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Country-level, mandatory, self-financeable pension replacement rates in OECD countries

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Abstract

The replacement rate (RR) is a quintessential property of pension systems. Yet, current measures of the RR are plagued with problems. We argue that the concept of RR should be based on the replacement of life-time permanent income rather than pre-retirement income, and we show that the self-financeable RR with respect to the permanent income has the advantage of being independent of labor income (wages and density of contributions). We define an RR measure, called CRR, as the country-level RR of the permanent labor income that the working-age population could buy with their mandatory pension deposits if they stay constant over time. Pension deposits refer to national mandatory contributions plus the fraction of non-contributory pensions whose financing could be attributed to the working-age population, all as a percentage of the gross domestic product. The CRR is easy to compute and interpret, is nationally representative, and provides an international ranking because it is independent of pension rules, GDP, intertemporal and intergenerational redistributions, and sustainability. The application of the CRR to most OECD countries using the available data shows a 65% average across them, with several countries achieving a 100% RR, all mostly due to their high mandatory contributions as a percentage of GDP.

1. Introduction

In most countries, the whole pension situation keeps changing due to demographic changes, labor market changes, and overall changes in societies. Pensions are continuously discussed in political debates. Often, this discussion lacks an efficient quantitative support.

To date, there is no leading summary measure (SM) for international comparisons of the pension situation. A review of current international comparisons in the leading pension publications shows many SMs in use (we review them in Section 2), but all of them lack either relevance, representativeness, or international comparability as a ranking.

This study aims at proposing a leading SM of the pension situation, based on the concept of 'replacement rate' (RR): the ratio of pension allowance over some reference labor income. The idea is that pensions should help individuals to maintain the economic life standard they had before retirement. The RR is a quintessential property of pension systems. Yet, current measures of the RR are plagued with problems.

Many of the problems with current RR measures that are analyzed here have been previously emphasized in Amzallag (1994) and Whiteford (1995), among others. A few authors have proposed alternative indicators, all of them multidimensional compounds of pension situations, as in Whiteford (1995), Alonso-Fernandez *et al.* (2018), and Chybalski and Marcinkiewicz (2016). The contribution to the literature in this study is to show that there is an RR dimension in which the RR definition is conceptually clear and countries are indeed comparable.

In general, the sole idea of a leading SM for pensions is ambitious (Harker, 2022). Pension systems are very complex and diverse across countries, and each pension system usually comprises different sub-systems, commonly in constant change.[1]

But SMs deal with challenges. There are a few leading SMs of social dimensions that are consistently used for international rankings and to keep track of country-level trends. Despite their empirical and conceptual limitations, those summary SMs do play a huge role in the social policy and academic arenas, as well as in public opinion. Some leading SMs are mainly descriptive, like the literacy rate, the Palma index of economic inequality, or the labor force participation of women. Other leading SMs are built upon elaborate constructions that manage quantitatively complex tasks; the *gross domestic product* (GDP), for example, and not exempt from criticism, is the leading country-level SM of the economic situation; another example is the *life expectancy*, the leading country-level SM of the health situation.

Indeed, an SM can be quantitatively complex, as long as it provides a clear international ranking and is easy to interpret for both the experts and the larger public. Leading SMs deliver a relevant measurement without necessarily covering many dimensions and many subpopulations.

In the pension arena, we can think of two fundamental roles for public pension systems: consumption smoothing because individuals supposedly are shortsighted,[2] and redistribution because that is a core function of all modern social security systems (Schwarz, 2006; Barr and Diamond, 2009[3]). Instead of mixing those roles, we propose here a measure for the *potential consumption smoothing*, regardless of the distribution role. The proposed measure, called CRR, is the country-level RR of the permanent labor income that the working-age population could buy with their mandatory pension deposits if they stay constant over time. Being based on a self-financeable replacement, the CRR measures the 'actuarially fair' consumption smoothing capabilities of the pension system. Labor income and pension deposits are defined macroeconomically here, as a percentage of GDP. The CRR is easy to compute and interpret, and unlike current measures of the RR, is nationally representative, and it provides an international ranking because it is fairly independent of pension rules (other than the legal retirement age), GDP's level and growth rate, intertemporal and intergenerational redistributions, and financial sustainability of the pension system.

Section 2 discusses several of the SMs in the literature about international pension rankings, with special attention to RR measures. Section 3 presents the CRR and Section 4 applies it to data from OECD countries. Section 5 concludes.

2. Current SMs of the pension situation

The current arrangement of pension SMs can be appreciated in OECD's publication 'Pensions at a Glance' (OECD, 2021), Europe Economic Commission's 'Ageing Report' (Ageing, 2021) and 'Pension adequacy Report' (Adequacy, 2021), and International Labour Office's 'Social Outlook' (ILO, 2021), all leading and recurrent publications on the pensions' world.

Many SMs used for international pension rankings refer to dimensions that, albeit important, do not rank countries, that is, do not have a simple association with wellbeing. A leading SM should point clearly in a specific direction for wellbeing improvement, at least within the framework where it is defined. But there is just no clear 'right' legal retirement age, or 'right' size of pension contributions, 'right' role of non-contributory or voluntary pensions, 'right' average duration of retirement, 'right' prevalence of early or late retirees, 'right' incidence of taxation on pensioners, 'right' share of recipients of minimum benefits, or 'right' financing system. Even the total spending in public pensions does not

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[1]Throughout this study, 'pension system' refers to the entire set of different sub-systems within a given country.

[2]Consumption smoothing refers to achieving a smooth path of consumption across time and across states of nature. Consumption smoothing emerges as a consequence of the optimizing behavior of 'rational agents' in the standard economic model.

[3]Barr and Diamond (2009) add *insurance* to this list. It is possible to think of insurance as consumption smoothing across states of nature.

offer a clear level of rightness; its association with equality, for example, is dubious: Adequacy (2021) shows a very mild relationship between pension spending and equality (p. 34), and both Niehues (2010) and Ebbinghaus (2021) discuss how behavioral responses jeopardize the equity effect of social spending.

Nevertheless, some international rankings in the literature do offer a clearer link with wellbeing; those are covered next.

2.1 Coverage measures

With minor variations, 'coverage' stands for either (A) passive coverage: the proportion of elderly individuals who receive a pension or (B) active coverage: the proportion of economically active individuals that contribute to any pension system. The extensive study of Latin American Countries by Arenas (2019), for example, applies these measures. 'Coverage' is a useful SM for pension systems because it is easy to compute and understand, it is nationally representative, and it provides an international ranking since most people will agree on the social convenience of a high coverage. Indeed, coverage might currently be the principal SM of pensions in international comparisons.

However, passive coverage is insensitive to the size of pension allowances, and, to that extent, to adequacy, sufficiency, sustainability, and other dimensions commonly used to analyze the performance of pension systems. Passive coverage, in other words, could be high even within a pension system that consistently provides little consumption smoothing and little redistribution. The passive coverage measure, then, is not very close to the fundamental goals of pension systems. Active coverage, on the other hand, depends heavily on labor market characteristics like formalization, and is insensitive to the size of contributions, thus again as a measure it is not necessarily close to the fundamental goals (active coverage could be high even if smoothing and redistribution are low).[4]

It is then hard for current coverage measures to rise as a leading SM of the pension situation.

2.2 RR measures

The RR concept stands for the proportion of labor income that is replaced by pension income. The RR takes the form of a ratio between some measure of pensions in the numerator and some measure of labor income in the denominator.

The RR is always among the top pension indicators. It has tremendous appeal for the general public, academia, and policymakers. Furthermore, most defined-benefit pension systems establish the size of pension allowances based on the idea of RRs,[5] and individual capitalization systems are probably set keeping a desired RR in mind. Another example is ILO Convention N°102 for pension and unemployment insurance, currently ratified by about 65 countries, which establishes minimum benefits using RRs.

Indeed, the RR concept points to the heart of one of the fundamental roles of pension systems: the consumption smoothing role. From the perspective of a public pension system, the RR from mandatory deposits can be interpreted as a ranking: a higher RR is better than a lower one, at least up to some advisable standard.

All leading pension publications give the RR concept a central place. Adequacy (2021) uses two measures of the RR:

- The *empirical aggregate-level replacement ratio*: the empirical ratio of the gross median individual pension income of the population aged 65–74, relative to gross median individual earnings from work of the population aged 50–59 excluding other social benefits.

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[4]Besides, current measures of active coverage focus only on the proportion of the economically active population. This leaves out the working-age but non-economically active population, thus losing national representativeness, especially for women and relatively less affluent individuals. However, this could be solved by computing a 'working-age coverage'.

[5]A compilation of pension rules across the world can be found at https://ww1.issa.int/country-profiles.

- The *theoretical individual-level RRs*: the RR of hypothetical workers that follow certain careers, most of them being a lifetime full-length and uninterrupted stream of pension contributions from a certain average or minimum wage.

Ageing (2021) uses one:

- The *empirical aggregate-level replacement ratio among new pensioners*: the empirical average new pension allowance over the average yearly gross wage at retirement.

OECD (2021) uses theoretical individual-level RRs along the lines of Adequacy (2021). ILO (2021) reproduces the ones in Ageing (2021).

2.2.1 Problems with current RR measures
However, despite the attractiveness of the RR concept, current computations of RRs have not emerged as leading measures. Furthermore, they might have introduced considerable confusion, probably because of the following problems:

First, the reference income problem:

- The RR is a ratio between a pension and what can be called a reference labor income (also known as pensionable earnings). Current measures and the literature in general use the *pre-retirement* labor income as the reference. Also, ILO Convention N°102, Article 67, recommends a 40% RR with respect to "previous" labor income. But such focus on pre-retirement labor income lacks a clear conceptual and empirical support.
- Furthermore, there are strong conceptual and empirical reasons to understand the RR as the replacement of the long-term or *permanent* or lifetime labor income, not the *pre-retirement* one. Conceptually, the life-cycle model (Modigliani and Brumberg, 1954) and the permanent income hypotheses (Friedman, 1956) state that consumption levels are to a great extent a function of long-term income, suggesting that the permanent income is the one that should be replaced by pensions; this hypothesis emerges from fundamental economic theory and keeps finding substantial support in the vast amount of research that explores it.[6] Besides, many individuals do not report any labor income during the pre-retirement window, so for those individuals it is not possible to compute an RR based on the pre-retirement wage. Empirically, there are several reasons for pointing at the permanent income as the target for replacement. First, the empirical literature shows that the wage ladder across the life cycle is steeper among individuals with higher education (Lagakos *et al.*, 2018), which suggests that a pre-retirement income target would favor workers with higher incomes. Second, a pre-retirement income target makes pensions more expensive, which pushes up the contributions rate, which increases the distortions in the labor market, which harms individuals with low education. Third, a pre-retirement income target might introduce perverse incentives. Fourth, the pre-retirement income target introduces a substantial amount of financial uncertainty regarding the evolution of the system. Fifth, young individuals face much more volatility regarding the pre-retirement income than the lifetime income, which makes the permanent income a much safer option for the target to be replaced by pensions, especially for individuals with less stable labor trajectories. In general, the idea of 'pre-retirement' income has been seldom analyzed so far. Probably all the previous arguments

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[6]A comprehensive survey of tests of the permanent income hypothesis can be found in Havranek and Sokolova (2020), and a thorough discussion of the evolution of the idea can be found in Carroll (2001) and Deaton (2005). As for the 'retirement puzzle', meaning the intriguing drop in consumption around the moment of retirement, Hurst (2008) summarized most of the evidence, pointing to work-related expenses and the replacement of market services with home production, which allegedly explains the puzzle.

explain why, indeed, '*the great majority* [...*of OECD countries*...] *use lifetime average* [...*labor*...] *earnings to calculate pension benefits from defined benefit schemes*' (OECD, 2015).

- Current pension articles and leading reports use different definitions of the reference labor income, and RR measures are sensitive to them (Biggs and Springstead, 2008). This dispersion in the definition of the reference introduces dispersion in the measurements, which naturally jeopardizes the advancement of RR measures as an SM of the pension situation.
- Because current measures of the RR use the narrow pre-retirement windows as the reference, then a faster growth rate of labor income means a lower RR score.[7] Therefore, the current measures of the RR penalize the pension system if labor income grows but they do not if it stays flat, or even celebrate it if it decreases. It is not clear why this is desirable.
- Many times, the policy debate uses the last pre-retirement months *with contributions* as the reference. But labor income should always be a year average at least, because labor income means 'wages times density of contributions'.[8] Otherwise, it would be just incoherent with socio-economic and financial assessments, since the situation of earning \$1.000 only during summer months is extremely different than the situation of earning them in all months.

Second, the 'rankeability' problem:

- Current RR measures purposely leave out non-contributory pensions, in the spirit of focusing on the smoothing role rather than the distributive one. However, current pensions across the world are not easily classifiable as contributory or non-contributory; many times, current pensions are partially financed by taxes, and also, pension rules can introduce large subsidies, for example, for individuals with low wages and a low density of contributions. Besides, non-contributive pensions are pensions, financed by some form of contributions, and to some extent they do replace labor income. Current measures of the RR, then, leave outside some of the consumption smoothing of the system, and leave inside some of the redistribution, complicating its use as an international ranking.
- Early and late retirement jeopardize the association between current *empirical* measures of RRs and wellbeing. Many systems allow early retirement under certain rules, which most likely introduce smaller pension allowances. This means smaller scores in the current empirical RR measures, which therefore penalizes the system. However, having a perhaps convenient alternative for early retirement is not necessarily a bad thing. Late retirement goes along the same lines: it will bring about higher scores, but with a questionable relationship to wellbeing.
- An unsustainable system produces an unsustainable score in the current measures of RR. Thus, a high score today might predict a low one in the future, therefore being a bad symptom rather than a good one. With current RR measures, the sustainability issue has to be necessarily taken into account if the score is going to be interpreted as a ranking.
- Intergenerational and intragenerational mechanisms in general are influential for current measures of RR, thus also making it necessary to include them in the interpretation of rankings.
- Current *empirical* RR measures focus on the ratio of medians or averages. But this ratio does not set a clear link between the workers in the denominator and the selected group that receives a pension in the numerator.
- For individuals on the high end of wages, where contributable wage ceilings apply, the score on the current *empirical* measures of the RR will be lower, again introducing a nuisance for rankings.

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[7]It means a lower score because pensions' growth rate lags behind wages' growth rate.

[8]The 'density' of contributions refers to the proportion of time where the individual does contribute to the pension system..

Finally, the representativeness problem:

- Individuals who do not get a pension at retirement, but a rebate or nothing, are excluded from all current measures of RR.
- Current *theoretical* measures of RRs are based on theoretical individuals (mostly with a very stable labor trajectory), representing only a likely small segment of the population. The focus of theoretical measures on careers with very high density of contributions [9] is especially restrictive in developing countries where informality is higher.
- Current RR measures focus on the replacement of formal-employee income, leaving out other forms of labor income.
- Many times, the RRs are not static but change across the retired life due to pension rules and indexation; current RR measures focus on the moment of retirement.
- As well as the reference wage, pension benefits can be defined in different ways and current RR measures are sensitive to them.

In summary, current RR measures do not provide a strong pension SM.

2.3 Other pension SMs

There are a handful of other measures in the current literature that perform international comparisons. Actuarial valuations, for instance, provide measures for sustainability that can be used as international rankings, and sustainability is certainly a very important dimension. All too relevant since many (if not the majority) of public pension systems in the world constantly operate below the standard sustainability line. However, some big problems arise: (A) Sustainability does not have a sufficiently close link with the fundamental roles of pension systems; a very small system, with very small pensions, could be perfectly sustainable without having a substantive impact on the population. (B) What is the sustainability standard for public systems? It is not clear, and many will dispute the idea that they are just the same as the one for private institutions. (C) Actuarial valuations are complex and costly, and require expensive and painful actuarial analysis and assumptions that are not easy to perform continuously across countries. (D) Actuarial valuations rarely focus on more than one subsystem in any given country.

The financial returns of pension funds are another important dimension of comparison. Each pension system has a different role for financial returns, though, and has its own particular set of preferences over the risk-return profile too.

Another international comparison refers to pension indexations. The underlying idea is that pensions should be indexed by either inflation or costs of living (usually captured by a wage growth index) or another index, rather than no indexing at all. However, this dimension captures only a small fraction of the pension situation.

Finally, another measure is the 'benefit ratio', defined in Ageing (2021) as *the average pension as a share of the economy-wide average wage (gross wages and salaries divided by employees).*[10] While very interesting as a measure, it shares most of the weaknesses of the current RR measures discussed above.

3. A proposal for a leading SM of the RR

As discussed in Section 2.2, the concept of RR captures the essence of consumption smoothing, a fundamental role of pension systems, and it also captures the attention of policymakers, academics, and the general public. However, as also discussed in Section 2.2, current applications of the RR concept have many problems that prevent them from emerging as a leading SM.

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[9]OECD (2021) also explores some alternative hypothetical careers with up to 10 years without contributions during the relatively young age.

[10]Along the same lines, Borella and Fornero (2009) proposed the ratio of living standards after retirement to living standards when active.

We propose a measure of the RR as an SM of the potential consumption smoothing of the pension system. The measure, called CRR, is the country-level, self-financeable RR of the lifetime labor income, and it avoids the problems detailed in Section 2.2, as we discuss next. It provides a simple yet powerful international ranking about the potential consumption smoothing that emerges from the working-age behavior regarding pension deposits, leaving out the redistribution role of pension systems. By focusing on the self-financeable replacement, the CRR has a focus on the accumulation stage as the determinant of the RR.

Section 3.1 presents the basic actuarial formula for an RR, which is then applied to the CRR in Section 3.2.

3.1 An actuarial formula for the RR

The next formulas assume a constant wage and density of contributions, and then it is shown that using wage or density trajectories does not alter the formula for the self-financeable RR.

As shown in the actuarial or financial fields, it is relatively easy to derive the following formula for the final account balance of a person that saves a contribution rate 'c' of a constant monthly wage 'w' with a density of contributions 'd', under constant monthly interest rate 'i', from age at entry (say, 25) until age at exit (say, 65)[11]:

$$\text{Final savings} = \underbrace{\frac{\left[(1+i)^{12\left(\frac{\text{exit}}{\text{age}} - \frac{\text{entry}}{\text{age}}\right)} - 1\right]}{i}}_{\substack{\text{Final savings from a monthly} \\ \text{deposit of 1}}} \cdot \underbrace{w \cdot d \cdot c}_{\substack{\text{Average monthly} \\ \text{deposit}}} \tag{1}$$

$$\text{Pension allowance} = \frac{\text{Final savings}}{\text{Actuarial factor}} \tag{2}$$

Then, to transform those final savings into a self-financed pension, the only required operation is to divide the final savings by an 'actuarial factor', as shown in equation (2). The actuarial factor is standard in the actuarial literature, and it represents precisely the neccesary ratio of dollars of savings for each dollar of self-financed pension allowance. More precisely, the actuarial factor can be defined as the present value of a monthly pension of $1 dollar payable until death for an individual currently of age 'age at retirement'; it depends only on life expectancy and the expected interest rate of low-risk assets which are the typical investment of savings during retirement.[12] A typical actuarial factor for a 65-year-old individual may lie around 220, meaning that at 65 years old, $220 of savings are necessary to, on average, finance a pension of $1 until death. So, savings of, say, $100,000 would translate into a monthly pension of around $100,000/220 = $450. This self-financed pension could also be called the actuarially fair pension.

The self-financeable RR, finally, is the ratio between the pension allowance and labor income, as shown in equation (3). The labor income here is $w \times d$, because, as mentioned in Section 2.2, the

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[11]All the elements in the formula are expressed in real terms, that is, indexed by inflation. The formula assumes that each payment is done at the end of each period ('due' format) rather than at the beginning ('anticipated' format); nevertheless, this distinction makes no difference for this study.

[12]If additional beneficiaries are added into the annuity, like widowers, the actuarial factor will be higher, reflecting (A) the added probability of dying while the spouse is alive, and (B) the pension allowance of the survivors.

year average is what counts as labor income. The self-financeable RR formula is:

$$\text{Self} - \text{financeable RR} = \frac{\text{pension allowance}}{w \times d}$$

$$= \underbrace{\frac{\left[(1+i)^{12 \left(\substack{\text{exit} \\ \text{age}} - \substack{\text{entry} \\ \text{age}} \right)} - 1 \right]}{ac \times i}}_{\substack{\text{Replacement rate of the dollar} \\ \text{that is deposited monthly}}} \cdot \underbrace{c}_{\substack{\text{\% of the dollar} \\ \text{that is deposited monthly}}} \quad (3)$$

where ac stands for actuarial factor. Equation (3) shows many important issues. First, it shows the key and simple linear role of the contribution rate: twice the contribution rate maps into twice the RR. Clearly, this accumulation stage variable, the contribution rate, is a prime determinant of the potential consumption smoothing of a pension system. Furthermore, across countries of similar levels of development there is a similar retirement age, entry age, and actuarial factor, because of which the contribution rate is probably the principal source of international heterogeneity in the self-financeable RR.

Second, from equation (3) it is easy to propose a general rule of thumb for how much RR buys each 1% of contribution rate. Plugging in the common 25/65 for age at entry/exit, 220 for the actuarial factor, and a constant 4% for the real annual interest rate, we get that each 1% of contribution rate buys about 5% of RR. If the target for the RR is 70%, for example, then the required contribution rate is $70/5 = 14\%$.

Third, it is very important to note from equation (3) that the self-financeable RR is *not* a function of labor income (wage or density of contributions); thus, the self-financeable RR is comparable across populations of different wages and densities.

If the wage or density is not constant across the life cycle, the reference labor income in the denominator of the RR should be the lifetime average labor income, rather than measures of recent labor income, as discussed in Section 2.2. Financially, the natural choice for the lifetime average is the permanent income that would attain the same final savings; in this case, *by construction* the RR in equation (3) does not depend on the permanent labor income (trajectories of wage and density of contributions), because this parameter is present in the numerator and the denominator of the RR and therefore it is canceled out in the same way that the constant labor income got canceled from equation (3). In other words, the RR with respect to the permanent labor income is comparable not only across different *constant* wages and densities, but also across different *trajectories* of wages and densities of contributions.

Thus, it is possible to generalize that with a real annual interest of 4% and a 25/65 life career, each 1% of contribution rate buys about a 5% RR with respect to the permanent income, and therefore a 14% contribution rate buys about a 70% RR, all this not depending on the particular trajectories of wages or densities of contributions. The spreadsheet with Formula 3 is available in the online Appendix.

3.2 An SM of the RR

We propose to compute the RR detailed in equation (3) using country-level aggregates. The resulting measure captures the potential consumption-smoothing of the pension system. It is not a prediction, but a projection of the current situation, which makes things simpler and avoids somewhat arbitrary assumptions for the future. The country-level aggregates to be plugged into equation (3) can be estimated from cross-sectional observations across recent years.

Before discussing how the proposed measure deals with the challenges described in Section 2.2, we discuss each country-level aggregate.

The contribution rate is an essential component of the RR detailed in equation (3). We base the country-level aggregate for this rate on the labor share of the GDP.[13] For the proposed measure, we define a *macro contribution rate* as the ratio between (A) the summation of all the working-age individuals' mandatory deposits into the pension dynamics as a percentage of GDP, and (B) the macroeconomic labor share as a percentage of GDP. The spirit of this macro contribution rate, then, is the percentage of national labor income that is mandatorily delivered by working-age individuals into the pension dynamics. The mandatory deposit stands here for the mandatory contributions and taxes for contributory pensions plus the working-age individuals' attributable share of the financing of non-contributory pensions.

The attributable share of the financing of non-contributory pensions is added because it represents additional economic resources that working-age individuals put into the pension dynamics.[14] We simply approximate the attributable share of working-age individuals by the proportion of the population below the legal retirement age.

For the remaining parameters in equation (3), we use the same '25' for the average age of entry into the labor market across countries, and the average legal retirement age as 'age at retirement'. Both are well known and understood parameters. For the real annual interest rate during working age, we propose a 4%, in the idea that although each country may prefer a particular risk-return profile, it is still a good idea to use the same conservative position when comparing them. For each country, we compute the actuarial factor using country-level data on life expectancy (mortality rates, to be precise) plus a conservative real annual interest rate of 1%.

The proposed measure, therefore, can be called the country-level mandatory self-financeable RR of the permanent income ('CRR'). It measures what fraction of their middle-career labor income could replace a working-age population mandatorily saving the current macro contribution rate, given their age of entry into the labor market and their legal retirement age. The CRR has the same structure as equation (3):

$$
\underbrace{CRR}_{\substack{\text{Country}-\text{level,}\\ \text{mandatory,}\\ \text{self}-\text{financeable}\\ \text{replacement rate}}} = \underbrace{\frac{\left[(1+i)^{12\left(\substack{\text{legal retirement}\\ \text{age} } - \substack{\text{average entry}\\ \text{age}}\right)} - 1 \right]}{af \times i}}_{\substack{\text{Replacement rate of the dollar}\\ \text{that is monthly deposited}}} \cdot \underbrace{\frac{\substack{\text{working}-\text{age}'\\ \text{mandatory contributions}\\ \text{and share of financing}\\ \text{of non-contributory,}\\ \text{pensions as \% of GDP}}}{\text{labor share of GDP}}}_{\text{Macro contribution rate}}
$$

(4)

The CRR has several advantages as an SM, which makes it comparable as a ranking across countries and times. Unlike current RR measures:

> First, the CRR focuses clearly on one fundamental role of pension systems, the consumption smoothing potential of current pension systems. Current measures of the RR are focused on actual current pensions being paid, where it is usually hard to, empirically, disentangle consumption smoothing from redistribution.

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[13]The labor share of the GDP is a standard concept in macroeconomics. It means the proportion of the GDP that the labor factor takes in exchange for their work. It typically fluctuates between 40% and 70% across countries (Guerriero, 2019).

[14]If a fund is built to finance the non-contributory pensions, still the whole population owns the fund and therefore the current working-age generations are 'paying' for a fraction of the non-contributory pensions.

Second, the CRR presents the replaceability of the *permanent* labor income, which implies that the CRR does not depend on either the level or the volatility of wages or density of contributions. Applied to the country-level aggregates, therefore, the CRR is comparable across countries with different levels and trajectories of GDP's labor share. Current measures of RRs focus on the replaceability of *pre-retirement* labor income without a clear conceptual and empirical framework, as discussed in Section 2.2.

Third, the CRR does not depend on sustainability issues (since it is a *self-financeable* RR), thus simplifying its use as an SM.

Fourth, the CRR does not depend on redistributive dynamics (since it is a *macro level* and *self-financeable* RR), again simplifying its use as a SM.

Fifth, the CRR does not depend on the heterogeneity of benefits rules (other than the legal retirement age), because all countries and times are measured by the same one: the self-financeable benefit at retirement age. To be precise, the CRR assumes the same 'likelihood of a survivorship' and 'survivorship allowance equals 60% of the original pension' configuration across countries, but the survivorship configuration is far from being a protagonist in pension debates.

Sixth, the CRR includes all working-age individuals and all labor income in the economy. All individuals are involved in the labor share of GDP, in the financing of non-contributory pensions, and in the computation of the average age of entry into the labor market; besides, the focal point of a legal retirement age is proposed as legitimate for everyone. Current measures of RRs, on the other hand, are focused on some forms of labor income, and some subgroups of real or hypothetical individuals, probably far from national representativeness.

Additionally, the CRR depends only mildly on the evolution of the system. The macro contribution rate might change if the public spending on non-contributory changes, but there is considerable risk in taking a stance about the future configurations of the pension system; the CRR takes the conservative position of projecting the situation with the current value of the macro contribution rate. The age of entry in the labor market and the interest rate in the CRR formula would probably remain stable as the system evolves. Finally, the life expectancy and the retirement age might evolve in a highly predictable way, in which case their expected value in the near future can be used; the results in the next section are based on the projected values for 2030.

4. Application to OECD countries

Data sources where several countries are included are used in this section. The idea is to estimate the CRR in equation (4) for a large group of countries in a relatively simple manner.

The 'total mandatory contributions as % of GDP' variable, a key component of the CRR, was only found in Ageing (2021). The results in this section, therefore, depend on the particular approach for this variable in Ageing (2021). Only for Chile, an especial database was used.

Labor shares of GDP are taken from Guerriero (2019). Old age dependency ratios come from OECD data, mortality rates from United Nations Population Division data, and legal retirement ages from Ageing (2021). Table 1 shows the results.

Table 1 shows that several OECD countries could self-finance 65% or more of their labor share, and several others could self-finance in the 50–70% range. Table 1 also shows that the variable that makes the most difference is the mandatory contributions. These results came from developed countries, though, and the picture from developing ones might be different, for example, placing more weight on the role of non-contributory pension spending or having a different dispersion on the age at retirement or the macro contribution rate.

The data also show a heterogeneous group of countries both in the lowest and the highest group of CRRs; one Nordic country, for example, falls among the lowest CRRs for OECD countries, while other Nordic countries fall among the highest.

Table 1. CRR replacement rates in OECD countries

Country	Labor share of GDP	Total yearly mandatory contribution as % GDP	Total spending in non-contributive pensions as % GDP	% of working age population that is below the retirement age	Macro contribution rate	Average age at entry into the labor market	Legal retirement age	Actuarial factor	Replacement rate of the dollar that is monthly contributed ($r = 0.04$)	CRR
	a	b	c	d	$e = (b + c \times d)/a$	f	g	h	$i = [(1 + r)^\wedge(12 \times (g - f) - 1]/(r \times h)$	$e \times i$
Ireland	63%	2.6%	0.3%	79%	4.5%	25	66	240.2	5.17	23%
Croatia	82%	6.0%	0.0%	72%	7.3%	25	65	224.6	5.26	38%
Sweden	80%	5.7%	0.5%	72%	7.6%	25	67	237.3	5.50	42%
Bulgaria	57%	5.0%	0.0%	79%	8.7%	25	64	217.7	5.20	46%
Chile (*)	50%	2.7%	2.0%	85%	8.7%	25	63	198.0	5.26	46%
Netherlands	78%	6.5%	0.0%	73%	8.4%	25	67	230.2	5.75	48%
Poland	72%	8.4%	0.0%	75%	11.7%	25	63	246.0	4.23	50%
Slovakia	70%	7.4%	0.0%	78%	10.6%	25	64	233.0	4.82	51%
Estonia	68%	6.5%	0.0%	74%	9.6%	25	66	228.2	5.31	51%
Austria	79%	9.4%	0.2%	74%	12.1%	25	64	257.6	4.42	53%
Slovenia	84%	9.3%	0.0%	73%	11.1%	25	65	244.6	4.83	54%
Hungary	74%	7.7%	0.0%	75%	10.4%	25	65	218.8	5.40	56%
Malta	66%	7.9%	0.2%	97%	12.3%	25	65	256.1	4.62	57%
Lithuania	66%	7.2%	0.0%	74%	10.9%	25	65	224.2	5.27	58%
Romania	60%	6.8%	0.1%	75%	11.6%	25	64	225.1	4.99	58%
Czech Republic	71%	8.5%	0.0%	74%	11.9%	25	65	229.7	5.15	61%
Latvia	72%	8.4%	0.0%	74%	11.7%	25	65	217.2	5.44	64%
Cyprus	72%	8.4%	0.3%	96%	12.0%	25	67	226.3	5.63	68%
Luxembourg	67%	9.9%	0.0%	79%	14.9%	25	65	250.1	4.73	70%
Germany	74%	10.1%	0.0%	71%	13.7%	25	67	233.2	5.60	77%
France	77%	11.8%	0.2%	72%	15.5%	25	67	246.0	5.30	82%
Spain	75%	11.8%	0.1%	74%	15.9%	25	67	243.1	5.37	85%
Italy	72%	10.7%	0.3%	71%	15.2%	25	68	233.3	5.79	88%
Portugal	80%	13.3%	0.3%	73%	16.8%	25	67	234.2	5.57	94%
Norway	70%	11.0%	2.6%	76%	18.6%	25	67	236.2	5.53	103%
Greece	64%	13.3%	0.1%	72%	20.8%	25	69	214.2	6.65	139%
Finland	79%	21.7%	0.6%	70%	27.9%	25	66	242.3	5.08	142%

CRR: country-level replacement rate of the permanent labor income that the working-age population could buy with their mandatory pension deposits if they stay constant over time.
Source: (a) Guerriero (2019); the average of the alternative measures of the labor share is used. (b, c) Ageing (2021, Tables II.i.6 and ii.1.19, respectively). (d) https://data.oecd.org/pop/old-age-dependency-ratio.htm. (f) Assumption. (g) Ageing (2021, Table ii.1.3). (h) Authors' calculations based on United Nations Population Division life tables for the period 2021–2025, plus the assumption of a 1% interest rate, a 70% probability of leaving a widow, and a 60% of the original pension as the widow pension. (r) 4% real annual rate of interest.
*Chile's column b and c are computed by the authors based on official data.

5. Discussion

The replacement rate (RR) is a leading social indicator of what people and societies intend to achieve with their pensions; indeed, it is among the principal figures in the policy arena and is at the center of the formula that computes the pension allowances in most public pension systems. However, the actuarial literature does not deal with the economic concept of RR, and current measures of RRs are plagued with problems, which probably explain why no RR measure has risen to the golden status that the RR concept deserves.

The RR always takes the form of a pension allowance over a reference labor income, and one key dimension that needs clarification and standardization is such reference income. In other words, what and why is the conceptual definition of the income that should be replaced by a public pension? We argue that it should be the lifetime *permanent* income, not the *pre-retirement* income used by current RR measures. Unlike pre-retirement income, the permanent income is connected with the idea of consumption smoothing and is not regressive or distortive. Besides, the narrative of the pre-retirement income target introduces substantial uncertainty into pension systems: if the future annual growth rate of labor income is 3%, for example, the same RR is *twice* as costly if defined with respect to the pre-retirement income instead of the permanent one, which shows that the pre-retirement income target poses a very high bar on both public expectations and public finances.

In particular, we show that the self-financeable RR with respect to the lifetime permanent income is *not* a function of wages or density of contributions, so it is easily comparable across any mix of labor trajectories. This seriously enhances its use as an SM. Current theoretical RR measures are informative mostly for the highly selected subpopulation with very stable labor trajectories (high and constant density of contributions and constant wage growth), and current empirical RR measures mix a highly selected subpopulation in the numerator with a general population in the denominator without offering a simple interpretation as a ranking. Most labor trajectories are not stable, especially in developing countries, so it is important to use an RR measure that is independent of the labor trajectories.

Many problems with RR measures have been known for a long time. The proposed alternatives have been focused on multidimensional measures. This study shows that there is an RR dimension in which the RR definition is conceptually clear and countries are indeed comparable. Indeed, the self-financeable RR with respect to the permanent income is a legitimate, simple, and useful measure of consumption smoothing for public pension systems, comparable across countries. It is straightforward to show that with a real annual interest rate of 4% and a 25/65 working life cycle, each 1% of contribution rate buys about a 5% RR of the permanent income. Therefore, a 14% contribution rate buys about a 70% RR. This is true regardless of the trajectory of wages or densities of the individual. It is possible to express the previous result as a self-financing accrual rate with respect to the permanent income: each 1% of contribution rate finances a 0.125% accrual rate.[15]

Aside from their pre-retirement income target, current RR measures are also jeopardized by the influence of many other confusing factors. The measure we propose is the country-level RR of the permanent labor income ('CRR'), and focuses on macroeconomic aggregates, thus is nationally representative. Also, It focuses on the self-financeable RR, so is not dependent on pension rules (other than the legal retirement age), inter and intra-generational redistributions, and sustainability. The CRR is easily comparable as a ranking across countries.

The computation of the CRR across OECD countries suggests a general recommendation: the need to put the accumulation stage in a more prominent role. Currently, the decumulation stage receives most of the attention. It is easy to appreciate how abundant the figures about pension spending are in pension reports, and how surprisingly scarce the figures about mandatory savings are. This turns out to be a limitation of our study; indeed, our results depend heavily on the only data table about total contributions by country that we found (Ageing, 2021, Table II.1.6).

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[15]The *accrual rate* is the RR that each year of contributions adds to the person's final RR. 0.125% × 40 years of contributions = 5% = final RR.

Another general recommendation is to put the entire 'self-financeability' issue in a more prominent role. Public pension systems rarely compute and communicate the self-financeable pensions. But societies need to be fully aware of the quantitative gap between the self-financeable and the actual pension allowances.

Using the available data, the empirical application of the CRR shows that the working-age population in OECD countries could self-finance about 65% of their permanent labor income if their pension deposits as a percentage of GDP stayed constant across life. The figure goes from about 30% in Ireland and Croatia to more than 100% in Greece, Norway, and Finland. Among the few parameters that enter the CRR formula, the mandatory macro contribution rate is the one that explains most of the difference across countries. Nevertheless, this study focuses on developed countries, and the CRR panorama across developing ones could be different.

Naturally, an SM must deal with simplifications, and cannot reflect too much. The CRR measure does not focus on redistribution, to the contrary, it pretends to be independent of it. Whiteford (1995), Alonso-Fernandez *et al.* (2018), and Chybalski and Marcinkiewicz (2016) explore multidimensional measures. Also, the CRR is based on the 'labor share' of GDP, which has its own measurement issues. Also, this study relies too critically on one particular piece of data. Also, the CRR focus on mandatory contributions, but the mandatory/not-mandatory distinction is not so clear in some contexts. Finally, the CRR does not include voluntary pension deposits; however, the idea of a public consumption smoothing device relies on the idea that individuals lack foreseeability, which calls 'mandatory' into the central position (besides, the voluntary pension deposits are hardly observable, since buying a house, e.g., can be a voluntary pension saving.)

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