity relates to ethnic fractionalization. Easterly and Levine (1997) and Alesina et al. (1999) indicate that higher ethnic diversity may increase polarization and as a result create disagreements about policies like the provision of public goods, investment in infrastructure which lead to leading to inferior social outcomes. Filmer and Pritchett (1999) indicate that minority groups often have lower health (with higher average mortality level) and education indicators.

4.3 Econometric Implementation

Cross-country growth regressions suffer from the common problem that they do not systematically address the model uncertainty that is intrinsic in growth regressions. Growth regressions also face considerable model uncertainty given potentially overlapping economic theories. Brock and Durlauf (2001) refer to this as 'openendedness' of economic theories. Also, there might be alternative empirical specifications of these theoretical channels and the number of observations may be smaller than the number of suggested explanations. The model averaging methodology departure from conditioning on a particular model and calculating quantities of interest (variables coefficients and standard errors) by averaging across different models instead. The sample information contained in the likelihood function for a particular model is combined with relative model weights or posterior model probabilities to estimate the unknown parameters (variables coefficients and standard errors) across models. As a result the estimates are more robust to the effects of misspecification than procedures which place all support on a single model.

The benchmark regression model used here is based on the framework of the canonical cross-country regressions. The dependent variable is life expectancy or the growth of life expectancy and the set of explanatory variables include a certain set of health related explanatory variables and other determinants used in the literature. The estimable equation is given by:

$$L_i = \mu_L + H_i\alpha_L + Z_i\beta_L + \varepsilon_{L,i} = X_i\theta_L + \varepsilon_{L,i}$$

where L is life expectancy of country i, H are health factors, Z are other determinants and ε is the error term.

The objective is to estimate the average impact of each explanatory variable over the life expectancy:

$$\hat{\theta}_L = \sum_{l \in M} \hat{\theta}_L \hat{\mu}\,(l \mid D) \tag{4.2}$$

where: $\hat{\theta}_L$ is a model specific estimate, $\hat{\mu}(l \mid D)$ is the model weight (posterior probability i.e. probability that model l is true) and D is the true model and M is the model space. We assess the probability that a given theory matters for growth by computing the posterior probability of inclusion of is that at least one one variable from theory τ is included in the model:

$$\sum_{l \in A_\tau} \hat{\mu}(l \mid D) \tag{4.3}$$

where A_τ is the event that "at least one proxy from theory τ is included in the model"

Implementation of model averaging methodology, by Baye's rule, include the estimation of:

$$\hat{\mu}(l \mid D) \propto \hat{\mu}(l)\, \hat{\mu}(D \mid l) \tag{4.4}$$

where $\hat{\mu}(l)$ is the prior probability of a model and $\hat{\mu}(D \mid l)$ is the likelihood of the data given the the model. We assume that the the prior probability that a theory is included in the model ($\hat{\mu}(l)$) to be equal to 0.5 and assume that theories are independent in the sense that inclusion of one theory in a model does not affect the probability is not included in the model. After we assign a prior to each theory we also assign a prior to each variable which belong to each theory. We use a prior structure proposed by George (1999), where for each subset s_τ associated with theory τ for $\tau = 1, \ldots, \mathscr{T}$, we assign the conditional prior probability:

$$\mu(s_\tau) = |R_{s_\tau}| \prod_{j=1}^{p_\tau} \pi_j^{s_j} \left(1 - \pi_j^{s_j}\right)^{1-s_j} \tag{4.5}$$

where p_τ is the number of proxy variables for theory $\tau, \tau \in 1, 2, \ldots, \mathscr{T}$, $\pi_j = 0.5$ for $j = 1, 2, \ldots, J$ and R_{s_τ} is the correlation matrix for the set of variables included in theory τ. The correlation matrix take values between zero and one ($|R_{s_\tau}| \in [0,1]$). It takes value equal to one when variables are orthogonal and zero when variables are collinear. This prior structure account for the potential multicollinearity between variables within a theory, something that other prior structures fail to do.

The likelihood that the data fit the model (capture the relative goodness of fit of different models) $\hat{\mu}(D \mid l)$ is estimated using the BIC-adjusted goodness of fit criterion following

Raftery (1995)[2].

4.4 Data

In this section we present the definition and source of the explanatory variables examined in section 4.2. The determinants of Economic Growth and Life Expectancy are organized into seven broad theories that are illustrated below.

1. Health Services. Seven policy variables are included in this theory. The number of physicians per thousand inhabitants, the percentage of government health expenditure over the total health expenditure, a measure of health system efficiency, the percentage of children immunized against measles, the percentage of the population with access to improved water conditions and the level of nutrition and initial life expectancy.

   The number of physicians is an important input into health services provision and overall population health status. The number of physicians per thousand persons is highly correlated with other health indicators and, in effect, appears to capture the overall availability of health care in each country[3]. The source of this variable is the WDI database. We capture the efficiency (performance) of national health systems using an index reported in WHO (2000) and Evans et al. (2001). The index assess the performance of countries in terms of achieving a broader set of health system outcomes. This index is constructed taking into account five broad health system outcomes: level of responsiveness, distribution of responsiveness, fairness of financing, performance of health system and health inequality[4]. The index was constructed using data generally available around the year 1997. A policy measure that partly captures the government willingness to provide health services to the population is the percentage of public health expenditure over total health expenditure. We take this variable from the WDI and its reported in an annual basis from 2003 to 2005. Two other factors that may influence the level of health is the percentage of children with age between twelve and twenty-three months immunized for measles and the percentage of population with improved access to water conditions. The source for both variables is the WDI. Data for immunization are reported 1980 onwards and for access to water conditions from 1990 onwards. The level of nutrition in the country is summarized by the logarithm of average dietary energy consumption (calories (kcal) per

[2] Another option to this prior is proposed by Kim (2002) and Tsangarides (2004) where weighting of LIML estimators are performed with BIC (LBIC) weights

[3] The correlation coefficient of the number of physicians with the number of hospital beds per thousand persons is 71 percent and 64 percent with the number of nurses and midwifes per thousand persons.

[4] We note that the ranking of efficiency which is similar to the estimation of efficiency in production is sensitive to assumptions and selection of control variables as shown by Almeida et al. (2001), Jamison and Sandbu (2001) and Williams (2001).

person per day). The nutrition variable is taken from the World Food Organization (FAO) Statistical Yearbooks. It is reported as an average for 1969-71, 1979-81, 1990-92, 1995-97, and 2001-03. We also include initial life expectancy (at year 1960), which may reflect health conditions, other diseases and policies not captured by other variables included it the set of explanatory variables, see Weil (2010).

2. Risk Factors. Health risk factor theory includes three different illnesses, incidence of tuberculosis per 100,000 persons, HIV/AIDS cases per 100,000 persons and the percentage of population at risk of contracting malaria. The AIDS variable is taken from the WHO's Global Health Atlas (2007) and covers the period between 1979 and 2001. The earliest observation available for the AIDS variable is in 1979 while regular observations for most countries start from the mid-1980's. The number of incidences of tuberculosis per 100,000 inhabitants and is taken from the WDI. This measure is available from 1980 onwards. Malaria is taken from Gallup and Sachs (2001) and it is defined as the percentage of the population at risk of contracting falciparum malaria in a country (Plasmodium falciparum is the the fatal species of the malaria pathogen) in 1994. We include two measures of geography and climate. The first is the percentage of a country's land area classified as tropical and subtropical based on the Köppen-Geiger classification system for climate zones, and a geographic accessibility/isolation variable, the percentage of a country's land area within 100km of an ice-free coast.

3. Neoclassical / Solow growth variables. This category consists of the logarithm of real GDP per worker in 1960 and average schooling. We include income in the beginning of the sample period to capture the initial economic condition in each country. Schooling is defined as the logarithm of the percentage of individuals who completed secondary and higher education in the total population aged older than fifteen. This variable is taken from Barro and Lee (2010). Schooling data are reported every five years starting from 1960 until 2000.

4. Institutions. Institutions are measured by using three following variables: risk of expropriation, government stability and executive constraints. The risk of expropriation measure is taken from Acemoglu et al. (2001) and it is logarithm of the average value of this variable between the years 1985 and 1995. We use the level of government stability to capture political institutions, consistent with Woodruff (2006) who argues for the use of variables measuring both formal and informal institutions. Government stability captures the ability of governments to stay in office and carry out their declared programs depending upon such factors as the type of governance, cohesion of the government and governing parties, approach of an election, and command of the legislature. It is created from three sub-components: government unity, legislative strength and popular support,

and given on a scale between zero and 12 from least to most stable. The index is reported on a monthly basis from the beginning of 1984 until the end of 2005. This is taken from the International Country Risk Guide dataset made available by the Political Risk Service (PRS) group, see PRS (2008). We also include a measure of the extent of institutionalized constraints on the decision making powers of chief executives from Marshall and Jaggers (2009). This measure is reported in a yearly basis from 1800 until 2005. The index is reported for the majority of countries in the sample from 1960 onwards.

5. Fractionalization This theory is measured using an index of ethnic fractionalization in each country as constructed by Alesina et al. (2003).

6. Religion. Religion is measured using religion shares for Protestant, Jewish, Muslim, Eastern, Hindu, and Other religions [5] for the year 1970 (Barro and McCleary (2005)). Religion proportion is defined as the fraction adhering to the specified religion among persons who express adherence to any religion. The Catholic fraction is omitted from the regressions and, thus, each coefficient should be interpreted relative to the Catholic share.

7. Geography To capture unexplained regional heterogeneity, we include a set of three dummy variables for East Asian countries, Sub-Saharan African countries, and Latin American and Caribbean countries

The dependent variable is life expectancy in 2005 and life expectancy growth rate from 1960 to 2005. Similarly, income level is estimated for 2005 and its growth from 1960 to 2005. We construct three samples based on the range we use to calculate the mean for the dependent variable. The first sample covers the period from 1960 to 2005, the second sample covers the period from 1960 to 1985 and the third sample consists of the values of the explanatory variables in 1960. In the first sample we have twenty-seven variables, in the second sample twenty variables and in the third sample seventeen variables. In the second sample the following variables are not included: risk of expropriation because it is reported from 1985 to 1995, government stability since its reported only after 1984, share of public sector health expenditure over the total health expenditure, which is reported only between 2003-05, health institutions, which is reported only for 1997, improved water conditions, which is reported after 1990, incidence of tuberculosis, which is reported after 1990 and malaria prevalence, which is reported for 1994. In the third sample do not include measles immunization because is reported after 1980, nutrition which is reported after 1969 and AIDS that is recorded after 1979. Appendix C.2 provides a more detailed description of the variables and the list of the countries included in our sample.

[5] Other religions include the share of Orthodox and other Christian denominations in the population.

4.5 Results

4.5.1 Determinants of Life Expectancy in 2005 and Life Expectancy Growth Rate between 1960-2005

Table 4.1 present the posterior inclusion probabilities for each theory in the estimations when the dependent variable is life expectancy in 2005 and the life expectancy growth rate between 1960 and 2005. The prior probability of a theory being in the true model is set to 0.5 and the theory robustness is assessed in terms of how the data update this prior; i.e. by a theory posterior probability of inclusion in the true model.

Table 4.1: Posterior Inclusion Probabilities of Theories

	Dependent Variable: Life Expectancy in 2005			Dependent Variable:Life Expectancy Growth 1960-2005		
	(1)	(2)	(3)	(4)	(5)	(6)
	1960-2005	1960-1985	1960	1960-2005	1960-1985	1960
Health	0.998	0.862	1.000	1.000	1.000	1.000
Health Risk Factors	0.063	0.288	0.633	0.065	0.081	0.300
Neoclassical/Solow	0.354	0.980	0.012	0.153	0.768	0.109
Institutions	0.047	0.052	0.010	0.086	0.081	0.057
Ethnic Fractionalization	0.043	0.078	0.016	0.050	0.058	0.088
Religion Shares	0.038	0.034	0.204	0.065	0.029	0.045
Regional Heterogeneity	1.000	1.000	1.000	1.000	1.000	1.000

Note: In columns (1) and (4) the explanatory variables are averages from 1960 to 2005, in columns (2) and (5) the explanatory variables are averages from 1960 to 1985 and in columns (3) and (6) the explanatory variables are measured in their initial value in 1960.

When we use the whole period average of the explanatory variables, from 1960 to 2005, we find that the robust theories include health and regional heterogeneity. Both theories are found to have posterior inclusion probability equal to one for both life expectancy in 2005 and the growth of life over the 1960-2005 period. When we use the 1960 to 1985 average of the explanatory variables we find that health and regional heterogeneity receive high posterior inclusion probabilities equal to 0.862 and 1.000. The neoclassical/Solow growth variables also receive a high posterior inclusion probability equal to 0.980 and 0.768 when the dependent variable is life expectancy in 2005 and life expectancy growth rate between 1960 and 2005 respectively. This is an indication that human capital in the form of schooling affects longevity. When we examine the effect of explanatory variables measured in 1960 over the dependent variables, we observe that health services and regional heterogeneity receive the highest posterior inclusion probabilities, which are equal to one in both cases.

Table 4.2: Explaining Life Expectancy in 2005 and Life Expectancy Growth rate from 1960 to 2005 using period averages of explanatory variables from 1960 to 2005.

	Life Expectancy in 2005			Life Growth Rate between 1960-2005		
	(1)	(2)	(3)	(4)	(5)	(6)
	PIP	PM	PSD	PIP	PM	PSD
Health	*0.998*†			*1.000*†		
Life Expectancy in 1960	0.031	0.002	0.016	1.000	-0.020	0.001
Physicians	0.110	0.003	0.009	0.043	0.000	0.000
% Public Health Exp.	0.104	0.003	0.010	0.071	0.000	0.000
Health Institutions	0.996	0.378	0.109	0.981	0.008	0.003
Immunization Measles	0.052	0.002	0.010	0.047	0.000	0.000
Improved Water Resources	0.019	0.001	0.009	0.020	0.000	0.000
Nutrition	0.876	0.187	0.088	0.804	0.004	0.002
Health Risk Factors	*0.063*†			*0.065*†		
AIDS Cases	0.006	-0.000	0.000	0.007	0.000	0.000
Incidence of TB	0.049	-0.001	0.006	0.051	0.000	0.000
Malaria Ecology Index	0.002	0.000	0.002	0.003	0.000	0.000
Ease of coastal access	0.016	0.001	0.007	0.017	0.000	0.000
% Area in Tropics	0.006	0.000	0.004	0.006	0.000	0.000
Neoclassical/Solow	*0.354*†			*0.153*†		
Income in 1960	0.048	-0.001	0.007	0.066	0.000	0.000
Schooling	0.344	0.008	0.013	0.125	0.000	0.000
Institutions	*0.047*†			*0.086*†		
Constraints on Executive	0.013	-0.000	0.002	0.046	0.000	0.000
Risk of Expropriation	0.026	-0.001	0.006	0.023	0.000	0.000
Government Stability	0.008	0.000	0.007	0.018	0.000	0.000
Ethnic Fractionalization	0.043	0.001	0.007	0.050	0.000	0.000
Religion Shares	*0.038*†			*0.065*†		
Protestant	0.002	-0.000	0.002	0.003	0.000	0.000
Jewish	0.003	-0.000	0.005	0.005	0.000	0.000
Muslim	0.024	-0.002	0.013	0.046	0.000	0.000
Hindu	0.028	-0.005	0.032	0.058	0.000	0.001
Eastern Religions	0.003	0.000	0.003	0.006	0.000	0.000
Other Religions	0.019	-0.002	0.018	0.037	0.000	0.001
Regional Heterogeneity	*1.000*†			*1.000*†		
Sub-Saharan Africa	1.000	-0.208	0.027	1.000	-0.005	0.001
Latin-America & Caribbean	0.096	0.002	0.009	0.067	0.000	0.000
East Asia & Pacific	0.070	0.002	0.007	0.083	0.000	0.000

Note: PIP stands for Posterior Inclusion Probability, PM stand for Posterior Mean and PSD stand for Standard Deviation of the Posterior Error of the distribution. † denotes the posterior inclusion probability for each theory.

In terms of individual determinants of life in 2005, Table 4.2 columns (1)-(3), we find that health institutions, nutrition and sub-Saharan Africa receive the higher posterior inclusion probabilities. All enter with the expected sign. Better health institutions and nutrition increase life expectancy and countries in sub-Saharan Africa have lower life expectancy.

In Table 4.2, columns (4)-(6) we report the determinants of life expectancy growth rate between 1960 and 2005. In terms of individual determinants we also find that health institutions, nutrition and sub-Saharan Africa receive the higher posterior inclusion probabilities. Life expectancy in the beginning of the period also receives posterior inclusion probability equal to one. This indicates that countries with lower life expectancies at the start of the period exhibited faster improvements in health compared to countries with higher life expectancies.

4.5.1.1 Robustness exercises

We next examine how results change and whether their robust changes in the assumptions of the baseline estimations. Firstly, we examine how earlier observations of the dependent variables affect life expectancy in 2005 or life growth rate from 1960 to 2005. Next, we reduce the degree of uncertainty over the model space by including the health related variables always in the model space and be agnostic for the other theories. Then, we investigate which variables are important when regional heterogeneity variables are omitted from the model space.

In Table 4.3 we examine if earlier values of the explanatory variables matter for life expectancy in 2005 and growth of life expectancy over the 1960 and 2005 period. In columns (2) and (5) we use the average values of the explanatory variables from 1960 to 1985. In columns (3) and (6) we use the values of the explanatory variables in 1960. In columns (1) and (4) we report the posterior inclusion probabilities from 4.2 as a reference.

When we investigate the effect of the average value of the variables over the 1960 to 1985 period to life expectancy in 2005 we find that the posterior inclusion probability of schooling is close to one. The posterior inclusion probability of the Health and Regional heterogeneity theories continue to have high posterior inclusion probability with the later being equal to one. Then we examine the effect of the explanatory variables when they are measured in start of the time period. We find that initial life and regional heterogeneity theories have posterior inclusion probabilities equal to one. The results are robust when we examine the effect of changes in dependent variables on life expectancy growth from 1960 to 2005. Health and regional heterogeneity have posterior inclusion probabilities equal to one in both cases.

In Table 4.4 we study the effect of keeping the health variables always in the model space and treating the other theories as uncertain. By construction the posterior inclusion probability for the two health-related theories is equal to one as well as the posterior inclusion probability for each variable in the theory. Under this exercise we examine the statistical significance of the variables in the two theories and which variables from the other theories are important. In terms of the determinants of life expectancy in 2005 health institutions and nutrition are statistically significant. In terms of the variables from other theories, the posterior inclusion probability for income increase to 0.733 and the posterior inclusion probability for sub-Saharan Africa have posterior inclusion probability equal to one. When the growth of life expectancy between 1960 and 2005 is considered, initial life expectancy, health institutions and nutrition are the most significant determinants. From the other theories, initial income and sub-Saharan Africa have the highest posterior inclusion probabilities.

Furthermore, we examine which variables receive the highest posterior inclusion probability when we remove the regional heterogeneity variables. In columns (1)-(3) of Table 4.5 we study the relationship of life expectancy in 2005 with variables in this reduced model space. In terms of posterior inclusion probabilities of theories, the health theories retain a posterior probability of one and health risk factors, neoclassical theory variables and religion have a posterior inclusion probability above 0.900. In terms of individual variables, health institutions receive a posterior inclusion probability equal to one and it is the most important variable in this theory. Incidences of tuberculosis per 100,000 inhabitants and malaria have posterior inclusion probabilities equal to 0.936 and 0.826 respectively. These are illnesses that, on average, are found to a greater extend in sub-Saharan Africa than in other areas of the world[6]. From the neoclassical theory we find that average schooling from 1960 to 2005 is positively related to life expectancy in 2005, in line with with Grossman (1972), Soares (2007b) and Cutler et al. (2006). Countries with lower income levels in 1960 have caught up with countries with higher income levels in terms of life expectancy in 2005. With regards to religion, we observe that other religions and Muslim share in the population have a posterior probability 0.944 and 0.819 respectively. In columns (4) to (6) we look into the relationship between growth rate of life expectancy from 1960 to 2005 and the set of explanatory variables. The results are similar to the relationship of life expectancy in 2005 to these variables. The variable that enters with posterior inclusion probability equal to one is initial life expectancy.

In Appendix C.1 we examine the robustness of results in Table 4.2 in the use of different prior structures of the model averaging methodology using Magnus et al. (2010) and Zellner (1986) prior structures. The results from the change of the prior structure conform with the results of Table 4.2.

[6]The average value of malaria ecology index in the sub-Saharan Africa countries in the sample is 0.891 and has an average value of 0.088 for non sub-Saharan Africa countries. The average incidence of tuberculosis in sub-Saharan African countries is 322 cases per 100,000 inhabitants and its 68 cases per 100,000 inhabitants for non sub-Saharan Africa countries.

Table 4.3: Posterior Inclusion Probability of theories and explanatory variables using different time intervals for the explanatory variables

	Life Expectancy in 2005			Life Growth Rate between 1960-2005		
	(1) 1960-2005	(2) 1960-1985	(3) 1960	(4) 1960-2005	(5) 1960-1985	(6) 1960
Health	*0.998*†	*0.862*†	*1.000*†	*1.000*†	*1.000*†	*1.000*†
Life Expectancy in 1960	0.031	0.050	1.000	1.000	1.000	1.000
Physicians	0.110	0.022	0.006	0.043	0.018	0.011
% Public Health Exp.	0.104	-	-	0.071	-	-
Health Institutions	0.996	-	-	0.981	-	-
Immunization Measles	0.052	0.150	-	0.047	0.141	-
Improved Water Resources	0.019	-	-	0.020	-	-
Nutrition	0.876	0.815	-	0.804	0.396	-
Health Risk Factors	*0.063*†	*0.288*†	*0.633*†	*0.065*†	*0.081*†	*0.300*†
AIDS Cases	0.006	0.121	-	0.007	0.074	-
Incidence of TB	0.049	-	-	0.051	-	-
Malaria Ecology Index	0.002	-	-	0.003	-	-
Ease of coastal access	0.016	0.247	0.631	0.017	0.142	0.262
% Area in Tropics	0.006	0.027	0.477	0.006	0.020	0.214
Neoclassical/Solow	*0.354*†	*0.980*†	*0.012*†	*0.153*†	*0.768*†	*0.109*†
Income in 1960	0.048	0.054	0.005	0.066	0.040	0.021
Schooling	0.344	0.980	0.007	0.125	0.765	0.090
Institutions	*0.047*†	*0.052*†	*0.010*†	*0.086*†	*0.081*†	*0.057*†
Constraints on Executive	0.013	0.052	0.010	0.046	0.081	0.057
Risk of Expropriation	0.026	-	-	0.023	-	-
Government Stability	0.008	-	-	0.018	-	-
Ethnic Fractionalization	*0.043*†	*0.078*†	*0.016*†	*0.050*†	*0.058*†	*0.088*†
Religion Shares	*0.038*†	*0.034*†	*0.204*†	*0.065*†	*0.029*†	*0.045*†
Protestant	0.002	0.001	0.012	0.003	0.001	0.003
Jewish	0.003	0.002	0.010	0.005	0.001	0.003
Muslim	0.024	0.002	0.022	0.046	0.002	0.005
Hindu	0.028	0.024	0.055	0.058	0.014	0.037
Eastern Religions	0.003	0.002	0.067	0.006	0.001	0.003
Other Religions	0.019	0.018	0.198	0.037	0.016	0.014
Regional Heterogeneity	*1.000*†	*1.000*†	*1.000*†	*1.000*†	*1.000*†	*1.000*†
Sub-Saharan Africa	1.000	1.000	1.000	1.000	1.000	1.000
Latin-America & Caribbean	0.096	0.050	0.021	0.067	0.081	0.137
East Asia & Pacific	0.070	0.052	0.016	0.083	0.050	0.059

Note:† denotes the posterior inclusion probability for each theory.

Table 4.4: Explaining Life Expectancy in 2005 and Life Growth Rate between 1960-2005 using the 1960-2005 average of explanatory variables and keeping health related variables always in the model space

	Life Expectancy in 2005			Life Growth Rate between 1960-2005		
	(1)	(2)	(3)	(4)	(5)	(6)
	PIP	PM	PSD	PIP	PM	PSD
Health	1.000†			1.000†		
Life Expectancy in 1960	1.000	0.030	0.083	1.000	-0.021	0.002
Physicians	1.000	0.017	0.014	1.000	0.000	0.000
% Public Health Exp.	1.000	0.034	0.022	1.000	0.001	0.000
Health Institutions	1.000	0.237	0.101	1.000	0.005	0.002
Immunization Measles	1.000	0.014	0.033	1.000	0.000	0.001
Improved Water Resources	1.000	0.001	0.062	1.000	0.000	0.001
Nutrition	1.000	0.196	0.074	1.000	0.004	0.002
Health Risk Factors	1.000†			1.000†		
AIDS Cases	1.000	-0.001	0.001	1.000	0.000	0.000
Incidence of TB	1.000	-0.016	0.010	1.000	0.000	0.000
Malaria Ecology Index	1.000	0.029	0.039	1.000	0.001	0.001
Ease of coastal access	1.000	0.034	0.033	1.000	0.001	0.001
% Area in Tropics	1.000	0.042	0.033	1.000	0.001	0.001
Neoclassical/Solow	*0.769*†			*0.765*†		
Income in 1960	0.733	-0.026	0.019	0.732	-0.001	0.000
Schooling	0.590	0.020	0.020	0.568	0.000	0.000
Institutions	*0.457*†			*0.515*†		
Constraints on Executive	0.434	-0.021	0.026	0.496	-0.001	0.001
Risk of Expropriation	0.159	-0.005	0.014	0.165	0.000	0.000
Government Stability	0.054	0.005	0.028	0.062	0.000	0.001
Ethnic Fractionalization	0.189†	0.008	0.021	0.176†	0.000	0.000
Religion Shares	*0.103*†			*0.100*†		
Protestant	0.008	0.000	0.004	0.008	0.000	0.000
Jewish	0.015	-0.001	0.013	0.015	0.000	0.000
Muslim	0.084	-0.009	0.031	0.081	0.000	0.001
Hindu	0.073	-0.013	0.050	0.067	0.000	0.001
Eastern Religions	0.010	0.000	0.005	0.010	0.000	0.000
Other Religions	0.090	-0.011	0.036	0.087	0.000	0.001
Regional Heterogeneity	*1.000*†			*1.000*†		
Sub-Saharan Africa	1.000	-0.179	0.036	1.000	-0.004	0.001
Latin-America & Cari bean	0.191	0.007	0.017	0.190	0.000	0.000
East Asia & Pacific	0.095	0.002	0.009	0.099	0.000	0.000

Note: PIP stands for Posterior Inclusion Probability, PM stand for Posterior Mean and PSD stand for Standard Deviation of the Posterior Error of the distribution. † denotes the posterior inclusion probability for each theory.

Table 4.5: Explaining Life Expectancy in 2005 and Life Expectancy Growth rate between 1960 and 2005 using period averages of explanatory variables excluding regional heterogeneity theories from the model space

	Life Expectancy in 2005			Life Growth Rate between 1960-2005		
	(1) PIP	(2) PM	(3) PSD	(4) PIP	(5) PM	(6) PSD
Health	*1.000*†			*1.000*†		
Life Expectancy in 1960	0.003	0.000	0.005	1.000	-0.023	0.002
Physicians	0.277	0.010	0.018	0.232	0.000	0.000
% Public Health Exp.	0.004	0.000	0.002	0.006	0.000	0.000
Health Institutions	1.000	0.491	0.126	1.000	0.011	0.003
Immunization Measles	0.004	0.000	0.002	0.006	0.000	0.000
Improved Water Resources	0.001	0.000	0.002	0.002	0.000	0.000
Nutrition	0.138	0.021	0.057	0.279	0.001	0.002
Health Risk Factors	*0.978*†			*0.918*†		
AIDS Cases	0.457	-0.001	0.001	0.277	0.000	0.000
Incidence of TB	0.936	-0.036	0.013	0.905	-0.001	0.000
Malaria Ecology Index	0.826	-0.084	0.048	0.817	-0.002	0.001
Ease of coastal access	0.384	0.024	0.036	0.327	0.000	0.001
% Area in Tropics	0.003	0.000	0.002	0.006	0.000	0.000
Initial Conditions	*0.935*†			*0.935*†		
Income in 1960	0.932	-0.051	0.019	0.933	-0.001	0.000
Schooling	0.925	0.041	0.017	0.885	0.001	0.000
Institutions	*0.314*†			*0.166*†		
Constraints on Executive	0.309	-0.014	0.023	0.161	0.000	0.000
Risk of Expropriation	0.012	0.000	0.003	0.008	0.000	0.000
Government Stability	0.012	0.000	0.009	0.008	0.000	0.000
Ethnic Fractionalization	*0.038*†	0.001	0.008	*0.026*†	0.000	0.000
Religion Shares	*0.944*†			*0.930*†		
Protestant	0.004	0.000	0.003	0.004	0.000	0.000
Jewish	0.078	-0.008	0.035	0.090	0.000	0.001
Muslim	0.819	-0.077	0.047	0.826	-0.002	0.001
Hindu	0.433	-0.070	0.096	0.550	-0.002	0.002
Eastern Religions	0.015	0.001	0.011	0.019	0.000	0.000
Other Religions	0.944	-0.180	0.064	0.928	-0.004	0.002

Note: PIP stands for Posterior Inclusion Probability, PM stand for Posterior Mean and PSD stand for Standard Deviation of the Posterior Error of the distribution. † denotes the posterior inclusion probability for each theory.

4.5.2 Relation of Income and Health variables

Our analysis has concentrated on the determinants of the improvements of the health as proxied by longevity, which is a fundamental goal of economic development. These determinants may help achieving a broader set of goals which are related to increasing income and reducing poverty across countries. The high prevalence of diseases, in some low income countries, especially in sub-Saharan Africa area, stands also as a barrier to economic growth and any strategies aiming the development of countries may address these problems. For example, Gallup and Sachs (2001) argue that the eradication of malaria in Sub-Saharan Africa could increase this area per capita growth rate as much as 2.6% a year. Bloom et al. (2004) summarize a number of papers that examine the relationship of income and life expectancy finding that in most studies has a positive and significant effect on income. In this section will examine the relationship of income with a broad set of health related explanatory variables. We will examine if an improvement in these factors can have a positive effect on income growth as we found that they have on life expectancy in the previous section. If we find a positive relationship between health factors and income this will reinforce the idea that improvements in health play a dual role, improving health not only will improve lives but also will have positive effects on economic growth. Next we will shift our focus to the examination of the effect of life expectancy on economic growth correcting for endogeneity. Most of the papers surveyed by Bloom et al. (2004) suffer from severe problems of endogeneity and omitted variable bias, as stressed by Weil (2007) and Acemoglu and Johnson (2007).

The model that will be used to evaluate the importance of the health related factors affecting income is given by:

$$g_i = \kappa_L + H_i\gamma_L + Z_i\delta_L + v_{L,i} = X_i\zeta_L + v_{L,i} \tag{4.6}$$

where g is the growth rate of income per capita growth between 1960 and 2005, H are health factors, Z are other determinants and v is the error term. The set of health factors H include two sets of variables, health services and health risk factors. The set of other determinants X include five sets of variables, neoclassical/Solow variables, institutions, religion, fractionalization and regional heterogeneity. In the set of the explanatory variables we include all the variables included in Section 4.5.1 and are described in Section 4.4.

In order to correct for endogeneity we will use a new instrument for life expectancy. This instrument is the fitted value of life expectancy from the regression of average life expectancy on the broad set of explanatory variables using the model averaging framework. In the second step we will estimate the relationship between income and life expectancy using as instrument the fitted value of life expectancy that we estimated in the first step. The other explanatory variables included in the second step include a set of variables that are considered as predetermined and exogenous. This set of variables include colonial history (British, French, Spanish or Portuguese colony), geography (percentage of area in tropics and ease of coastal access) and an institutions variable (constraints on executive).

More precisely, in the first step we regress average life expectancy over the 1960 to 2005 period against the set of health related explanatory variables and other determinants used in Section 4.5.1 and are described in Section 4.4 using the Bayesian model averaging methodology. From this estimation we use the posterior mean to create the fitted value of average life expectancy over the 1960 to 2005 period. In the second step we regress the level of income in 2005 against the average life expectancy using the fitted values of average life expectancy we get from the first step as instruments. The second step of estimation is performed using the 2SLS-MA Bayesian model averaging methodology proposed Durlauf et al. (2011)[7]. The first step estimated equation is given by:

$$\bar{L}_i = \mu_L + H_i\phi_L + Z_i\tau_L + \varepsilon_{L,i} = X_i\theta_L + \varepsilon_{L,i} \tag{4.7}$$

where $\bar{L}$ is average life expectancy of country i, H are health factors, Z are other determinants and ε is the error term. The second step estimator is given by:

$$y_i = \pi_L + \bar{L}_i\varphi_L + \Phi_i\chi_L + u_{L,i} = \Psi_i\xi_L + u_{L,i} \tag{4.8}$$

where y is the log of income per capita in 2005, $\bar{L}_i$ is the average life expectancy from 1960 to 2005 and Φ is a set of explanatory variables which include a set of colonial origin dummies (British, French, Portuguese or Spanish or other colonial origin[8]), geography, average constraints of executive over the 1960 to 2005 period. This specification is in line with the contributions of Acemoglu et al. (2001) and Acemoglu and Johnson (2007).

[7]The second step standard errors are corrected in order to account for the fact that the instrument utilized is the fitted value from the first step

[8]The excluded category is no colonial origin

Table 4.6: Explaining Income Growth between 1960 and 2005 using period averages of explanatory variables.

	Income Growth Rate 1960-2005		
	PIP	PM	PSD
Health	*1.000*†		
Life Expectancy in 1960	0.017	0.000	0.003
Physicians	0.370	0.002	0.002
% Public Health Exp.	0.748	0.004	0.004
Health Institutions	0.004	0.000	0.001
Immunization Measles	0.010	0.000	0.001
Improved Water Resources	0.838	0.020	0.012
Nutrition	0.866	0.033	0.017
Risk Factors	*0.430*†		
AIDS Cases	0.425	0.000	0.000
Incidence of TB	0.030	0.000	0.000
Malaria Ecology Index	0.020	0.000	0.001
Ease of coastal access	0.005	0.000	0.000
% Area in Tropics	0.056	0.000	0.002
Neoclassical/Solow	*1.000*†		
Income in 1960	1.000	-0.014	0.002
Schooling	0.007	0.000	0.000
Institutions	*0.967*†		
Constraints on Executive	0.696	0.006	0.004
Risk of Expropriation	0.485	-0.004	0.005
Government Stability	0.503	0.010	0.013
Ethnic Fractionalization	*0.014* †	0.000	0.001
Religion Shares	*0.855*†		
Protestant	0.041	0.000	0.001
Jewish	0.038	0.000	0.002
Muslim	0.094	-0.001	0.003
Hindu	0.064	0.001	0.004
Eastern Religions	0.854	0.019	0.010
Other Religions	0.104	0.001	0.003
Regional Heterogeneity	*0.263*†		
Sub-Saharan Africa	0.237	-0.003	0.005
Latin-America & Caribbean	0.021	0.000	0.001
East Asia & Pacific	0.081	0.001	0.002

Note: PIP stands for Posterior Inclusion Probability, PM stand for Posterior Mean and PSD stand for Standard Deviation of the Posterior Error of the distribution. † denotes the posterior inclusion probability for each theory.

In Table 4.6, we present the results where we study the relationship between income growth rate with the set of explanatory variables. In terms of the determinants of income growth rate the theories with the higher posterior inclusion probabilities are the health variables and the neoclassical growth variables. In terms of individual variables nutrition and improved water resources receive the highest posterior inclusion probability. In terms of the neoclassical growth variables, our findings are consistent with those in the existing conditional convergence literature as well as previous studies that have employed model averaging methods to growth. Consistent with Fernandez et al. (2001) and i Martin et al. (2004), we observe very strong posterior evidence in favor of an important negative coefficient to initial income per capita. We also find a high posterior inclusion probability for the religion theory. The variable with the highest inclusion probability in this theory is the Eastern Religion share. This category includes also the share of the population showing adherence to the Confucian religion. This finding is consistent with the findings of Fernandez et al. (2001), i Martin et al. (2004) and Durlauf et al. (2008).

The results from the instrumental variables two step estimation are presented in Table 4.7. Average life expectancy has a posterior inclusion probability equal to one. The effect of life expectancy on income is positive and statistically significant. The other explanatory variables have lower posterior inclusion probabilities. The second most important determinant is the percentage of a country area in tropical areas which have posterior inclusion probability higher than 0.850. These results provide evidence of a link between average life expectancy and income, which is robust when we account for model uncertainty in both steps of the 2SLS estimation.

Table 4.7: Effect of Average Life Expectancy to Income level in 2005

	Income in 2005		
	(1)	(2)	(3)
	PIP	PM	PSD
Average Life Expectancy 1960-2005	1.000	5.121	0.706
British Colony	0.113	-0.003	0.045
French Colony	0.110	0.002	0.057
Spanish or Portuguese Colony	0.270	-0.056	0.117
Other Colonial origin	0.149	-0.034	0.128
% Area in Tropics	0.856	-0.492	0.272
Ease of coastal access	0.168	0.044	0.147
Constraints on Executive	0.736	0.395	0.294

Note: PIP stands for Posterior Inclusion Probability, PM stand for Posterior Mean and PSD stand for Standard Deviation of the Posterior Error of the distribution. † denotes the posterior inclusion probability for each theory.

4.6 Conclusions

In this chapter we attempt to examine the determinants of life expectancy considering a large number of economic theories. The theories examined are health related inputs, health risk factors, neoclassical/Solow variables, institutions, fractionalization, religion and regional heterogeneity. We also examine the effect of this large number of theories on income growth rate.

Our findings show that health inputs matter for life expectancy in 2005 and life expectancy growth rate between the 1960 and 2005 period. We find that health institutions and average nutrition have a positive effect over these health outcomes and that sub-Saharan African countries have lower health outcomes. Furthermore, we find that, countries with lower life expectancy in 1960 exhibited larger increases in life expectancy. These effects are robust in the use of different Bayesian model averaging methodologies, along the lines of Durlauf et al. (2008); Magnus et al. (2010) and Zellner (1986).

The analysis of the determinants of income growth show that a number of health variables affect income. These variables include nutrition, improved water resources, health expenditure. Using a two-step instrumental variables Bayesian methodology we correct for the potential endogeneity of life expectancy on income. Our results show that life expectancy has a positive and significant effect on income.

Our work serves as the basis for further examination of the relationship between life expectancy and its determinants as well as the relationship between income and average life expectancy.

APPENDICES

Appendix A

The Gender Wage Gaps, 'Sticky Floors' and 'Glass Ceilings' of the European Union

A.1 Sample construction and description of variables

Exclusions:

1. Excluded from study are individuals who are:
    - Older than 54 or younger than 25 years
    - Employers or self-employed
    - Pupils, students, individuals in further training and unpaid work experience
    - In retirement or in early retirement or have given up a business
    - Permanently disabled and/or unfit to work
    - In compulsory military or community service
2. In the 'base' sample we include individuals who self-declare to be:
    - unemployed,
    - fulfilling domestic tasks and care responsibilities, and
    - other inactive persons
3. In the 'working' sample we include individuals who:

a) Work as employees (includes 777 individuals in the armed forces)

b) Worked full time during the whole of the last year, worked for at least one hour during the last week and did not have a second job

c) Received an annual wage larger than €1000

Variables Definition

1. Annual Wage Income: The annual cash income paid from the employer to the employee. It excludes non-cash benefits from the employer and the employer's social insurance contributions and include usual paid overtime, tips and commissions but excludes income from investments- assets, savings, stocks and shares. It includes supplementary payments (13th or 14th month payments) or payments like holiday pay, profit share bonuses etc. The annual wage income is in euro.

2. Other Income: Income in euro from renting a property or land; income from interest and dividends; profit from capital investments in unincorporated businesses; allowances (including family/child allowance, housing allowance)

3. Mortgage Expenses: Gross interest repayments on mortgage (in euro).

4. Age: Individual's age at time of survey; used to construct a set of country-consistent age dummies. The age groups are 25-34, 35-44 and 45-54.

5. Education: Elementary (Illiterate, Primary or Lower Secondary) Secondary, Higher (Post-secondary or Tertiary Education)

6. Married: Individual is Married

7. Other Marital Status: Individual is Divorced, Separated, or Widowed

8. Child Care Provision: Individual received child care for at least one child of the following type:

    - Child care services at a center (before or after school and normal working times)

    - Child care services at a day-care center

    - Child care by a child-minder (on a paid basis)

- Child care by a relative etc (on an unpaid basis)

9. Industry of Employment:

    - Agriculture, Fishing, Hunting and Forestry
    - Manufacturing, Mining and Quarrying, Electricity Gas and Water Supply
    - Construction
    - Wholesale and Retail Trade
    - Hotels and Restaurants
    - Transport, Storage and Communication
    - Financial Intimidation
    - Real Estate, Renting and Business Activities
    - Public Administration and Defense
    - Education
    - Health and social work
    - Other Community, Social and Personal Service activities. Private households with employed persons, extra-territorial organizations and bodies

10. Firm Size: Number of persons working in firm is more than 10

11. Occupation:

    - Legislators, senior officials and managers
    - Professionals
    - Technicians and associate professionals
    - Clerks
    - Service workers and shop and market sales workers

- Skilled agricultural and fishery workers
- Craft and related trades workers
- Plant and machine operators and assemblers
- Elementary occupations
- Armed forces

12. Experience: Years of working experience since joining workforce (not available for Denmark, Finland, Greece, Hungary, Sweden and United Kingdom). In some countries, a few observations do not record experience and are omitted when experience is used.

A.2 Sample size and country code

Table A.1: Countries included in the estimation and their two-letter code

#	Country	Code	#	Country	Code
1	Austria	AT	13	Italy	IT
2	Belgium	BE	14	Latvia	LV
3	Cyprus	CY	15	Lithuania	LT
4	Czech Republic	CZ	16	Luxembourg	LU
5	Denmark	DK	17	Netherlands, The	NL
6	Estonia	EE	18	Poland	PL
7	Finland	FI	19	Portugal	PT
8	France	FR	20	Slovak Republic	SK
9	Germany	DE	21	Slovenia	SI
10	Greece	GR	22	Spain	ES
11	Hungary	HU	23	Sweden	SE
12	Ireland	IE	24	United Kingdom	UK

Table A.2: Sample size for the Oaxaca-Ransom decompositions

	Base Sample		Working Sample		Base Sample (estimation with experience)		Working Sample (estimation with experience)	
	Male	Female	Male	Female	Male	Female	Male	Female
Austria	2361	1780	2183	983	2355	1769	2177	972
Belgium	2088	1642	1840	886	2083	1637	1835	881
Cyprus	1302	1549	1220	990	1302	1549	1220	990
Czech Republic	3330	3612	3119	2610	3330	3612	3119	2610
Denmark	313	284	298	215	-	-	-	-
Estonia	1949	2090	1751	1676	1947	2089	1749	1675
Finland	1545	1737	1237	1066	-	-	-	-
France	3496	2795	3179	1957	3483	2791	3166	1953
Germany	3912	3165	3482	1590	3867	3147	3437	1572
Greece	1403	1850	1232	765	-	-	-	-
Hungary	3009	3436	2549	2321	-	-	-	-
Ireland	1270	1327	1065	606	1244	1318	1039	597
Italy	6617	6923	5580	2898	6617	6923	5580	2898
Latvia	1411	1690	1198	1272	1407	1688	1194	1270
Lithuania	1528	1628	1321	1302	1527	1627	1320	1301
Luxembourg	1913	1506	1757	767	1902	1502	1746	763
Netherlands, The	1498	1328	1401	394	1482	1325	1385	391
Poland	4388	5126	3561	2870	4372	5117	3545	2861
Portugal	1502	1710	1306	1146	1500	1709	1304	1145
Slovak Republic	2289	2508	2072	2069	2285	2505	2068	2066
Slovenia	4638	5058	4080	4003	1932	2516	1374	1461
Spain	4530	4980	3997	2384	4479	4959	3946	2363
Sweden	1183	974	1075	750	-	-	-	-
United Kingdom	2471	2232	2301	1493	-	-	-	-
Total	59946	60930	52804	37013	47114	47783	41204	27769

A.3 Oaxaca-Ransom decomposition

In order to apply the Oaxaca-Ransom decomposition, wage equations are estimated separately for the males and females of each country using the natural logarithm of Annual Wage Income (see Section A.1). The set of explanatory variables includes age, education, occupation and industry dummies and a variable indicating whether the individual is married and a variable indicating if the individual is separated, divorced or widowed and firm size. It is necessary to examine whether the individuals in the working sample are randomly drawn from the base sample and, if not, to alter the estimation process to avoid bias. A Probit equation models the selection into the working sample and, in standard practice, the inverse Mills ratio is then added to the working sample wage equations for the two genders. The significance of the coefficient (λ) on the inverse Mills ratio (ϑ) would indicate whether the base sample is randomly selected from the working sample. The set of explanatory variables in the Probit selection equations include: age, education and occupation dummies, married, separated divorced or widowed. number of children that the individual has, income, and mortgage expenses and child care availability (Appendix A.1). When the estimates of the wage estimation are corrected for sample selection, the Oaxaca-Ransom decomposition involves calculating the average value of the product of the estimated coefficient (λ) and Mills ratio (ϑ) for males and females and subtracting their difference from the left hand side of Eq. (2.1) in the text. The LHS of the resulting equation has the interpretation of the 'offered' gender wage gap and the three RHS terms in Eq. (2.1) now refer to the constituent parts of this offered wage gap.

A.4 Quantile decomposition based on Melly (2005)

The whole whole conditional wage distribution is estimated by quantile regression. Then, the conditional distribution is integrated over the range of covariates in order to obtain an estimate of the unconditional distribution. Let $\{y_i, x_i\}_{i=1}^{N}$ an independent sample from the same population where x_i is a $K \times 1$ vector of regressors. Following Koenker and Bassett (1978) we assume that:

$$F_{y|x}^{-1}(\tau \mid x_i) = x_i \beta(\tau), \forall \tau \in (0,1)$$

where $F_{y|x}^{-1}(\tau \mid x_i)$ is the τ^{th} quantile of y conditionally on x_i. Koenker and Bassett (1978) show that $\beta(\tau)$ can be estimated by:

$$\hat{\beta} = \underset{b \in \mathbb{R}^{\mathbb{K}}}{arg\,min} \frac{1}{N} \sum_{i=1}^{N} (y_i - x_i b)(\tau - 1(y_i \leq x_i b)) \tag{A.1}$$

where $1(.)$ is the indicator function. The coefficients $\beta(\tau)$ are estimated separately for each τ. In order to estimate the unconditional quantiles of y, the conditional distribution must be integrated over the whole range of the regressors. The sample analog of the population's θ^{th} quantile of y and $q_0 = F_Y^{-1}(\theta)$ is given by:

$$\hat{q}\left(\hat{\beta},x\right) \quad = \quad inf\left\{q:\frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{J}\left(\tau_j-\tau_{j-1}\right)1\left(x_i\hat{\beta}\left(\tau_j\right)\leq q\right)\geq\theta\right\} \tag{A.2}$$

The decomposition of differences in distribution is performed as follow. The wage equation of each gender is estimated:

$$y_i^g = x_i^g\beta^g(0.5)+u_i^g,\ g=M,F$$

where $\beta^g(0.5)$ is the coefficient vector of the median regression for gender g (males and females). We estimate, first, the counterfactual distribution of female wages that would have prevailed if the distribution of individual attributes had been the same to males by minimizing equation A.2 over the distribution of male characteristics but using the estimated female coefficients. Formally,

$$\hat{q}\left(\hat{\beta}^F,x^M\right) \quad = \quad inf\left\{q:\frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{J}\left(\tau_j-\tau_{j-1}\right)1\left(x_i^M\hat{\beta}^F\left(\tau_j\right)\leq q\right)\geq\theta\right\} \tag{A.3}$$

is the θ^{th} quantile of this counterfactual distribution of wages. Thus, the difference between $\hat{q}\left(\hat{\beta}^F,x^M\right)$ and $\hat{q}\left(\hat{\beta}^F,x^F\right)$ is explained by differences in characteristics.

To separate the effects of coefficients from the effects of residuals, note that the τ^{th} quantile of the residuals distribution conditionally on x is consistently estimated by:

$$x\left(\hat{\beta}(\tau)-\hat{\beta}(0.5)\right)$$

We define the $K\times 1$ vector $\hat{\beta}^{mM,rF}$ where its j^{th} element is given by:

$$\hat{\beta}^{mM,rF}\left(\tau_j\right)=\left(\hat{\beta}^M(0.5)+\hat{\beta}^F\left(\tau_j\right)-\hat{\beta}^F(0.5)\right)$$

Thus, we estimate the distribution that would have prevailed if the median return to characteristics had been the same as that of males but the residuals were distributed as in females by $\widehat{q}\left(\hat{\beta}^{mM,rF},x^M\right)$. Therefor, the difference between $\widehat{q}\left(\hat{\beta}^{mM,rF},x^M\right)$ and $\widehat{q}\left(\hat{\beta}^{F},x^M\right)$ is due to changes in coefficients since characteristics and residuals are kept at the same level. Finally, the difference between $\widehat{q}\left(\hat{\beta}^{M},x^M\right)$ and $\widehat{q}\left(\hat{\beta}^{mM,rF},x^M\right)$ is due to residuals.

The final decomposition is the following:

$$\begin{aligned} \hat{q}(\hat{\beta}^M,X^M)-\hat{q}(\hat{\beta}^F,X^F) \;=\; & \left[\hat{q}(\hat{\beta}^M,X^M)-\hat{q}(\hat{\beta}^{mM,rF},X^M)\right]+ \\ & \left[\hat{q}(\hat{\beta}^{mM,rF},X^M)-\hat{q}(\hat{\beta}^F,X^M)\right]+ \\ & \left[\hat{q}(\hat{\beta}^F,X^M)-\hat{q}(\hat{\beta}^F,X^F)\right] \end{aligned} \tag{A.4}$$

where the first bracket represents the effect of differences in residuals, the second the effects of differences in (median) coefficients and the third the effects of changes in the distribution of the covariates.

A.5 Labour market institutions and policies

A.5.1 A work-family life reconciliation index

The OECD Work-Personal Life Reconciliation Index was published by the OECD (2001) and discussed by Evans (2002). It was constructed by combining the following variables: (i) The proportion of children aged less than three using formal child-care arrangements, (ii) maternity pay entitlement, (iii) the availability of voluntary family leave in firms, (iv) flexible-time working and (v) voluntary part-time work. This index was constructed for **fourteen** European countries[1] and Australia, Canada, Japan and the United States. This indicator was used in previous studies to examine the relationship between gender differences in pay and differences in government policies (Arulamplam et al. (2006) and Nicodemo (2009)).

We re-constructed this index for all the European countries in our sample. Out of the five variables used to create the original OECD index we have been able to collect data for all countries for three variables: The proportion of children aged less than three using formal child-care arrangements, the availability of maternity pay and voluntary part-time work. Data for firm policies towards employees were not available for all countries and we have substituted

[1] The fourteen countries are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, The Netherlands, Portugal, Spain, Sweden and United Kingdom.

using for (iii) the percentage of employed persons (aged 25-49) who can take entire days off for family reasons without using holidays or special leave and for (iv) the percentage of employed persons (aged 25-49) who can vary the start/end of their working day for family reasons.

The data for the proportion of children aged under three using formal child-care arrangements are from the EU-SILC dataset. A more detailed discussion of the data can be found in Eurostat (2009), page 56. This information is available for all countries in the sample from 2005 onwards. We use the 2005 data because the sample used in the study is for 2007 and 2005 policies may, therefore, be considered as exogenous. In Table A.3, some data for all countries are presented but we use column 2. The highest percentage of children aged up to 3 using formal child-care agreements for more than 29 hours per week is found in Denmark and Sweden (60% and 31% respectively). On the other hand this proportion for Austria and the Czech Republic is zero.

The measures of the ability of individuals to take leaves for family reasons and to vary the start/end of their working day (variables (iii) and (iv) above respectively) are based on the Labour Force Survey (LFS). These two variables are found in Eurostat (2009), pages 121-122. In the last four columns of Table A.3 the available data for all countries are presented. The percentage of employees who are generally able to vary the start or the end of their working day for family reasons (column 7, Table A.3) is highest in The Netherlands and Luxembourg (91% and 70% respectively) and lowest in Poland and Lithuania (26%). The percentage of employed persons who are generally able to take entire days off for family reasons (column 9, Table A.3) varies from 15% and 23% in Cyprus and Poland, respectively, to 61% and 59% in The Netherlands and Denmark, respectively.

Table A.3: Child Care Arrangements in European Union countries & Firm Policies towards work - family reconciliation

	% of children aged under 3 using formal child-care arrangements			% of children aged 3 to mandatory school age using formal child-care arrangements			% of employed persons (aged 25-49) who can vary start/end of their working day for family reasons		% of employed persons (aged 25-49) who can take entire days off for family reasons (without using holidays or spacial leave)	
	1-29 hours	More than 30 hours	Total	1-29 hours	More than 30 hours	Total	Generally Possible	Generally & Rarely Possible	Generally Possible	Generally & Rarely Possible
Austria	4	0	4	53	16	69	62	78	57	74
Belgium	23	19	42	50	48	98	60	77	51	68
Cyprus	7	12	19	42	43	85	28	71	15	29
Czech Republic	2	0	2	30	40	70	41	72	38	66
Denmark	13	60	73	15	79	94	70	81	59	72
Estonia	3	9	12	9	69	78	37	76	37	77
Finland	8	19	27	25	51	76	65	84	39	86
France	16	16	32	56	39	95	39	79	26	63
Germany	8	8	16	61	26	87	31	53	32	63
Greece	3	4	7	27	34	61	36	73	33	66
Hungary	2	5	7	30	54	84	36	63	31	58
Ireland	14	6	20	64	14	78	-	-	-	-
Italy	9	16	25	21	70	91	36	75	29	71
Latvia	2	16	18	6	60	66	42	76	38	77
Lithuania	2	9	11	11	46	57	25	49	26	59
Luxembourg	14	8	22	51	12	63	70	77	34	43
Netherlands, The	36	4	40	82	7	89	91	94	61	66
Poland	0	2	2	8	22	30	26	55	23	40
Portugal	4	26	30	12	18	30	42	60	28	42
Slovak Republic	0	3	3	10	57	67	32	56	24	50
Slovenia	2	22	24	10	67	77	50	82	48	77
Spain	25	14	39	54	40	94	56	75	49	69
Sweden	22	31	53	35	52	87	58	78	53	74
United Kingdom	24	5	29	64	24	88	57	70	40	54

Note: Data are taken from Eurostat (2009) and LFS.

Table A.4: Maternity Leave Entitlement in European Union Countries and voluntary part-time work

Country	Maternity Leave (weeks)	% rate of allowance	FTE paid maternity leave*	Voluntary part-time work due to family, children and other reasons
Austria	16	100	16	36.8
Belgium	15	77	12	32.6
Cyprus	18	75	14	3.8
Czech Republic	28	69	19	3.7
Denmark	18	100	18	14.3
Estonia	20	100	20	6.9
Finland	16	100	16	3.9
France	17.5	81	12	17.1
Germany	14	100	14	32.6
Greece	16	100	16	2.0
Hungary	24	70	17	1.9
Ireland	26	80	21	-
Italy	21	80	17	14.9
Latvia	16	100	16	2.1
Lithuania	18	100	18	5.0
Luxembourg	16	100	16	31.1
Netherlands, The	16	100	16	55.9
Poland	16	100	16	2.2
Portugal	17	100	17	1.7
Slovak Republic	28	55	15	1.9
Slovenia	-	-	-	1.8
Spain	17	100	17	6.8
Sweden	15	80	12	19.1
United Kingdom	26	46	12	32.2

Note: Data source is Eurostat (2009)

The maternity leave data, in Table A.4, are taken from Eurostat (2009) (page 89) and describe the situation as of 1st July 2007. The weeks of maternity leave possible range from 14 in Germany to 28 weeks in the Czech and Slovak Republics. For 13 out of the 22 countries in the sample 100% of their wage is paid during the maternity leave. For the other 9 countries the rate of allowance ranges from 46% in the United Kingdom to 81% in France. The Full Time Equivalent (FTE) paid maternity leave ranges from 12 in Belgium, France, Sweden and United Kingdom to 21 in Ireland. Paternity leave data are not available for all the European Union member states and this variable is not utilized in the study.

The information about voluntary part-time employment due to family, children or other reasons (column 4, Table A.4) is taken from Eurostat (2009), page 23, and it is based on the con-

Table A.5: Summary Indicators of work/family reconciliation policies among the European Union countries

	Child-Care Coverage for under-3s	Maternity pay entitlement	Voluntary part-time working	Adjust Working Day for Family Reasons	Take Leave for Family Reasons	Composite Index
Austria	-1.01	0.02	1.50	0.88	1.55	2.94
Belgium	0.46	-1.63	1.22	0.76	1.06	1.86
Cyprus	-0.08	-0.81	-0.71	-1.16	-1.85	-4.62
Czech Republic	-1.01	1.26	-0.71	-0.38	0.01	-0.84
Denmark	3.62	0.84	0.00	1.36	1.71	7.53
Estonia	-0.32	1.67	-0.50	-0.62	-0.07	0.16
Finland	0.46	0.02	-0.70	1.06	0.09	0.92
France	0.23	-1.63	0.18	-0.50	-0.96	-2.69
Germany	-0.39	-0.81	1.22	-0.98	-0.48	-1.44
Greece	-0.70	0.02	-0.83	-0.68	-0.39	-2.59
Hungary	-0.62	0.43	-0.83	-0.68	-0.56	-2.27
Ireland	-0.55	2.08	0.00	0.00	0.00	1.54
Italy	0.23	0.43	0.04	-0.68	-0.72	-0.71
Latvia	0.23	0.02	-0.82	-0.32	0.01	-0.89
Lithuania	-0.32	0.84	-0.63	-1.34	-0.96	-2.40
Luxembourg	-0.39	0.02	1.12	1.36	-0.31	1.79
Netherlands, The	-0.70	0.02	2.78	2.61	1.88	6.59
Poland	-0.86	0.02	-0.81	-1.28	-1.21	-4.14
Portugal	1.00	0.43	-0.85	-0.32	-0.80	-0.54
Slovak Republic	-0.78	-0.39	-0.83	-0.92	-1.12	-4.05
Slovenia	0.69	0.00	-0.84	0.16	0.82	0.83
Spain	0.07	0.43	-0.51	0.52	0.90	1.41
Sweden	1.38	-1.63	0.32	0.64	1.23	1.93
United Kingdom	-0.62	-1.63	1.19	0.58	0.17	-0.31

Note: All indicators scaled as to have mean zero and standard deviation unity. A value of zero implies that the country concerned is at the average value for the countries in the sample. The composite index is calculated as the sum of the five indicators. A more detailed discussion of the indicators is find in Appendix A.5.1

ducted in each member state. The different reasons evoked for working part-time are education, own illness and disability, looking after children or incapacitated adults, other family or personal reasons, unavailability of a full-time job and other reasons. The percentage of individuals working part time due to family, children or other reasons is calculated by adding the three relevant categories. For certain countries data for some of the sub-categories are not available so the voluntary part-time variable is calculated by subtracting from the total percentage the available categories. For Denmark, Hungary, Slovenia and Slovak Republic the percentage of part-time employment due to family reasons is not available, for Latvia part-time due to children and family reasons are not available, for Lithuania part-time due to children are not available. For Estonia only the total voluntary part-time employment variable is available. The percentage of voluntary part-time work due to family, children and other reasons is presented in the final column of Table A.4. The percentage of voluntary part-time work varies considerably among the European Union countries. It ranges from the high of 55.9% in The Netherlands down to 1.7% in Portugal. Most of the countries with low part-time work are in southern Europe (Portugal and Greece) and eastern Europe (Slovenia, Hungary and Slovakia).

The variables used to construct the index in Table A.5 below and in the text are (i) % of children aged lees than 3 using formal child-care arrangements for more than 29 hours, column 2 of Table A.3, (ii) % of employed persons (aged 25-49) who can vary start/end of their working day due to family reasons column 7 of Table A.3, (iii) % of employed persons (aged 25-49) who can take entire days off for family reasons (without using holidays or special leave), column 9 of Table A.3, (iv) FTE paid maternity leave, column 3 of Table A.4 and (v) Voluntary part-time work due to family, children and other reasons, column 4 of Table A.4. Following the construction of the OECD (2001) index, the variables used in the construction of our index in Table A.4 are transformed to exhibit a zero mean and a variance equal to unity. Where data are not available for a certain country, the mean value is assigned to the missing observation. The composite index is created by adding the sub-indices.

A.5.2 Union Membership Rate

Trade union density corresponds to the ratio of active wage and salary earners who are trade union members divided by the total number of wage and salary earners and it is taken from OECD (2001). Density is calculated using survey data on active trade union members and administrative data otherwise. Data from the OECD database cover 19 European countries. Data for Estonia are taken from ILO (1997). From these two databases data have not been found for Cyprus, Latvia, Lithuania and Slovenia. The union membership data have as reference date 2007, except for Austria, Czech Republic, Luxembourg, Slovak Republic and Spain which refer to 2006, Greece and Poland which refer to 2005, Portugal (2004) and Estonia (1995). This information is summarized in Table A.6 below and in the last column of Table 2.5 in the text.

Table A.6: Unionization Rate

	Unionization Rate (%)
Austria	31.7
Belgium	52.9
Cyprus	-
Czech Republic	21.0
Denmark	69.1
Estonia	36.1
Finland	70.3
France	7.8
Germany	19.9
Greece	23.0
Hungary	16.9
Ireland	31.7
Italy	33.3
Latvia	-
Lithuania	-
Luxembourg	41.8
Netherlands, The	19.8
Poland	14.4
Portugal	18.7
Slovak Republic	23.6
Slovenia	-
Spain	14.6
Sweden	70.8
United Kingdom	28.0

A.6 Industry and occupation segregation in the EU

The segregation index calculation is based in Blau and Kahn (1996). The index is calculated as follow:

$$I = \frac{1}{2}\sum \left| p_{im} - p_{if} \right| \tag{A.5}$$

where p is the proportion of each gender in occupation or industry i. The segregation index represents the proportion of women (men) who would have to change jobs for the occupational or industrial distributions of males and females to be the same. Low (high) values of the index suggest that segregation is low (high)[2].

In Table A.7 the results from the estimation of segregation index *I* for industries and occupations in the sample used in the study are presented. In the first two columns the segregation index is calculated using the whole sample used in the study. In the third and fourth column the segregation index is calculated for the lower 25% paid employees and in the last two columns the 75% higher paid employees. The highest occupation segregation over the whole working population is found in Latvia and Estonia. The lower segregation is found in Belgium and Denmark. The highest industry segregation index is found in Finland and Denmark whereas the lower segregation index is found in Belgium and Ireland.

If we focus in the lower 25% paid employees for both genders, the higher occupational segregation is found in Luxembourg and Cyprus and lower in Belgium and Ireland. The higher industry occupational segregation index is found in Luxembourg and Cyprus and lower in Slovenia and Ireland.

In the the top 75% paid employees, the highest segregation index is found in Estonia and Latvia and the lower is found in Sweden and Luxembourg. The highest industry segregation index is found in Portugal and Slovak Republic and the lower in Ireland and Luxembourg.

[2]Using data covering the 1985-88 period Blau and Kahn (1996) found that in the United States occupational segregation was higher compared to Australia, Austria, Germany. Hungary, Norway, Sweden and United Kingdom with the exception of Switzerland. Industry segregation in the United States is similar to the rest countries in the sample. Within the European countries, Austria and Sweden have the lower and higher segregation index in industry respectively. The lower occupational segregation index is found in Hungary and the highest in Sweden.

Table A.7: Industry and Occupation Segregation Index

	Complete Sample		25% lower paid employees		75% higher paid employees	
	Occupation	Industry	Occupation	Industry	Occupation	Industry
Austria	0.392	0.310	0.407	0.315	0.308	0.328
Belgium	0.276	0.271	0.265	0.246	0.213	0.265
Cyprus	0.369	0.296	0.519	0.509	0.343	0.358
Czech Republic	0.366	0.300	0.445	0.346	0.339	0.310
Germany	0.310	0.283	0.407	0.298	0.167	0.282
Denmark	0.261	0.392	0.363	0.458	0.214	0.377
Estonia	0.439	0.357	0.505	0.488	0.464	0.384
Spain	0.381	0.318	0.358	0.335	0.337	0.313
Finland	0.382	0.396	0.504	0.385	0.267	0.328
France	0.361	0.324	0.465	0.307	0.215	0.345
Greece	0.400	0.278	0.445	0.379	0.357	0.274
Hungary	0.373	0.323	0.336	0.331	0.315	0.346
Ireland	0.298	0.269	0.342	0.218	0.184	0.252
Italy	0.305	0.279	0.297	0.295	0.271	0.275
Lithuania	0.414	0.353	0.463	0.384	0.396	0.353
Luxembourg	0.353	0.388	0.596	0.576	0.134	0.235
Latvia	0.448	0.371	0.506	0.457	0.440	0.402
Netherlands	0.278	0.308	0.350	0.344	0.213	0.296
Poland	0.430	0.353	0.385	0.338	0.398	0.357
Portugal	0.373	0.378	0.304	0.429	0.370	0.473
Sweden	0.321	0.386	0.347	0.348	0.135	0.303
Slovenia	0.327	0.302	0.273	0.233	0.256	0.384
Slovakia	0.394	0.379	0.364	0.329	0.412	0.444
United Kingdom	0.316	0.299	0.489	0.352	0.178	0.309

Note: Data are taken from the EU-SILK databases and authors calculations.

A.7 Tables 2.2 and 2.3 in the text without industry and occupation controls

Table A.8: Oaxaca-Ransom Decomposition Occupation&Industry Effects not Included (age is used as a proxy for experience)

	Oaxaca-Ransom Decomposition				Heckman-Corrected Oaxaca-Ransom Decomposition			
	Total Difference	Explained	Unexplained		Total Difference	Explained	Unexplained	
		Endowments	Male Advantage	Female Disadvantage		Endowments	Male Advantage	Female Disadvantage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Austria	0.225***	0.015*	0.065***	0.145***	0.272***	0.004	0.052	0.216***
Belgium	0.127***	-0.022***	0.049***	0.101***	0.113***	-0.016**	0.026***	0.102***
Cyprus	0.502***	-0.001	0.226***	0.278***	0.652***	0.009	-0.009	0.652***
Czech Republic	0.323***	0.026***	0.136***	0.162***	0.267***	0.023***	0.038***	0.205***
Denmark	0.198***	-0.011	0.087***	0.121***	0.226***	-0.019	0.006	0.240***
Estonia	0.423***	-0.001	0.207***	0.217***	0.695***	0.022***	0.239***	0.433***
Finland	0.245***	-0.037***	0.131***	0.152***	0.237***	-0.027***	0.027*	0.236***
France	0.202***	-0.026***	0.087***	0.141***	0.266***	-0.026***	0.067***	0.225***
Germany	0.196***	0.039***	0.049***	0.108***	0.404***	0.031***	0.190***	0.183***
Greece	0.186***	-0.040***	0.086***	0.139***	0.200**	-0.035***	0.010	0.225***
Hungary	0.100***	-0.042***	0.068***	0.074***	0.041	-0.038***	-0.053	0.132***
Ireland	0.236***	0.008	0.083***	0.145***	0.270***	0.023*	0.041*	0.206***
Italy	0.164***	-0.031***	0.067***	0.129***	0.153***	-0.028***	0.067***	0.114***
Latvia	0.305***	-0.036***	0.176***	0.165***	0.416***	0.003	0.090	0.324***
Lithuania	0.286***	-0.036***	0.160***	0.162***	0.199***	-0.010	-0.080*	0.289***
Luxembourg	0.176***	-0.005	0.055***	0.126***	0.143***	-0.003	0.074***	0.072**
Netherlands, The	0.178***	0.036**	0.031***	0.111***	0.169***	0.037**	0.055***	0.077*
Poland	0.181***	-0.068***	0.111***	0.138***	0.358***	-0.056***	0.208***	0.206***
Portugal	0.122***	-0.146***	0.125***	0.142***	0.193***	-0.125***	0.104*	0.215***
Spain	0.153***	-0.037***	0.071***	0.119***	0.246***	-0.028***	0.126***	0.148***
Slovak Republic	0.268***	0.008	0.130***	0.130***	0.225***	0.004	-0.049*	0.270***
Slovenia	0.087***	-0.067***	0.076***	0.078***	0.182***	-0.050***	-0.045*	0.278***
Sweden	0.198***	-0.029***	0.093***	0.133***	0.156***	-0.019***	0.043***	0.132***
United Kingdom	0.253***	0.003	0.099***	0.152***	0.249***	0.005	0.046***	0.199***
European Union	*0.381****	*0.142****	*0.099****	*0.141****	*0.512****	*0.150****	*0.094****	*0.268****

Note: The first four columns report the results of the Oaxaca-Ransom decomposition and columns 7-8 the Heckman corrected Oaxaca-Ransom decomposition. The total difference between the predicted log male and female wage from the wage equation. The explained part (corresponds to the first term of Eq. (2.1)) measure the part of the wage difference that can be attributed to the difference between the male and female characteristics. The unexplained part (correspond to the second and third term of Eq. (2.1)) and correspond to the part of the wage difference than canto be attributed to the difference in observable characteristics.

Table A.9: Oaxaca-Ransom decomposition without occupation and industry effects included (based on actual experience)

	Oaxaca Ransom Decomposition				Heckman-Corrected Oaxaca Ransom Decomposition			
	Total	Explained	Unexplained		Total	Explained	Unexplained	
		Endowments	Male Advantage	Female Disadvantage		Endowments	Male Advantage	Female Disadvantage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Austria	0.226***	0.033***	0.060***	0.133***	0.231***	0.022***	0.016	0.193***
Belgium	0.126***	-0.018**	0.047***	0.097***	0.127***	-0.013*	0.021**	0.118***
Cyprus	0.502***	0.043***	0.206***	0.254***	0.628***	0.048***	-0.007	0.587***
Czech Republic	0.323***	0.028***	0.134***	0.161***	0.274***	0.020***	0.041***	0.213***
Denmark	-	-	-	-	-	-	-	-
Estonia	0.424***	-0.009	0.211***	0.221***	0.703***	0.012*	0.236***	0.455***
Finland	-	-	-	-	-	-	-	-
France	0.202***	-0.014**	0.082***	0.134***	0.276***	-0.014**	0.074***	0.215***
Germany	0.198***	0.043***	0.049***	0.106***	0.303***	0.035***	0.092***	0.175***
Greece	-	-	-	-	-	-	-	-
Hungary	-	-	-	-	-	-	-	-
Ireland	0.234***	0.022	0.077***	0.135***	0.264***	0.033**	0.037	0.193***
Italy	0.164***	-0.017***	0.062***	0.119***	0.151***	-0.016***	0.065***	0.101***
Latvia	0.308***	-0.037***	0.177***	0.167***	0.440***	0.004	0.089	0.348***
Lithuania	0.286***	-0.043***	0.163***	0.166***	0.298***	-0.016*	-0.003	0.317***
Luxembourg	0.177***	0.027	0.045***	0.104***	0.175***	0.028*	0.071***	0.076**
Netherlands, The	0.180***	0.031**	0.033***	0.115***	0.161***	0.032**	0.022*	0.107***
Poland	0.184***	-0.057***	0.107***	0.133***	0.334***	-0.045***	0.173***	0.206***
Portugal	0.121***	-0.126***	0.115***	0.131***	0.153**	-0.107***	0.047	0.214***
Slovak Republic	0.268***	0.009*	0.129***	0.129***	0.242***	0.004	-0.028	0.266***
Slovenia	0.076***	-0.071***	0.076***	0.071***	0.236***	-0.068***	0.006	0.298***
Spain	0.153***	-0.011	0.061***	0.102***	0.249***	-0.005	0.102***	0.152***
Sweden	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-

Note: Columns 1-4 report the results of the Oaxaca-Ransom decomposition and columns 7-8 the Heckman-corrected Oaxaca-Ransom decomposition. The explained part (the first term of Eq. (2.1)) measures the part of the predicted average wage difference that can be explained by the difference between the male and female characteristics. The unexplained part (the second and third terms of Eq. (2.1)) corresponds to the male advantage and female disadvantage. Three stars indicate significance at the 1%, two stars at the 5% and one star at the 10% level.

Appendix B

A Contribution to the Empirics of Welfare Growth

B.1 Countries included in the sample

Table B.1: Cross-section of countries in sample

East Asia & Pacific	Nicaragua
Australia	Panama
China[‡]	Paraguay
Indonesia	Peru
Japan	Trinidad & Tobago
Korea, Rep.[†,‡]	Uruguay
Malaysia	Venezuela
New Zealand	*Middle East & North Africa*
Philippines	Algeria
Thailand	Egypt [‡]
Europe & Central Asia	Iran
Austria	Israel
Belgium[†,‡]	Jordan
Denmark[†,‡]	Syria
Finland[†,‡]	Tunisia
France [‡]	*Northern America*
Greece	Canada
Ireland[†,‡]	United States
Italy[†,‡]	*Southern Asia*
Netherlands	India
Norway	Pakistan
Portugal	Sri Lanka
Spain[†,‡]	*Sub-Saharan Africa*
Sweden	Cameroon [‡]
Switzerland	Congo, Rep. [†,‡]
Turkey	Gambia
United Kingdom	Ghana
Latin America & Caribbean	Guinea-Bissau
Argentina	Kenya
Bolivia	Malawi
Brazil	Mali
Chile	Mozambique
Colombia	Niger
Costa Rica	Senegal
Dominican Rep.	South-Africa
Ecuador	Tanzania
El Salvador	Togo
Guatemala	Uganda
Honduras	Zambia
Jamaica	Zimbabwe
Mexico[†,‡]	

[†] Countries that are not included in the estimations reported in Table 3.3. [‡] Countries that are not included in the estimations reported in 3.4

Appendix C

Health and Economic Growth: a Model Averaging Methodology

C.1 Robustness check using different prior structures

C.1.1 Estimation using Magnus et al. (2010) Laplace-priors

Magnus et al. (2010) propose a new method of Bayesian estimation called weighted-average least squares (“WALS”). The method enables to distinguish two sets of explanatory variables. The first set contain all variables that the researcher want to include in the model on theoretical or other grounds and are called “focus” variables. The second set include the explanatory variables which we are not certain for them, called “auxiliary” regressors. The framework of the estimator is:

$$y = X\beta + \varepsilon = X_1\beta_1 + X_2\beta_2 + \varepsilon$$

where y is a $n \times 1$ vector of depended variable, X_i is a $n \times k_i$ matrix of regressors, β_i is a $k_i \times 1$ vector of parameters, $i = 1,2$, and ε is the error term $\varepsilon \sim N\left(0, \sigma^2\right)$. The set of explanatory variables is separated to the “focus” variables X_1 and the “auxiliary” variables X_2.Implementation of model averaging methodology include the estimation of the prior distribution of the unknown terms $\left(\beta_2, \sigma^2\right)$ which are defined by:

- $\beta_2 = \sigma P \Lambda^{-1/2}\eta$ where P (orthogonal) and Λ (diagonal) are computed such as: $P'X_2'M_1X_2 = \Lambda$ and $\eta \equiv \beta_2/\sigma$. The k_2 components of η are i.i.d according to a Laplace distribution $\pi(\eta_i) = \frac{c}{2}exp\left(-c\left|\eta_i\right|\right)$, $c = log(2)$. The prior moment conditions for β_2 are given by: $E(\beta_2) = 0$ and $Var(\beta_2) = \sigma^2\sigma_\eta^2 P\Lambda^{-1/2}P' = \frac{\sigma^2}{c^2/2}\left(X_2'M_1X_2\right)^{-1}$

- σ^2 is assumed to be known and it is replaced by s^2

The "WALS" estimator has bounded risk, allows a coherent treatment of ignorance and its computational effort is negligible. In addition it allow to keep a number of key variables always in the estimation and examine the significance of the other variables[1]. This methodology is also used in Magnus et al. (2011) to examine the determinants of Honk Kong real estate market and by Wan and Zhang (2009) to examine the use of Bayesian Model Averaging in tourism studies[2].

Table C.1 present the results when the Magnus et al. (2010) "WALS" methodology is used. Because PIP are not reported in this methodology, the importance of different variables is examined using the ratio of posterior mean to posterior standard error. Raftery (1995) proposes the use of a threshold of unity in the ratio of posterior mean to posterior standard error to consider a variable effective. Masanjala and Papageorgiou (2008) put forward a value of 1.3 for the threshold, which is generally equivalent to a 90% confidence interval in frequentist hypothesis testing. We follow the later more strict rule in the analysis. The variables with ratio of PIP to PSD higher than 1.3 are indicated with a star.

First, we consider $X_1 = \underline{1}$ a n-dimensional vector of 1's and X_2 contain all the other variables in the dataset which are considered as "auxiliary". Thus, we are agnostic about which variables are key determinants of the dependent variable y. Second, we include in X_1 all the health related theories (health and health risk factors) and in X_2 all the other theories in the spirit of Magnus et al. (2010). We report results when all variables are considered as "auxiliary" in columns (1) to (3) and in columns (4) to (6) we report results when the health related theories are included in the "focus" group.

In Table C.1 we examine the relationship of life expectancy in 2005 and variables in the model space. The most significant variables are health institutions from the health theory, AIDS cases, incidence of tuberculosis, and ease of coastal access from the health risk factors, and sub-Saharan Africa from regional heterogeneity. Using this prior structure we find evidence of a relationship of institutions and health. Constraints on executive and risk of expropriation are inversely related to health level in 2005. Again we find support for a positive effect of education over longevity. When we include health variables in the model space and the rest theories in the "auxiliary" group we find similar results to the "agnostic" estimation.

In Table C.2 we examine the relationship of life growth between 1960 and 2005 and variables in the model space. The most significant variables are initial life expectancy and health institutions from the health theory, AIDS cases, incidence of tuberculosis, and ease of coastal

[1] Authors used the i Martin et al. (2004) dataset to examine the determinants of economic growth. In line with the previous results in the literature neoclassical variables are robust determinants of growth but also institutions also matter for growth

[2] The "WALS" methodology is further extended by Einmahl et al. (2011)

access from the health risk factors, and sub-Saharan Africa from regional heterogeneity. Using this prior structure we find evidence of a relationship of institutions and health, constraints on executive is inversely related to life growth between 1960 and 2005. When we include health variables in the model space and the rest theories in the "auxiliary" group we find similar results to the "agnostic" estimation.

Table C.1: Explaining Life Expectancy in 2005 using Magnus et al. (2010) Laplase priors

	Agnostic Model Structure			Health Theories as “focus” variables		
	(1)	(2)	(3)	(4)	(5)	(6)
	PM	PSD	T	PM	PSD	T
Health						
Life Expectancy in 1960	0.002	0.077	0.024	-0.023	0.083	-0.273
Physicians	0.017	0.016	1.102	0.018	0.016	1.099
% Public Health Exp.	0.010	0.023	0.438	0.009	0.024	0.382
Health Institutions	0.193	0.110	1.756*	0.339	0.119	2.843*
Immunization Measles	0.015	0.032	0.469	0.014	0.037	0.374
Improved Water Resources	0.030	0.054	0.557	0.013	0.062	0.209
Nutrition	0.070	0.068	1.023	0.089	0.083	1.064
Risk Factors						
AIDS Cases	-0.001	0.001	-1.383*	-0.001	0.001	-0.894
Incidence of TB	-0.033	0.011	-3.057*	-0.028	0.011	-2.429*
Malaria Ecology Index	-0.024	0.039	-0.612	-0.034	0.043	-0.804
Ease of coastal access	0.062	0.034	1.810*	0.064	0.036	1.786*
% Area in Tropics	-0.016	0.036	-0.432	0.000	0.039	-0.002
Neoclassical/Solow						
Income in 1960	-0.044	0.015	-2.989*	-0.043	0.015	-2.938*
Schooling	0.017	0.010	1.630*	0.017	0.010	1.730*
Institutions						
Constraints on Executive	-0.043	0.022	-2.000*	-0.040	0.022	-1.790*
Risk of Expropriation	-0.033	0.025	-1.326*	-0.033	0.024	-1.385*
Government Stability	-0.003	0.078	-0.036	-0.008	0.074	-0.108
Ethnic Fractionalization	0.044	0.033	1.319*	0.039	0.030	1.307*
Religion Shares						
Protestant	-0.007	0.041	-0.169	-0.009	0.040	-0.220
Jewish	-0.042	0.075	-0.555	-0.039	0.077	-0.505
Muslim	-0.067	0.053	-1.271	-0.062	0.052	-1.177
Hindu	-0.067	0.083	-0.798	-0.061	0.086	-0.716
Eastern Religions	-0.031	0.055	-0.573	-0.033	0.054	-0.614
Other Religions	-0.079	0.051	-1.550*	-0.082	0.053	-1.553*
Regional Heterogeneity						
Sub-Saharan Africa	-0.105	0.038	-2.749*	-0.099	0.038	-2.590*
Latin-America & Caribbean	0.013	0.025	0.523	0.014	0.027	0.529
East Asia & Pacific	0.022	0.025	0.867	0.022	0.025	0.874

Note: PM stand for Posterior Mean, PSD stand for Standard Deviation of the Posterior Error of the distribution and T is the ratio of PM to PSD. * denotes that T exceed the threshold of 1.3

Table C.2: Explaining Life Expectancy growth Rate between 1960 and 2005 using Magnus et al. (2010) Laplase priors

	Agnostic Model Structure			Health Theories as "focus" variables		
	(1) PM	(2) PSD	(3) T	(4) PM	(5) PSD	(6) T
Health						
Life Expectancy in 1960	-0.018	0.002	-9.544*	-0.022	0.002	-12.327*
Physicians	0.000	0.000	0.287	0.000	0.000	1.053
% Public Health Exp.	0.000	0.001	0.654	0.000	0.001	0.397
Health Institutions	0.005	0.003	2.037*	0.007	0.003	2.863*
Immunization Measles	0.000	0.001	0.316	0.000	0.001	0.402
Improved Water Resources	0.001	0.001	0.539	0.000	0.001	0.197
Nutrition	0.001	0.002	0.688	0.002	0.002	1.100
Risk Factors						
AIDS Cases	0.000	0.000	-1.364*	0.000	0.000	-0.864
Incidence of TB	-0.001	0.000	-2.460*	-0.001	0.000	-2.423*
Malaria Ecology Index	-0.001	0.001	-0.697	-0.001	0.001	-0.854
Ease of coastal access	0.002	0.001	2.217*	0.001	0.001	1.808*
% Area in Tropics	-0.001	0.001	-0.801	0.000	0.001	-0.008
Neoclassical/Solow						
Income in 1960	-0.001	0.000	-3.290*	-0.001	0.000	-2.950*
Schooling	0.000	0.000	1.188	0.000	0.000	1.741*
Institutions						
Constraints on Executive	-0.001	0.000	-2.535*	-0.001	0.000	-1.861*
Risk of Expropriation	-0.001	0.001	-1.194	-0.001	0.001	-1.360*
Government Stability	0.000	0.002	-0.029	0.000	0.002	-0.085
Ethnic Fractionalization	0.001	0.001	1.993*	0.001	0.001	1.254
Religion Shares						
Protestant	0.000	0.001	-0.160	0.000	0.001	-0.249
Jewish	-0.001	0.002	-0.437	-0.001	0.002	-0.518
Muslim	-0.002	0.001	-1.565*	-0.001	0.001	-1.196
Hindu	-0.001	0.002	-0.461	-0.001	0.002	-0.701
Eastern Religions	-0.001	0.001	-0.664	-0.001	0.001	-0.653
Other Religions	-0.002	0.001	-1.698*	-0.002	0.001	-1.589*
Regional Heterogeneity						
Sub-Saharan Africa	-0.002	0.001	-2.796*	-0.002	0.001	-2.585*
Latin-America & Caribbean	0.000	0.001	0.542	0.000	0.001	0.503
East Asia & Pacific	0.001	0.001	0.983	0.000	0.001	0.866

Note: PM stand for Posterior Mean, PSD stand for Standard Deviation of the Posterior Error of the distribution and T is the ratio of PM to PSD. * denotes that T exceed the threshold of 1.3

C.1.2 Estimation using Zellner (1986) priors

Fernandez et al. (2001) its one of pioneer papers that used the BMA technique in the growth literature. The model estimated is described by:

$$y = Z\gamma + \varepsilon$$

where y is a vector that contain the GDP growth rate for n countries which is regressed over a number of explanatory variables which is contained in Z of dimension $n \times k$ and γ is a vector of parameters to be estimated. They denote by M_j the model with regressors grouped by Z_j, leading to:

$$y = \alpha \iota_n + Z_j \gamma_j + \sigma \varepsilon \tag{C.1}$$

where ι_n is an n-dimensional vector of 1's, $\beta_j \in \Re^{k_j}$ $\left(0 \leq k_j \leq k\right)$ groups the relevant regression coefficient and $\sigma \in \Re_+$ is a scale parameter. they assume that ε follow an *n-dimensional Normal Distribution* with zero mean and identity covariance matrix.

We need to compute the prior distribution for parameters α, β_j and σ. Authors propose a "benchmark" prior distribution that has little influence on posterior inference. The use improper non-informative priors for the parameters that are common to all models, namely α and σ, and a g-prior structure for β_j. this corresponds to:

$$p\left(\alpha, \sigma\right) \propto \sigma^{-1} \tag{C.2}$$

and the conditional prior of the coefficient is based on Zellner (1986):

$$p\left(\beta_j \mid \alpha, \sigma, m_j\right) = f_N^{k_j}\left(\beta_j \mid 0, \sigma^2\left(gZ_j'Z_j\right)^{-1}\right) \tag{C.3}$$

where $f_N^q\left(w \mid m, V\right)$ denotes the density of a q-dimensional Normal distribution on w with mean m and covariance matrix V. They choose g as $g = \frac{1}{max\left(n, k^2\right)}$.

The sampling prior distribution over the space M is :

$$P\left(m_j\right) = p_j\ ,\ j = 1,\ldots,2^k, \quad with\, p_j > 0\ and\ \sum_{j=1}^{2^k} p_j = 1$$

and authors choose $p_j = 2^{-k}$ so we have a Uniform distribution on the model space. This implies that the prior probability of including a regressor is $1/2$, independently of the other regressors included in the model.

The estimation of any unknown quantity Δ, is an average of the posterior distributions of that quantity under each of the models with weights given by the posterior model probabilities.

$$P_{\Delta|y} = \sum_{j=1}^{2^k} P_{\Delta|y,M_j} \times P\left(m_j \mid y\right)$$

$$P\left(m_j \mid y\right) = \frac{l_y\left(m_j\right) p_j}{\sum\limits_{h=1}^{2^k} l_y\left(m_h\right) p_h}$$

where $l_y\left(m_j\right)$, the marginal likelihood of model M_j, is obtained as

$$l_y\left(m_j\right) = \int p\left(y \mid \alpha, \beta_j, \sigma, m_j\right) p\left(\alpha, \sigma\right) p\left(\beta_j \mid \alpha, \sigma, m_j\right) d a d\beta_j d\sigma$$

with $p\left(y \mid \alpha, \beta_j, \sigma, M_j\right)$ the sampling model corresponding to equation C.1 and $p\left(\alpha, \sigma\right)$ and $p\left(\beta_j \mid \alpha, \sigma, m_j\right)$ the priors defined by C.2 and C.3, respectively. The marginal likelihood can be computed analytically. Without loss of generality, the regressors are demean, such that $\iota_n' Z = 0$, and defining $X_j = \left(\iota : Z_j\right)$, $\bar{y} = \iota' y/n$ and $M_{X_j} = I_n - X_j\left(X_j' X_j\right)^{-1} X_j'$ it can be obtained that:

$$l_y\left(M_j\right) \propto \left(\frac{g}{g+1}\right)^{k_j/2} \left(\frac{1}{g+1} y' m_{X_j} y + \frac{g}{g+1}\left(y - \bar{y}\iota_n\right)'\left(y - \bar{y}\iota_n\right)\right)^{-(n-1)/2}$$

A number of papers examine the choice of the g-prior. Liang et al. (2008) propose the use of a “hyper g-prior” which is based on the Beta distribution, $\frac{g}{1+g} \sim Beta\left(1, \frac{a}{2} - 1\right)$, where a is a parameter in the range $2 < a \leq 4$. By setting $a = 4$ corresponds to uniform prior distribution of $\frac{g}{1+g}$ over the interval $[0, 1]$, while $a \to 2$ concentrates prior mass very close to unity and correspond to $g \to \infty$. Feldkircher and Zeugner (2009) indicate that the "hyper g-prior" among other alleviate the "supermodel effect" that is the concentration of posterior mass on a very small set of models.

Table C.3 present the results when the Zellner (1986) hyper g-priors are used. The highest posterior inclusion probability (with value larger than 0.9). When we explain life expectancy in 2005 is observed for sub-Saharan Africa and health institutions. When we examine the relationship between life expectancy growth and the explanatory variables in the model space, the highest posterior probability is observed for initial life expectancy, sub-Saharan Africa countries and health institutions. The results obtained by the estimation using the Zellner (1986) priors are comparable to results obtained using Durlauf et al. (2008) hierarchical/dilution priors.

Table C.3: Health Determinants Bayesian estimation using Zellner (1986) priors

	Life Expectancy in 2005			Life Growth Rate between 1960-2005		
	(1) PIP	(2) PM	(3) PSD	(4) PIP	(5) PM	(6) PSD
Health						
Life Expectancy in 1960	0.051	-0.002	0.026	1.000	-0.023	0.002
Physicians	0.212	0.005	0.012	0.102	0.000	0.000
% Public Health Exp.	0.055	0.001	0.008	0.075	0.000	0.000
Health Institutions	0.982	0.356	0.120	0.978	0.007	0.002
Immunization Measles	0.029	0.001	0.007	0.085	0.000	0.000
Improved Water Resources	0.028	0.001	0.011	0.054	0.000	0.000
Nutrition	0.676	0.124	0.102	0.894	0.004	0.002
Risk Factors						
AIDS Cases	0.038	-0.000	0.000	0.093	-0.000	0.000
Incidence of TB	0.489	-0.012	0.014	0.835	-0.001	0.000
Malaria Ecology Index	0.014	-0.000	0.004	0.046	-0.000	0.000
Ease of coastal access	0.109	0.005	0.019	0.227	0.000	0.001
% Area in Tropics	0.049	0.002	0.010	0.061	0.000	0.000
Neoclassical/Solow						
Income in 1960	0.349	-0.013	0.020	0.813	-0.001	0.000
Schooling	0.456	0.014	0.018	0.804	0.001	0.000
Institutions						
Constraints on Executive	0.162	-0.006	0.015	0.162	-0.000	0.000
Risk of Expropriation	0.214	-0.009	0.019	0.151	-0.000	0.000
Government Stability	0.031	0.002	0.017	0.063	0.000	0.000
Ethnic Fractionalization	0.023	0.001	0.006	0.068	0.000	0.000
Religion Shares						
Protestant	0.018	-0.000	0.006	0.045	-0.000	0.000
Jewish	0.016	-0.000	0.012	0.057	-0.000	0.000
Muslim	0.333	-0.025	0.040	0.773	-0.002	0.001
Hindu	0.426	-0.078	0.105	0.746	-0.003	0.002
Eastern Religions	0.057	0.003	0.018	0.058	0.000	0.000
Other Religions	0.231	-0.027	0.055	0.720	-0.002	0.001
Regional Heterogeneity						
Sub-Saharan Africa	1.000	-0.194	0.036	1.000	-0.004	0.001
Latin-America & Caribbean	0.081	0.003	0.011	0.093	0.000	0.000
East Asia & Pacific	0.069	0.002	0.009	0.091	0.000	0.000

Note: PIP stands for Posterior Inclusion Probability, PM stand for Posterior Mean and PSD stand for Standard Deviation of the Posterior Error of the distribution.

C.2 Definition of variables and countries included in the sample

Variable	Description	Source
Initial Income	Log of Income in 1960	PWT
Initial Schooling	Average years of secondary and higher education in female population aged more than 15 in 1960	Barro and Lee (2010)
Constraints on Executive	Logarithm of average value of constraints on executive in 1960. A measure of the extent of institutionalized constraints on the decision making powers of chief executives. This variable ranges from one to seven where higher values equal a greater extent of institutionalized constraints on the power of chief executives	Marshall and Jaggers (2009)
Risk of Expropriation	Risk of "outright confiscation and forced nationalization" of property. Mean value for all years from 1985 to 1995	Acemoglu et al. (2001)
Government Stability	Governments ability to stay in office and carry out its declared programs.. It is created from three sub-components: government unity, legislative strength and popular support.	PRS (2008)
Initial Life	Life Expectancy in 1960	PWT
Physicians	Logarithm of average value of number of physicians (per 1,000 people) in 1960. Physicians include generalist and specialist medical practitioners.	WDI
Share of public expenditure over total health expenditure	Logarithm of Public Health expenditure, public (% of total health expenditure) between 2002 and 2005.	WDI
Health Institutions	Logarithm of Composite Health Institutions Index in 1997. It is calculated as the weighted average of five variables: level of health, health inequality, responsiveness, responsiveness inequality and fairness of financial contribution.	Evans et al. (2001) and WHO (2000)
Immunization Measles	Logarithm of average value of measles immunization rate (percentage of children aged 12-23 months) between 1980-2005.	WDI
Improved Water Resources	Logarithm of average value of improved water source access rate (% of population with access) between 1990-2005.	WDI
Nutrition	Logarithm of average dietary energy consumption (calories (kcal) per person per day)	FAO

Variable	Description	Source
AIDS	Logarithm of AIDS cases (per 100,000 people)	WHO
Incidence of TB	Incidence of tuberculosis (per 100,000 people). Logarithm of average value of incidence of tuberculosis between 1980-2005.	WDI
Malaria Prevalence	Logarithm of percentage of population population at risk of contracting malaria in 1994	Gallup and Sachs (2001)
Ease of coastal access	Logarithm of percentage of a country's land area within 100km of an ice-free coast.	The Center for International Development (CID) at Harvard University
Tropical	Logarithm of percentage of land area classified as tropical and sub-tropical via the in Köppen-Geiger system.	The Center for International Development (CID) at Harvard University
Ethnic Fractionalization	Logarithm of a measure of measure of ethnic fractionalization.	Alesina et al. (2003)
Protestant	Protestant share in 1970 expressed as a fraction of the population who expressed adherence to some religion	Barro and McCleary (2005)
Jewish	Jewish share in 1970 expressed as a fraction of the population who expressed adherence to some religion	Barro and McCleary (2005)
Muslim	Muslim share in 1970 expressed as a fraction of the population who expressed adherence to some religion	Barro and McCleary (2005)
Hindu	Hindu share in 1970 expressed as a fraction of the population who expressed adherence to some religion	Barro and McCleary (2005)
Eastern Religion	Eastern Religion share in 1970 expressed as a fraction of the population who expressed adherence to some religion. This category includes also the Buddhist and Confucian religion shares.	Barro and McCleary (2005)

Variable	Description	Source
Other Religion	Other Religion share in 1970 expressed as a fraction of the population who expressed adherence to some religion. This category include also the fraction of Christian Orthodox and Other Christian denominations.	Barro and McCleary (2005)
Sub-Saharan Africa	Dummy variable for sub-Saharan Africa countries	WDI
Latin America & Caribbean	Dummy variable for Latin America & Caribbean countries	WDI
South-Asia	Dummy variable for South Asia countries	WDI

Countries in the Sample

East Asia & Pacific	*Latin America & Caribbean*	*Northern America*
Australia	Argentina	Canada
China	Bolivia	United States
Indonesia	Brazil	*Southern Asia*
Japan	Chile	Bangladesh
Korea, Rep.	Colombia	India
Malaysia	Costa Rica	Iran, Islamic Rep.
New Zealand	Dominican Republic	Pakistan
Philippines	Ecuador	Sri Lanka
Thailand	El Salvador	*Sub-Saharan Africa*
Europe & Central Asia	Guatemala	Botswana
Austria	Haiti	Cameroon
Denmark	Honduras	Congo, Dem. Rep.
Finland	Jamaica	Congo, Rep.
France	Mexico	Cote d'Ivoire
Greece	Nicaragua	Gabon
Ireland	Panama	Gambia, The
Italy	Paraguay	Ghana
Netherlands	Peru	Kenya
Norway	Trinidad and Tobago	Malawi
Portugal	Uruguay	Mali
Spain	Venezuela, RB	Mozambique
Sweden	*Middle East & North Africa*	Niger
Switzerland	Algeria	Senegal
Turkey	Egypt, Arab Rep.	South Africa
United Kingdom	Israel	Tanzania
	Jordan	Togo
	Morocco	Uganda
	Syrian Arab Republic	Zambia
	Tunisia	Zimbabwe

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