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Public pension institutions and old-age mortality in a comparative perspective

Norström T, Palme J. Public pension institutions and old-age mortality in a comparative perspective
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The aim of the study was to estimate the impact of changes in pension rights on old-age mortality. We made a distinction between two dimensions of pension benefits, one of providing basic security (BASIC), and the other of providing income security (INCOME). Analyses were based on data for 18 OECD countries during the post-war period. The outcome comprised old-age excess mortality, defined as the ratio of the mortality rate 65+ to the mortality rate in the age group 30–59 years. The latter was regarded as a proxy for unobserved factors potentially related to old-age mortality as well as pension rights. The pooled cross-sectional time series data were analysed through fixed effects modelling. The results suggest that BASIC (but not INCOME) has a beneficial impact on old-age excess mortality, which was statistically significant. We interpret the results in terms of the poverty-reducing effects of pension entitlements with a basic security orientation.

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Key words: pension rights, old-age mortality, time series analysis, fixed effects model, OECD countries

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Mortality rates have decreased dramatically in the advanced welfare democracies during the past century. Still, there is a marked variation across countries in the rate of the mortality decrease, not least amongst the elderly. The main purpose of the present study was to investigate whether this variation across time and space in old-age mortality is related to variations in pension rights. The analyses focus on 18 OECD countries during the post-war period.

How could pension rights affect old-age mortality?

Public pension rights have the potential to affect old-age mortality mainly through two mechanisms. First, the more generous the pension benefits, the higher the income in the elderly population. This provides more resources that can be invested in health-enhancing products and activities. Second, a more generous pension system may, in addition, have a redistributive impact, thus reducing income differences in society, and particularly amongst the elderly. Of particular importance is the potential of well-designed pension programmes to reduce poverty amongst the elderly (Palme, 2006). There are many findings suggesting that lower income differences are associated with better health and lower mortality (Wilkinson, 1992), although the evidence is far from conclusive (Deaton, 2003).

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For historical and political reasons, countries have followed different paths in the development of pension systems, and these paths have led to somewhat different profiles in terms of the level and distribution of benefits. For the analytical purpose of the present article, we will focus on the two different goals of these development paths: *basic security* and *income security*. For descriptive purposes, we will also classify countries into three broad categories (cf. Korpi & Palme 1998): *basic/targeted*, *state corporatist* and *encompassing*. The *basic/targeted* model awards only basic benefits, allowing a large role for private pensions; the *state corporatist* model delivers earnings-related benefits, that is, income security, separately for different corporations (different segments of the labour market); and the *encompassing* model relies on a combination of universal basic benefits and earnings-related social insurance benefits.

Data

The study comprised 18 OECD countries, that is, Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, The Netherlands, New Zealand, Norway, Sweden, Switzerland, the United Kingdom and the United States. The observation period was 1950–2000. Annual age-specific data on all-cause mortality for men and women were obtained from the WHO Mortality Data Base (www.who.int/en/) and The Human Mortality Database (www.mortality.org). Age-standardised mortality rates (number of deaths per 100,000 population) were constructed for the categories 65 years and above, and 30–59 years.

Data on pension rights were obtained from the Social Citizenship Indicator Program. This database provides comparable and multidimensional information on welfare state institutions as well as on income distribution. The concepts of basic security and income security discussed above were operationalised as follows. The *Basic Security Index* (denoted BASIC in the analyses) reflects the situation of person(s) with no or small earnings records, and is an average of net replacement rates for different type cases. The indicators thus reflect three types of benefits: (i) *citizenship pension*, which is paid without needs-testing or any requirements of previous earnings; (ii) *minimum pension*, which, in addition to citizenship-based benefits, may include needs-tested components and (iii) *worker minimum pension*, which requires the fulfilment of a minimum number of years of work/contribution. The *Income Security Index* (denoted INCOME in the analyses) is also an average of replacement rates for type cases that reflect the situations of average income earners, single householders as well as married couples. They reflect two types of benefits: (i) *worker pension,* which is the benefit given on the basis of 35 years work/contributions with average production worker earnings and (ii) *full worker pension,* which takes a full (45 years) contribution record into account, but which also assumes an average production worker earnings. A comprehensive indicator of pension rights was constructed as PENSION = BASIC + INCOME. The pension data pertain to every fifth year between 1950 and 2000.

It is important to underline that these pension variables are typically of varying importance to men and women because of the difference in labour force attachment. The absence of good basic provisions is likely to be particularly harmful for women in terms of protecting them from poverty. In this context, two more things deserve to be emphasised. Firstly, countries that score highest on the BASIC have a universal (citizenship-based) component in their basic benefits provisions. Secondly, there is a weak positive correlation between the basic and the income security indicators, suggesting that there is no trade-off between providing basic security or income security. Rather, not only does it appear possible to fulfil both goals, but they may also reinforce each other. In all analyses of the relationship between the pension indicators and mortality, the annual mortality data were averaged over 5-year periods. This means that for 1950, say, while the pension indicators express the conditions that year, the mortality indicators express the average mortality during the period 1950–1954. In this way, a plausible lag-effect is incorporated into the analyses.

It seems warranted to include GDP per capita in the analysis, as this indicator could be related to pension rights as well as to mortality. Data on GDP per capita were obtained from Angus Maddison's data bank (www.ggdc.net/Maddison).

In some analyses, the data were aggregated into three country groups (Table 1) that are characterised by the different pension regimes described above. It should be noted here that the grouping of the countries was based on the character of their pension systems during the later stages of the post-war development. Finland, Norway and Sweden, for example, would have been classified in the Basic/targeted category if we had relied on the situation that pertained in the 1950s.

Table 1. Grouping of countries according to dominating pension regime.

Regime 1: Encompassing
Finland
Norway
Sweden
Regime 2: State corporatist
Austria
Belgium
France
Italy
Japan
West Germany
Regime 3: Basic/targeted
Australia
Canada
Denmark
Ireland
Switzerland
Netherlands
New Zeeland
UK
US

Methods

Generally, we used old-age excess mortality as our outcome, defined as the ratio of the mortality rate in the age group 65 years and above to the mortality rate in the age group 30–59 years. There are two rationales for this approach. The first one is more substantive, that is, the pension rights indicators are operationalised in terms of benefits that are relative to the economic conditions for the working population. The second rationale is more methodological, that is, it is to decrease the risk of omitted variable bias. If a factor that is not included in the model were to be causally linked to the explanatory variable as well as to the outcome, we would run the risk of obtaining biased estimates. It is conceivable that, for example, increasing generosity of the pension benefits tends to go along with improvements in healthcare. If improved health care lowers mortality in general, including old-age mortality, the estimate of the pension effect would be biased. Because we lack any direct measure of healthcare (and other potential confounders), we controlled for this possibility indirectly by focusing on *old-age excess mortality* rather than on old-age mortality per se.

As a first step in modelling how mortality responds to variations in pension rights, it seems feasible to assess whether the potential confounder GDP per capita has any impact and should be included in the subsequent analyses. The reason for doing this in the initial step is that we can then take advantage of the fact that we have annual data on GDP per capita, which makes the analysis more powerful. Finally, we estimated a fixed effects model on the pooled cross-section time series data (a more detailed description of the method is given below).

The relationship between GDP and mortality was estimated through country-specific time series analyses of annual data. The analyses were performed according to the method developed by Box and Jenkins (1976), often referred to as ARIMA (autoregressive

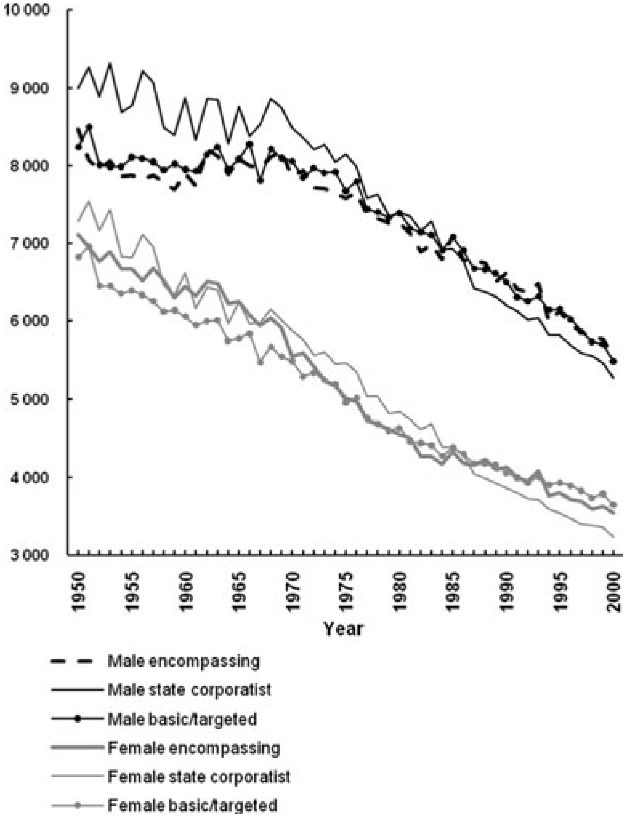

Figure 1. Trends in gender specific old-age mortality (65+) in three country groups.

integrated moving average) models. The presence of strong time trends in the data necessitates a filtering to achieve the stationarity required for the ARIMA modelling. In this case, a simple differencing was sufficient to remove nonstationary trends, that is, rather than using raw series, the yearly changes were analysed. The differencing reduces greatly the risk of obtaining spurious correlations, because an omitted variable is more likely to be correlated with the explanatory variable as a result of common trends than as a result of synchronisation in the yearly changes. The drawback of differencing is that the ratio of noise to signal increases, which makes it more difficult to uncover an existing relationship. This loss of power can to some degree be compensated for by pooling the country-specific estimates. In pooling, the estimates are weighted in proportion to the inverse of their standard errors. This procedure increases the power of the analyses by shrinking the estimated standard errors. The standard errors of the pooled estimates were calculated according to the following formula (n = number of countries):

$$SE_{pool} = \frac{\sqrt{\sum_i SE_i^2}}{n}$$

Further, the noise term, which includes explanatory variables not considered in the model, is allowed to have a temporal structure that is modelled and estimated in terms of autoregressive (AR) or moving average (MA) parameters. The model residuals should not differ from white noise; this is tested using the Box-Ljung statistics Q.

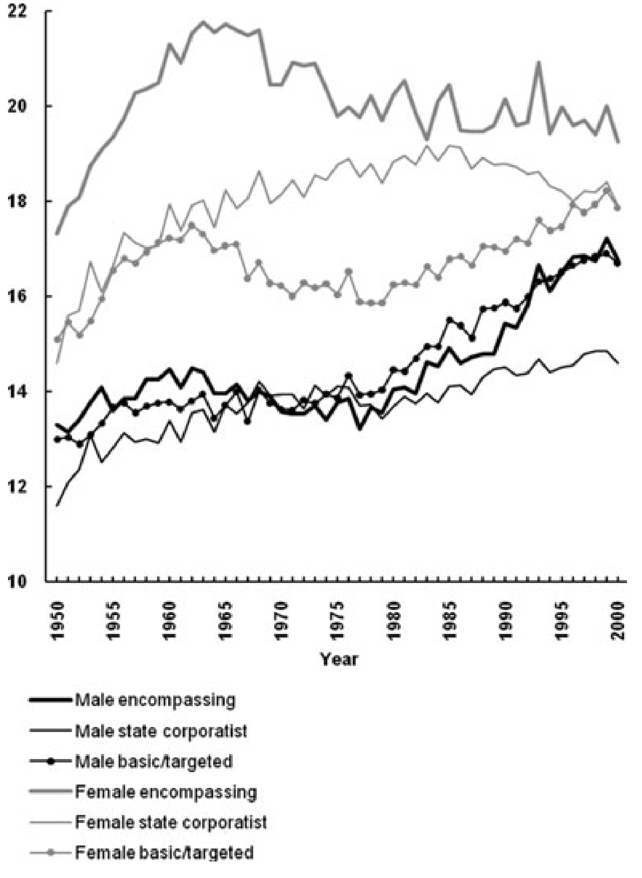

Figure 2. Trends in gender specific old-age excess mortality (ratio of 65+ to 30–59) in three country groups.

As mentioned earlier, pension data are not annual but for every fifth year, which yields too few observations for time series analysis. To estimate the impact of pension rights on mortality, we therefore analysed the pooled cross-sectional time series data. However, there are two obvious sources of bias that may distort the outcome. One is the possible presence of unobserved country differences that are linked to the dependent as well as the independent variables. The other threat to the validity of the results is the possibility that the X and Y variables have converging (or diverging) time trends that do reflect, not a causal relationship, but rather the impact of other factors. In an assessment of alternative modelling techniques, Podesta (2006) found the use of differenced data to eliminate long-term trends to be the most efficient device for avoiding spurious relationships due to trends. We thus chose to analyse the differenced data, because the differencing not only eliminates the trends but also means that only the intrastate co-variation over time is explored (fixed effects models), thus eliminating the first-mentioned source of bias as well. Further, we used panel-adjusted standard errors to avoid the estimation problems that occur in analyses with fewer observations than time points (Beck & Katz, 1995). Lastly, we made a panel-specific estimation of residual autocorrelation. In sum, we imposed the strongest restrictions possible on the model.

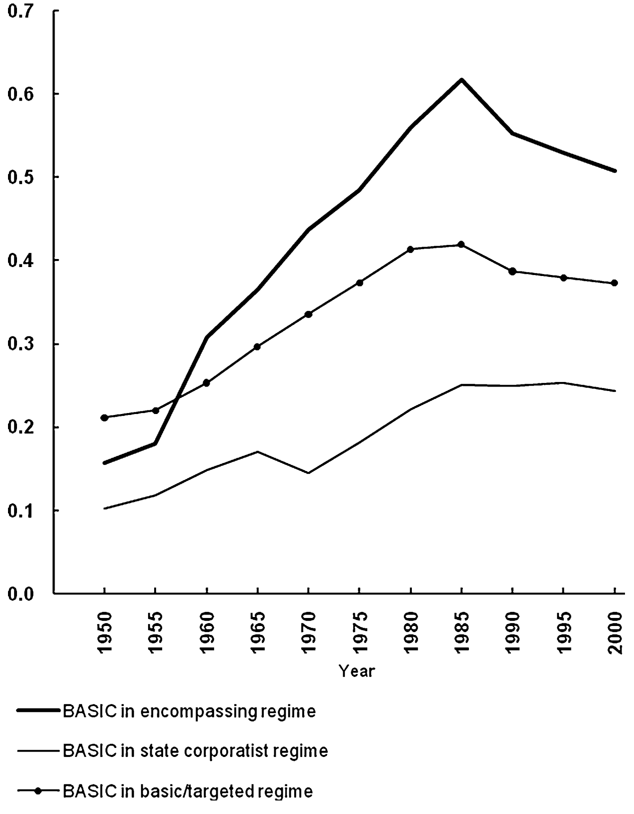

Figure 3. Trends in the pension indicator BASIC in three country groups.

Results

As can be seen in Figure 1, there is a steady decline in old-age mortality; it is more marked for women (annual decrease of 1.8 per cent, obtained by regressing the log of mortality against time) than for men (annual decrease of 0.9 per cent). Further, the decline is stronger in the country group that has the highest initial level (Regime 2, state corporatist model).

Figure 2 shows the trends in old-age excess mortality (the ratio of mortality in the age group 65 years and above to the mortality in the age group 30–59 years), which we used as our outcome in most of the analyses. This measure shows a more diverse picture than above. Excess mortality for men increased in all regime types, starting in the late 1970s. Excess mortality for women increased until the mid-1960s, after which the development patterns have been different but stagnating, or even decreasing, in the various regimes.

Figures 3–5 show the development of the pension rights indicators in the three country groups. Until the mid-1980s, there was a general increase in BASIC as well as INCOME (and thus in PENSION, too) in all three country groups. Note that the countries in the encompassing regime developed higher BASIC and INCOME benefit levels only gradually. However, there was a subsequent stabilisation, and even a decrease (in the country group labelled encompassing). Yet, the encompassing regime ends up with on average higher both BASIC and INCOME security than the basic security and state corporatist regimes, respectively. The combined

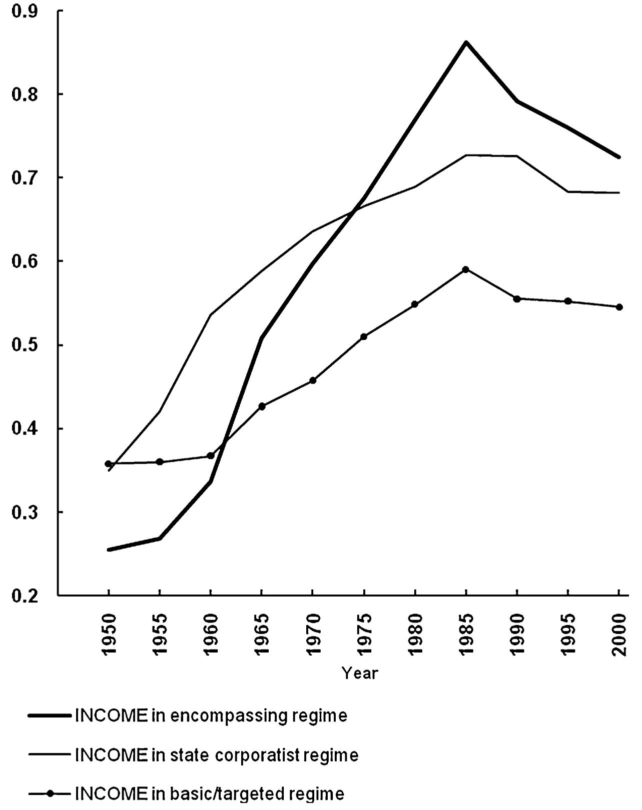

Figure 4. Trends in the pension indicator INCOME in three country groups.

indicator PENSION is on average at the same level in the basic security and state corporatist regimes, and since the mid-1960s higher in the encompassing regime. It should be strongly emphasised that, in the subsequent analyses, we rely on the pension variables, not the regime classification.

As a first step in the modelling work, we estimated the effect of GDP per capita on excess mortality, using the fairly long series of time series data that makes ARIMA modelling possible. If GDP proved to be insignificant, we could exclude this variable from the pooled time series regression analyses. The outcome of the ARIMA modelling is shown in Table 2. Most of the estimates were insignificant, but the great majority were negative. Pooling the estimates yielded a significant effect, for both men and women; an increase in GDP per capita was associated with a decrease in old-age excess mortality. It thus seems warranted to include GDP in the multivariate analyses, to which we now proceed.

In all, we estimated four models, separately for women and men, all of which included GDP as control. It is of interest to note that the estimated effect of GDP was significant (or close to significant for women), and of the same magnitude as that obtained in the ARIMA analyses reported in Table 2. The first model included the comprehensive indicator PENSION; this turned out to be insignificant for women as well as for men (Table 3). Next, we included the more specific indicators BASIC and INCOME, one by one. The latter proved to be statistically insignificant, but not the former, that is, an

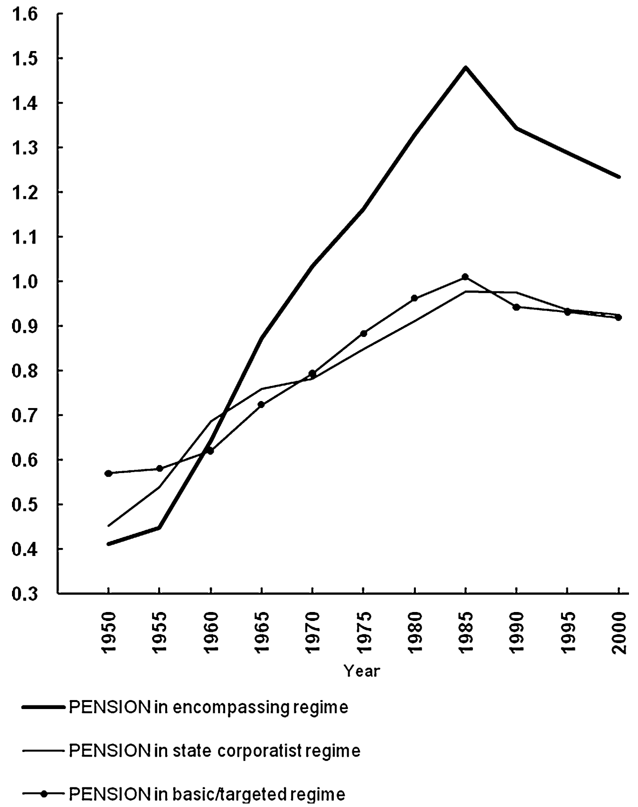

Figure 5. Trends in the comprehensive pension indicator PENSION in three country groups.

increase in BASIC was associated with decreased old-age excess mortality. The final model, which included BASIC as well as INCOME, confirmed the significant effect of BASIC. One sensitivity test is to exclude a country that is extreme in some respect and that may have affected the outcome. Japan is an obvious candidate here due to its exceptionally strong mortality decline; 1.7 per cent per year for men and 2.4 per cent for women during the study period (corresponding figures for all countries were 0.9 per cent and 1.8 per cent, respectively). However, leaving Japan out of the analyses did not have any noticeable effect on the estimates. Finally, as a test of the internal validity of the result, we estimated the final model (Model 4) with infant mortality as the outcome; as could be expected if the results for old-age mortality were not artefactual, none of the pension indicators were significant. We also estimated models in which excess mortality was replaced by mortality per se. However, the resultant estimates of the effects of pension rights were not statistically significant and did not yield any consistent pattern.

Conclusions

In the present study, we investigated how old-age excess mortality in post-war welfare democracies responds to changes in public pension rights and economic development. The results from the times series analyses suggest that an increase in GDP per capita is associated with decreased old-age excess mortality; this result was confirmed in the fixed effects models for men, although the effect was of borderline significance for women. We made a distinction between two goal dimensions of pension benefits – one of providing basic security, and the other of providing income security. The comprehensive indicator, including (adding) both dimensions, did not have any significant effect on mortality. However, more detailed analyses suggested that BASIC but not INCOME had a beneficial impact. It was noticed that alternative model specifications (with mortality per se) did not reproduce our findings, which might be a cause for concern. On the other hand, the rationale for our specification was that it was expected to yield more reliable estimates by minimising the risk for omitted variable bias. The estimated effect of BASIC is somewhat difficult to interpret. On the basis of the estimate and the average of BASIC and the outcomes, we converted it into an elasticity coefficient that yielded a value of –0.05. That is, a 1 per cent increase in BASIC would reduce old-age mortality by 0.05 per cent. (The elasticity was about the same for men and women. Although the outcome measure is old-age excess mortality, we may make the interpretation in terms of mortality per se, assuming that adult mortality, the denominator, is constant.) This may seem to be a fairly modest effect, but in the context of an outcome with such an inherently multi-faceted aetiology as all-cause mortality, we cannot expect any single determinant to exert a very strong influence. Still, it makes a marked difference if BASIC increases from its lowest to

Table 2. Estimated effects of GDP per capita on old-age excess mortality (ratio of mortality 65+ to mortality 30–59).

	Women		Men	
	Estimate	SE	Estimate	SE
Australia	0.097	0.223	0.003	0.173
Austria	–0.874**	0.310	–0.820**	0.225
Belgium	–0.429	0.278	–0.318	0.239
Canada	–0.379*	0.174	–0.107	0.158
Denmark	0.343	0.315	–0.027	0.200
Finland	–0.341	0.233	–0.217*	0.100
France	–0.688*	0.294	–0.453*	0.175
West Germany	–0.117	0.248	–0.285(*)	0.148
Ireland	–0.182*	0.080	–0.226(*)	0.118
Italy	–0.683	0.390	–0.259	0.309
Japan	–0.020	0.309	0.108	0.231
Netherlands	–0.172	0.321	–0.123	0.209
New Zeeland	0.438	0.250	0.192	0.223
Norway	–0.885**	0.291	0.131	0.189
Sweden	–0.380	0.245	–0.173	0.190
Switzerland	0.249	0.217	0.230*	0.113
UK	–0.005	0.220	–0.161	0.147
USA	0.072	0.083	–0.019	0.074
Pooled estimate	–0.220***	0.061	–0.140**	0.044

Semi-logarithmic ARIMA models estimated on differenced national data, 1950–2000. All models included MA parameter to estimate error term structure. All models were satisfactory with regard to residual correlation (tested with the Box-Ljung statistics Q).
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, (*) $p < 0.10$.

Table 3. Estimated effects of GDP per capita and pension rights indicators on old-age excess mortality (ratio of mortality 65+ to mortality 30–59) and infant mortality.

	Women				Men				Infant mortality
	1	2	3	4	1	2	3	4	
GDP	–0.17	–0.18	–0.17	–0.19(*)	–0.15**	–0.14**	–0.15**	–0.14**	–0.39
	(0.11)	(0.11)	(0.11)	(0.11)	(0.05)	(0.05)	(0.05)	(0.05)	(1.33)
PENSION	–0.46				–0.51				
	(0.58)				(0.34)				
BASIC		–1.87(*)		–2.31*		–1.90**		–2.31***	–3.67
		(1.10)		(1.10)		(0.59)		(0.61)	(7.00)
INCOME			0.12	0.86			–0.06	0.73	9.59
			(0.78)	(0.74)			(0.51)	(0.48)	(7.46)

Estimates based on differenced data for 18 countries 1950–2000. Number of observations = 162. Panel-specific estimation of residual autocorrelation. Standard errors in parentheses.
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, (*) $p < 0.10$.

its highest value observed in our data; such a leap would entail an old-age mortality reduction of about 10 per cent for men and women.

We interpret the results in terms of the poverty-reducing effects of pension entitlements with a basic security orientation, especially universal basic pensions (Palme, 2006). The cross-sectional analyses by Esser and Palme (2010) indicate similar beneficial effects of BASIC on old-age morbidity. The study by Ferrarini and Norström (2009) using an approach similar to the present one, suggests that mortality in early life as well, that is, infant mortality, can be curbed by a more generous social policy (cf. Lundberg et al., 2008).

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