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Please address correspondence to
Banco de Portugal, Economics and Research Department
Av. Almirante Reis 71, 1150-012 Lisboa, Portugal
T +351 213 130 000 | estudos@bportugal.pt

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Content

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Editor's note[1]

Pedro Duarte Neves

October 2022

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1. This issue of *Banco de Portugal Economic Studies* includes four studies. The first two share a focus on the assessment of poverty in Portugal: the first examines the role of social transfers in reducing child poverty, the second develops a new poverty indicator for Portugal. The third study pinpoints stylised facts on the behaviour of Portuguese firms over their life cycle. These three studies explore statistical information from several individual databases, covering the past 10-15 years. The final study provides a graphic view – the business cycle clock – to identify the cyclical position of the Portuguese economy.

2. About a month ago, Eurostat[2] reported that around 95 million people in the European Union experienced poverty or social exclusion in 2021. Eurostat's definition is quite broad, as it encompasses poverty risk situations identified by income, and/or by severe material and social deprivation and/or by low labour market participation.[3] The Eurostat figure estimated for Portugal (22.4% of the population in poverty or social exclusion) is above the estimate for the European Union (21.7%).

Identifying poverty – as well as the economic policy measures that mitigate the effects of poverty – is currently of particular relevance, given the negative effects of rising inflation on welfare, which are particularly strong across the most disadvantaged segments of the population.

3. The study that opens this issue of *Banco de Portugal Economic Studies*, by Narazani, Riscado and Wemans, examines the effects of existing measures in the tax and social benefit system to reduce child poverty in Portugal (defined as poverty among children under the age of 18). In line with Eurostat, the authors consider a child to be at risk of poverty if they live in a household whose income – adjusted for size and composition – is below 60 per cent of the country's median income.

The authors compare the results of three policy instruments – Social Integration Income, Family Allowance and Tax Deduction per Dependent – in reducing the

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E-mail: pneves@bportugal.pt

1. The analyses, opinions and conclusions expressed in this editorial are entirely those of the editor and do not necessarily coincide with those of Banco de Portugal or the Eurosystem.

2. https://ec.europa.eu/eurostat

3. For a more detailed presentation, see "A multidimensional poverty indicator for Portugal" by Nuno Alves in this issue of *Banco de Portugal Economic Studies*.

incidence of poverty (proportion of poor children) and intensity of poverty (gap between household income and the poverty line income). A particularly relevant criterion for assessing the results achieved by each measure is the instruments' *effectiveness* in reducing child poverty: it corresponds to the percentage of expenditure transferred to households at risk of poverty before that measure was introduced.

Unsurprisingly – given its targeted nature – the Social Integration Income is the most successful measure for this specific target: between 90 and 100 per cent of additional spending, depending on the nature of simulations carried out, is channelled to lower-income households.

This study uses an individual database that is representative of the Portuguese reality, covering around 11,000 households and 27,500 individuals. The authors carried out several exercises to confirm the robustness of the results, by covering aspects such as: effects of the measures considered on incentives for labour market participation (participation and working hours) of greater relative importance in the case of the Social Integration Income; budget neutrality scenarios where increased expenditure on measures considered is offset by an increase in higher marginal tax rates; different scales of equivalence, i.e. different ways of considering household size and composition; and also different poverty lines. These exercises confirm the relative merits of the Social Integration Income in reducing child poverty.

4. The study by Alves elaborates a poverty indicator for Portugal based on the following areas: labour market participation, signs of material deprivation and social deprivation, health and housing. The most striking feature of this multidimensional poverty indicator is that it uses neither income nor consumption in identifying poverty situations; according to the design of the indicator, it is the accumulation of actual or perceived situations of deprivation and/or social exclusion that determines the existence of a poverty situation.

The study presents highly relevant results. Firstly, it suggests a significant reduction of poverty in Portugal in the 2014-2020 period. Nevertheless, in 2020, 15.4% of the Portuguese population lived in poverty and 5.9% in severe poverty. Secondly, the indicator shows Portugal's position within the European Union, which is not significantly different from that shown in the official Eurostat statistics:[4] poverty rate lower than in Spain and Greece, substantially higher than in countries like Finland and the Netherlands, and not far from that of countries such as Italy, Belgium and France.

5. Monitoring the incidence of poverty will become of the utmost importance in the near future, given recent developments, which are affecting – and may further affect – the most vulnerable strata of the population. From this point of view, the use of alternative indicators for measuring the incidence of poverty will, in a combined reading, allow for a better assessment of this phenomenon. Similarly, the assessment of alternative policies to mitigate poverty or social exclusion will certainly benefit from the use of a broad set of indicators to draw better informed conclusions.

4. See point 2 of this editorial.

This issue of *Banco de Portugal Economic Studies* presents alternative poverty incidence measures: the percentage of the population below the poverty line, as used in the study by Narazani, Riscado and Wemans; the multidimensional poverty indicator presented in the study by Alves, which, as already mentioned, is not calculated using any income or quantitative consumption measure; and also the Eurostat indicator of poverty and social exclusion which, due to its calculation method, is an intermediate way of measuring poverty when compared to the other two indicators. Combined monitoring of these different measurements of poverty will certainly allow for a better informed and comprehensive overview of incidences of poverty in Portugal, in the European area and the world.

6. The third study in this issue of *Banco de Portugal Economic Studies*, by Kozeniauskas, Moreira, Santos and Tetenyi, elaborates on the life cycle model of a firm. It identifies aspects that are associated with firms' longer (shorter) life spans and higher (lower) business resilience throughout their lifetimes in a relevant way. This study seeks to understand the importance in the growth pattern of firms of (i) their original conditions, and (ii) capital and labour market frictions they encounter. Based on the theoretical model developed by the study, the authors obtain empirical implications that are tested with firm-level data.

The first finding highlights the importance of the firm's conditions at the time it was set up. The empirical finding suggests that firm size persists, which also means a persistence in firms' sorting by size. Note that the probability of exiting the market is lower for firms that are larger from the outset. In other words, initial conditions are a good predictor of firm longevity.

The second important finding shows that the capital-labour ratio increases, on average, over the business life cycle. In accordance with the theoretical model, this outcome reflects a reality where frictions in capital accumulation are relatively greater than in the labour market: in fact, the model shows that if the level of capital is suboptimal in the start-up period of a firm, it tends to be offset by an increased use of labour, which brings the capital-labour ratio below optimal level. As the firm remains in business – and therefore in a position to adjust the number of production factors – this ratio tends to grow and converge towards optimum.

The factors that determine firms' size and how much they grow over their life cycle are important to understand aggregate economic growth. Furthermore, they can be relevant in designing policies to support firms in setting-up and growing their businesses.

7. The study by Lourenço and Rua develops an innovative visual approach to present the cyclical position of an economy. The authors propose a business cycle clock that indicates the direction of the variation of the cyclical position of the economy[5] (output gap). Going anti-clockwise, the peak of the business cycle corresponds to noon, when the output gap reaches its highest positive value; its rotation to 9 a.m. narrows the

5. The authors also use this methodology for the output growth rate (in addition to the output gap).

output gap to zero (at 9 a.m.); from then on, the output gap becomes progressively more negative until it reaches the cycle trough, corresponding to 6 a.m.; the output gap becomes less negative until it reaches zero again (at 3 a.m.); it then becomes progressively more positive until it reaches the cycle's peak again (noon). A full rotation of the clock hand thus corresponds to a complete business cycle.

The clock does not show the magnitude of the output gap but focuses on its signal (positive or negative) and variation (whether it increases or decreases). The innovative nature of this business cycle clock goes far beyond the clock hand reading, which corresponds to a central location measure (the mean, in this case) of the output gap position. The estimated accuracy of the business cycle clock position is visually illustrated by a confidence interval represented by the arc of a circle (the amplitude of which, for a fixed significance level, increases with the level of estimation uncertainty). The degree of consensus on the cyclical position of the economy – i.e. the degree of synchronisation of the economic indicators from which the position of the business cycle clock hand is calculated – is visually represented by a circular histogram.

It will be interesting to monitor this indicator's development in the future, in addition to the indicators usually used to analyse – in real time – the development of the Portuguese economy:

- What time is the business cycle clock ticking in this highly atypical month of October 2022, given such an unlikely coincidence of rare events (such as pandemic recovery, war in Europe and heightened inflation)?
- What indications will this business cycle clock give about economic developments over the coming months?
- How will noon (6 a.m.) – which corresponds to the most (the least) intense values of productive resource use – coincide, or not, with other indications of the degree of productive factor use: low (high) unemployment rate, high (low) employment, high (low) capacity utilisation rates, high (low) confidence and economic sentiment indicators?

The challenge is that the regular use of this indicator can help to understand the cyclical position of the Portuguese economy in the near future.

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Non-technical summary

October 2022

The role of family social transfers in reducing child poverty in Portugal

Edlira Narazani, Sara Riscado, Lara Wemans

The share of children at risk of poverty in Portugal reached 20.4% in 2020. A child is considered to be at risk of poverty whenever her family income (adjusted by the household size) falls below the poverty line. The most commonly used poverty line is 60% of the median income in the country and, in 2020, it amounted to 998 euros per month for a couple with a child under the age of 14.

The most relevant fiscal instruments of the Portuguese tax and benefit system that take the number of children in the family specifically into account are the *Abono de Família* (AF), the *Rendimento Social de Inserção* (RSI) and the *Dedução Fiscal por Dependente* (DFD).

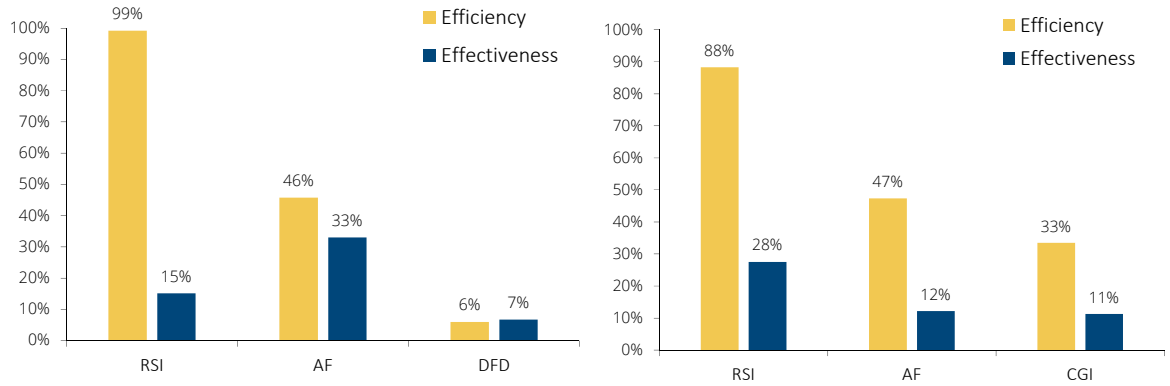
The AF is a means-tested benefit, which transfers an amount per dependent child taking into account several characteristics of the household, such as income and age of children. The RSI is a minimum income scheme designed to tackle extreme poverty, which complements household revenues in order to ensure that everyone eligible receives a total income equal to a certain threshold. The DFD is a non-refundable tax credit that is deducted from the personal income tax liability and depends on the age and number of children in the household. Additionally, the *Complemento Garantia para a Infância* (CGI) was created in 2022, ensuring a minimum amount per child received in the sum of the AF, the DFD and the CGI. The CGI resembles a refundable tax credit as it allows households who do not earn enough income to fully take advantage of the DFD, to be compensated by a complementary transfer. As such, it is more targeted to families with lower income than the DFD is.

We use the microsimulation model EUROMOD - which simulates direct taxes, social contributions and cash benefits - and data from the European Union Survey on Income and Living Conditions - that collects harmonized observations on income and living conditions - to study what happens to poverty and income distribution when the RSI, the AF and the DFD are introduced, and in case of scaling-up each of the policies amounting to 0.1% of GDP. When designing the policy scale-up, we increase the elements of these policies more directly targeted to poor families with children, focusing on the CGI instead of the DFD.

When assessing the effects of the measures, we consider their impact on the poverty incidence - the proportion of poor children - and poverty intensity - the distance of

the equivalized income of poor children to the poverty line. The AF is the policy contributing for a more significant reduction in the incidence of child poverty (-5.4 p.p.) and its intensity (-2.4 p.p.). However, the AF and the DFD represent more than twice the budgetary cost of the RSI and are only targeting families with children, while the RSI is also aimed to households with no children. Introducing changes to these policies with an equivalent budgetary cost and affecting only families with children is a more directly comparable exercise. In this case, the AF remains the policy with a greater impact on the incidence of poverty, but scaling up the RSI reduces more poverty intensity.

Figure 1 presents indicators of effectiveness and efficiency of the different policies. Effectiveness is measured by the percentage of the poverty gap of families with children reduced by the policy, without taking into account its budgetary cost. Efficiency is measured by the share of additional public spending channelled to households with children that would be at risk of poverty without its implementation. Regarding effectiveness, the introduction of the AF reduces the poverty gap of these families by one third, doubling the estimated impact of the RSI. However, the RSI is by far the most efficient instrument to reduce poverty among these households, if it is introduced in the system with its current design (almost all expenditure goes to previously poor families with children) or scaled-up (88% of the additional expenditure is channelled to poor households with children). RSI is also the most effective instrument for an equivalent budgetary cost.



(A) Introducing policies (B) Scaling up policies

FIGURE 1: Efficiency and effectiveness of different policies in reducing child poverty

Source: Authors' calculations based on EUROMOD simulations and EU-SILC data.
Notes: Efficiency is measured as the proportion of additional income going to previously poor families with children, while effectiveness is measured as the percentage reduction in the poverty gap of these families. In the scenario when policies are introduced (panel A), the CGI adds to the AF, having a residual budgetary impact and limited coverage. In the scaling up scenario (panel B) the budgetary cost of each policy is increased to represent 0.1% of GDP. All calculations consider an anchored poverty line and take into account the equivalized disposable income.

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The role of family social transfers in reducing child poverty in Portugal

Edlira Narazani
European Commission - JRC

Sara Riscado
Banco de Portugal

Lara Wemans
Banco de Portugal

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Abstract
One fifth of the children in Portugal live in households at risk of poverty, and reforms to strengthen fiscal support to families with children are often being proposed by scholars and policy makers. This paper uses the microsimulation model EUROMOD and data from the EU-SILC to assess the power of selected tax and benefit rules currently in place to reduce child poverty and to simulate hypothetical changes to these rules in a revenue-neutral set-up. To obtain a comprehensive view of the effects of these hypothetical policy changes, their impacts on the labour market are also quantified using a discrete choice labour supply model. Considering a parametric reform with a limited cost, the *Rendimento social de inserção*, the Portuguese minimum income benefit, is the most efficient instrument to reduce child poverty, being also the one generating higher labour market disincentives. (JEL: H53, I32, I38)

1. Introduction

Child poverty and social exclusion is a pressing social injustice that hampers the development of the true potential of a significant part of the population even in advanced economies. This impacts a wide range of outcomes, from health, to education and labour market integration (Black *et al.* 2000, Case *et al.* 2002 and Duncan *et al.* 2010), deterring output growth in the long run. In Portugal, the intergenerational transmission of poverty is high (Diogo 2021), with a particularly tight link between wages and parents educational levels (Causa and Åsa Johansson 2010). In this context, the provision of equal opportunities since early childhood is crucial to promote social inclusion and well-being.

The tax and benefit system is one of the most immediate policy instruments at the disposal of the decision maker impacting overall welfare and, in particular, that

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E-mail: edlira.narazani@ec.europa.eu; sriscado@bportugal.pt; lcwemans@bportugal.pt

of children. Although a comprehensive approach including other relevant policies[1] is needed to fully address child poverty, looking at the tax and benefit system is still relevant, since different public policies should be viewed as complementary (Atkinson 1998). In fact, studying the functioning of social transfers and tax rebates to families, their budgetary and distributional impacts and how they shape economic incentives is crucial to improve policy interventions and help inform the public opinion (Hendren and Sprung-Keyser 2020). This paper adds to this literature, by focusing on how social transfers and tax benefits to families with children in Portugal influence child monetary poverty, comparing the impacts of those measures on the disposable income distribution, in different policy scenarios.

According to Eurostat statistics, in Portugal, around 20% of the population with less than 18 years (hereinafter referred to as *children*) is at risk of poverty, belonging to families with an equivalised income below 60% of the median. There has been a clear reduction in this rate since 2014 and a convergence to the euro area average, but the role of social transfers, other than pensions, in reducing the incidence of child poverty in Portugal is below average. In particular, the poverty rate when including these transfers is reduced by around 10 p.p. on average in the euro area and only by 5 p.p. in Portugal. Social transfers to families with children in Portugal became more generous in the recent past, especially for younger children and low-income families. Still, the country remains as having one of the lowest spending in this item within the euro area, as a percentage of GDP. In 2021, a new strategy to fight poverty was approved, setting the goal to reduce the population at risk of monetary poverty to 10% (660 thousand people less) and halve it in the case of children (170 thousand children less) by 2030[2]. In the last years, the government announced several changes to the main tax and benefit policies, aiming at boosting the incomes of households with children.

Poverty and social exclusion are complex matters and monetary poverty is only one of the relevant dimensions (Diogo 2021). Addressing specifically monetary poverty, this paper focuses on a particular aspect of poverty, so its results should be complemented with other approaches and information. Moreover, we focus on income since it is the variable more directly influenced by the fiscal support to families with children. This is also the most commonly used variable, although we acknowledge that part of the literature considers other variables, like consumption, as more suitable to capture poverty (Deaton and Zaidi 2002 and Alves 2009).

We compare the income of families with different sizes on the basis of an equivalised disposable income, reflecting different household composition and the existence of economies of scale. We follow Eurostat methodology by weighting each element of the family according to the OECD-modified scale, in which the first individual is counted as 1, additional people aged 14 or above have a lower weight to account for economies of scale (0.5) and children up to 14 years-old have an even lower weight (0.3). However,

1. Namely health, childcare, work-life balance for parents, education, social assistance and the provision of school meals and materials.

2. *Resolução de Conselho de Ministros* n. 184/2021, December 29.

some studies indicate that, in particular for low income families, economies of scale may be lower (Deaton and Zaidi 2002 and Pereirinha *et al.* 2020). For robustness, we complement the results obtained using the OECD modified-scale with the ones derived from applying the original OECD equivalent scale, which counts additional household members above 14 years-old as 0.7 and those below 14 as 0.5.

Another fundamental aspect of the analysis is to establish a "fair" level of the equivalised disposable income below which a household is considered poor. Taking into account that the concept of at-risk-of poverty, as defined by Eurostat, is intended to measure "low income in comparison to other residents" (in Eurostat glossary), the at-risk-of-poverty line is defined by the distance to typical living standards (proxied by median income) and is specific to each society (proxied by the people living in a given country and year). Once again, we follow the main poverty line used by Eurostat, which is set at 60% of the median income in each country. However, we also refer to results obtained using the 40% of the median income threshold, whenever relevant for the analysis.[3]

The European Union Survey on Income and Living Conditions (EU-SILC) is the source used to compute official poverty and social inclusion statistics. We rely on this survey to simulate the disposable income distribution in different policy scenarios with the European microsimulation model, EUROMOD. This model abstracts from behavioural responses by economic agents. However, as we are studying the impact of different levels of transfers to households with children, parents' labour supply reaction would be particularly relevant. To tackle this limitation, we use EUROLAB, a discrete choice labour supply model that relies on EUROMOD for identification purposes. This allows us to evaluate the trade-off between the effectiveness of the policies to alleviate poverty and labour market efficiency, both in terms of participation and hours worked, as discussed for instance in Vandelannoote and Verbist (2020) and Collado *et al.* (2017).

Several papers analyse child benefit policies in different European countries using EUROMOD (Salanauskaite and Verbist 2013, Avram and Militaru 2016 and Cantó *et al.* 2012) and some include Portugal (Immervoll *et al.* 2000 and Matsaganis *et al.* 2006). Portugal seems to have a low level of child benefits with reasonably limited distributional and poverty impacts. This paper uses some of the metrics proposed in Matsaganis *et al.* (2006) to assess the efficiency and effectiveness of social transfers. Apart from updating the analysis to the current situation, the novelty of this paper consists on simulating the impact of stylised parametric changes to existing policies with similar budgetary costs, addressing budget neutrality (especially relevant taking into account the Portuguese public debt levels) and discussing labour market incentives.

We focus the analysis on the *Rendimento social de inserção* (RSI), the *Abono de família* (AF) and the *Dedução fiscal por dependente* (DFD). We find that, for a budgetary cost of

3. Pereirinha *et al.* (2020) estimate that the minimum income to live with dignity in Portugal was around twice the 60% poverty line, illustrating how far the poverty line may lie relatively to the level society understands as enabling full economic and social integration. This study followed the Minimum Income Standard methodology, which relies, alternatively, on the opinion of focus groups, based on news regarding actual consumption baskets, and expert opinion (Bradshaw *et al.* 2008).

0.1% of GDP, scaling up the transfers to the first two brackets of the AF is more effective to tackle child poverty incidence, while an increase of the child component of the RSI has a stronger impact on child poverty intensity and extreme child poverty incidence. We estimate negative impacts of these reforms on overall labour supply, which are more salient in the case of the RSI. These findings should be interpreted taking into account the relatively high female labour market participation rate in Portugal, the low prevalence of part-time jobs and the conditionality rules of the RSI.

The remainder of the paper is organized as follows. Section 2 briefly describes the dataset and the models used in the analysis. Section 3 gives an overview of child poverty in Portugal and of the poverty mitigation power of selected fiscal measures (in terms of hypothetical and actual households). Section 4 presents the impacts on child poverty from boosting the selected fiscal measures, as well as a possible budget neutral reform able to finance the increased budget spending, and the estimated labour market incentives produced. Section 5 concludes.

2. Data and models

In order to assess the role of selected fiscal instruments in strengthening household disposable incomes and to obtain the direct - "morning-after" - effects of policy changes, we use the microsimulation model EUROMOD (model i4.0+) and data from the 2020 EU-SILC dataset for Portugal (in which monetary aggregates refer to 2019).

The EU-SILC is a harmonized dataset produced by Eurostat, consisting of cross-sectional and longitudinal data on income, poverty, social exclusion and living conditions, covering all EU countries. This annual survey collects information at the individual and at the household level on detailed income components - wages, social contributions, taxes and pensions and other social transfers - and living conditions. It also includes individuals' demographic and socio-economic characteristics such as gender, age, marital status and parenthood, education, labour market status, among others. In this study, we use only the cross-sectional version of this survey for Portugal, consisting of a representative sample of 27,638 individuals, corresponding to 11,367 households[4].

EUROMOD is a static calculator, which simulates direct taxes, social contributions, as well as cash benefits, according to the tax and benefit rules in place in each European Union Member State and data from EU-SILC. In this way, EUROMOD allows us to compute the disposable income of individuals and households and to evaluate the "first-order" (non-behavioural) fiscal, distributional, equity and poverty impacts from actual and hypothetical reforms of the tax and benefit rules (for further details about the model, see Sutherland and Figari 2013). Taking into account the information available about the sampling procedure, we assess the statistical significance of the EUROMOD results (for a discussion on the effects of limited sample information see Goedemé 2013).

4. For more details on EU-SILC see https://ec.europa.eu/eurostat/web/microdata/european-union-statistics-on-income-and-living-conditions.

We start from the 2021 tax and benefit system[5], updated to 2022 and modified with the recent changes introduced by the 2022 State Budget[6]. This system will be considered our baseline for comparison purposes and we will build upon it our hypothetical scenarios. Measures aimed at supporting incomes related with the Covid-19 pandemic or the energy shock have a temporary nature and were, therefore, not considered in the baseline system, nor in the simulations implemented.

For a more comprehensive analysis that accounts for the behavioural impacts - "second order" effects - on the labour market, we use EUROLAB. EUROLAB builds upon a discrete choice microeconometric model and EUROMOD to predict labour market effects at the intensive (supply of working hours) and extensive (labour market participation) margins, upon a policy change. In a nutshell, EUROLAB estimates a set of utility parameters that explain individual behaviour over income and hours worked, comparing the utility of counterfactuals of disposable income (a proxy for consumption), which are provided by EUROMOD for each combination of working hours, employment status and occupational sectors, and controlling for the individual's socio-demographic characteristics. This model also incorporates labour demand elasticities, so the partial equilibrium effects of a policy change can also be obtained as well as the new equilibrium wage. The preference parameters are estimated based on the 2019 EUROMOD system and the data used in the estimation is also coming from the 2020 EU-SILC dataset for Portugal (for a complete description of the model see Narazani *et al.* 2021).

3. A snapshot at the current policies

3.1. Child poverty incidence and main policy instruments

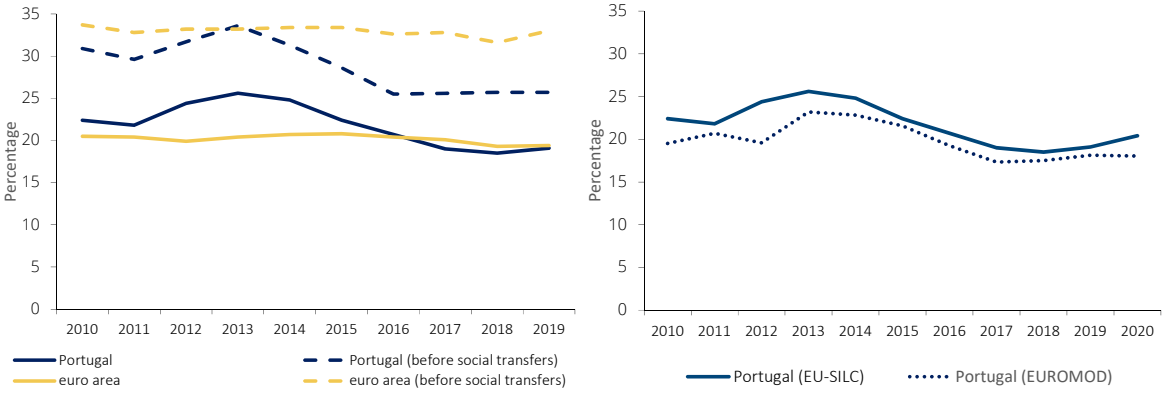
Portuguese children have a higher risk of poverty than adults do. The gap to the adult population has been declining since 2014 (with the exception of 2020) and in recent years this indicator became close to the euro area average, both for children (Figure 1A) and adults. EUROMOD estimates a lower poverty rate which, as discussed in Rodrigues *et al.* (2021), can be related to the fact that in its simulations it assumes full take-up - eligible individuals always receive the benefits they are entitled to - of most of the social transfers. Still, regarding recent years this underestimation is low (Figure 1B).

From the total households with children in Portugal, 30% are composed of two adults with one dependent child, a similar proportion is composed of three or more adults with children, 25% by two adults with two dependent children, 11% by a single adult with dependent children and 3% by two adults with three or more dependent children. Child poverty is especially prevalent in the last two household types, reaching in both cases around 30%. When comparing the at-risk-of-poverty rate for children before and after

5. 2021 is the most recent available system in EUROMOD.

6. Results of the uprating procedure and details on the policy changes included, which will gradually come into force in 2022 and 2023, can be consulted in appendix A.

social transfers other than pensions, it is clear that the role of these transfers in reducing the prevalence of poverty in Portugal is lower than the average for euro area countries (Figure 1A), as shown in Leventi *et al.* (2021), using several alternative measures.



(A) Role of social transfers excluding pensions (B) EU-SILC and EUROMOD simulations

FIGURE 1: At-risk-of-poverty rates for children in Portugal and the euro area

Source: Statistics Portugal, Eurostat and authors' calculations based on EUROMOD simulations and EU-SILC data.
Notes: The year reflects when the income was earned and not when the survey was conducted.

We identify three main measures in the Portuguese tax and benefit system that affect our target population – families with children – and aim at reinforcing their incomes: the RSI and the AF, on the benefits side, and the DFD, on the tax side. Briefly, the RSI is a benefit created to mitigate extreme poverty and social exclusion of the very low-income families, guaranteeing them a minimum income. As a top-up benefit, the amount received by eligible individuals results from the difference between the guaranteed income and the family's total income, taking household composition, namely the number of children, into account. The AF is calculated considering four income brackets and the age of the child. It includes a supplement for large families with small children and for single parents, and it is reinforced by a minimum amount assigned to children below an extreme poverty bracket. The DFD is a non-refundable tax credit from the personal income tax (PIT), which allows the deduction of an amount from the tax liability, depending on the age and number of dependent children in the tax unit. Between the AF and the DFD, a minimum amount per child is guaranteed - *Complemento Garantia para a infância (CGI)* - topping up the sum of the AF already received and the DFD used so that the guaranteed minimum amount is attained (working, in fact, as a refundable tax credit to the AF beneficiaries)[7]. The RSI distinguishes from the other policies as it requires the participation in a social integration programme, including labour market activation measures (see Gabinete de Estratégia e Planeamento (GEP) do Ministério do Trabalho Solidariedade e Segurança Social (MTSSS) (2019) for a discussion

7. For simplicity, in this section, the CGI has been added to the AF. Its implementation in EUROMOD followed the information made available by September 2022. However, some details were yet to be legislated.

on the types of social integration measures). Moreover, all children are required to attend school.

In assessing these policies we will not take administrative costs into account, although means-tested benefits would have in principle higher administrative costs[8]. Means-tested benefits face take-up issues related to lack of information and fear of social stigma, as not all the eligible households apply. From the three selected policies, in EUROMOD only the RSI is corrected to assume incomplete take-up, although still considering very high levels of take-up (Rodrigues *et al.* 2021).

3.2. Disposable income simulations for hypothetical households

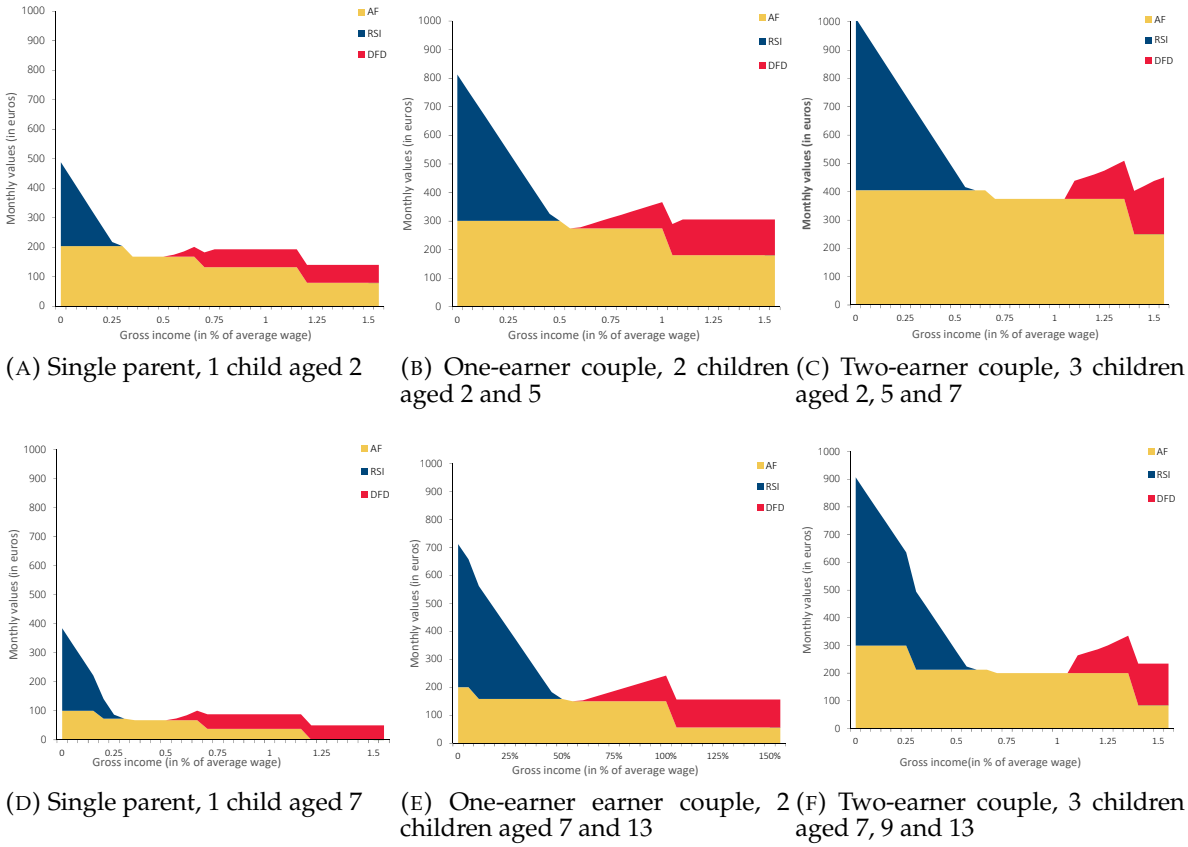
To better understand how the three benefits identified change with wage, we generated a series of hypothetical households[9]. The households include a single parent with one child, one-earner couple with two children and two-earner couple with three children. Each of the household types is split in two, one considering small kids and another for older ones to better capture the AF dependency on child age and, to a lesser extent, that of the DFD.

Focusing on these very stylised cases, the RSI is rapidly decreasing with wages (80% of the wages net of social contributions are included in the income test), while the AF shows several discontinuities, in which a small increase in wage leads to a sharp drop in the benefit received at the top of each income bracket. The DFD - measured as the difference between PIT simulated without this tax credit and after including it - only benefits these hypothetical families earning above the minimum wage (at around 50% of the average wage which in Portugal was approximately 1500€ per month in 2021) and is, above this threshold, increasing with wage before becoming fixed (Figure 2).

Social transfers to small children are much higher than for older ones, which can be justified by the literature advocating that early life parental investment is crucial to determine adult skills (Cunha and Heckman 2008) and by a higher burden of childcare costs before entering compulsory schooling. In terms of the role of the policies to reduce poverty intensity as measured in this paper, different levels of transfers according to child age are less efficient as all children aged 14 or below have the same weight on the computation of the household equivalised disposable income.

8. For instance, Gabinete de Estratégia e Planeamento (GEP) do Ministério do Trabalho Solidariedade e Segurança Social (MTSSS) (2019) indicates that around 10% of the expenditure on RSI is spent in protocols with institutions to promote social inclusion.

9. The simulations, made using the EUROMOD hypothetical household tool described in Hufkens *et al.* (2019) assume rented houses at 250 euros per month and that all the children attend school.



(A) Single parent, 1 child aged 2

(B) One-earner couple, 2 children aged 2 and 5

(C) Two-earner couple, 3 children aged 2, 5 and 7

(D) Single parent, 1 child aged 7

(E) One-earner earner couple, 2 children aged 7 and 13

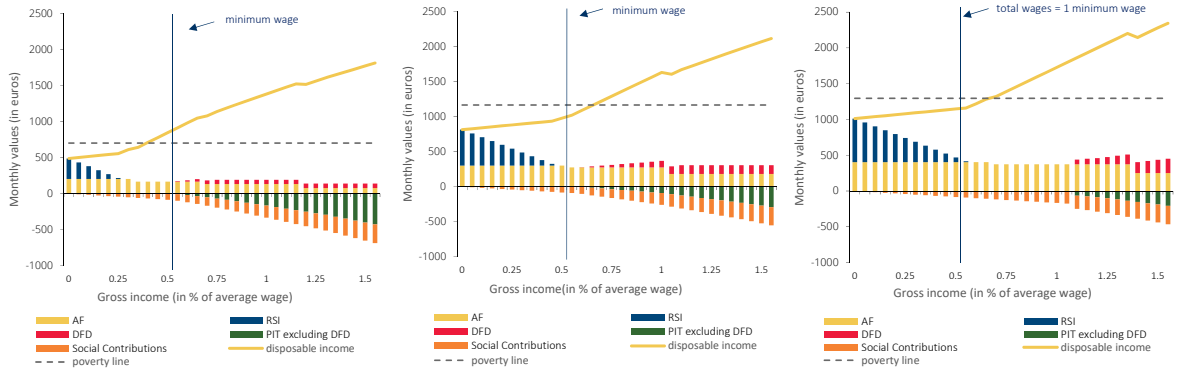
(F) Two-earner couple, 3 children aged 7, 9 and 13

FIGURE 2: The value of child benefits by gross income in % of average wage (in euros per month)

Source: Authors' calculations based on EUROMOD simulations and EU-SILC data.
Notes: Simulations made by progressively increasing gross wage by 5 p.p. For two earner couples, the horizontal axis takes into account the sum of the household wages (and not the average).

Considering only hypothetical households with small children, we can analyse what the impact of these policies is and how they fill the gap between gross wage and disposable income (Figure 3). As the value of the AF is not taken into account in the income assessed in the context of the RSI, families with children and very low incomes accumulate these two benefits. Nevertheless, these policies are clearly insufficient to lift their incomes above the poverty line. For families with more than one child even one minimum wage is still insufficient to cross the poverty line.

Finally, it is important to stress that, due to the link between the AF income brackets and the amount of the transfer, some increases in gross wages lead to a reduction of the household disposable income. Even if the decline is small, a limited increase in the complexity of the policy design in order to tackle this issue would increase its fairness.



(A) Single parent, 1 child aged 2 (B) One-earner couple, 2 children aged 2 and 5 (C) Two-earner couple, 3 children aged 2, 5 and 7

FIGURE 3: Disposable income (and its non-wage components) by gross wage (in % of average wage) (in euros per month)

Source: Authors' calculations based on EUROMOD simulations and EU-SILC data.
Notes: Disposable income is not in terms of equivalent income. Simulations made by progressively increasing gross wage by 5 p.p. For two earner couples, the horizontal axis takes into account the sum of the household wages (and not the average).

3.3. *The child poverty mitigation power of selected benefit and tax measures*

In this section, we quantify the power of the selected policy instruments - RSI, AF and DFD - to reduce child poverty in 2022. Altogether the three selected measures amount to around 2,000 million euros, representing 0.87% of the Portuguese GDP as projected for 2022[10]. According to EUROMOD simulations, the RSI is clearly the policy with a lower budgetary cost, estimated at 0.1% of GDP[11], while AF and DFD both account to around 0.4% of GDP, close to general government statistics for 2021 (AF) and 2020 (DFD). In the absence of all measures, the child at-risk-of-poverty rate would increase by 7.4 percentage points (p.p.), from 15.8% to 23.2%, while the child poverty gap would widen by 3.8 p.p., from 3.9% to 7.8% (Figure 4A). Overall, the poverty rate of the entire population would rise from 17% to close to 19.7% and the distribution of income would become more unequal (the Gini index would increase 0.013 p.p.).

When considered individually, we find that each measure contributes differently to mitigate child poverty (Figure 4A). The AF stands out as the instrument whose absence would deteriorate the most both the child poverty rate and the child poverty gap[12]. This finding seems to be consistent with the main goal of the instrument, its specific

10. Banco de Portugal projection on June 2022.

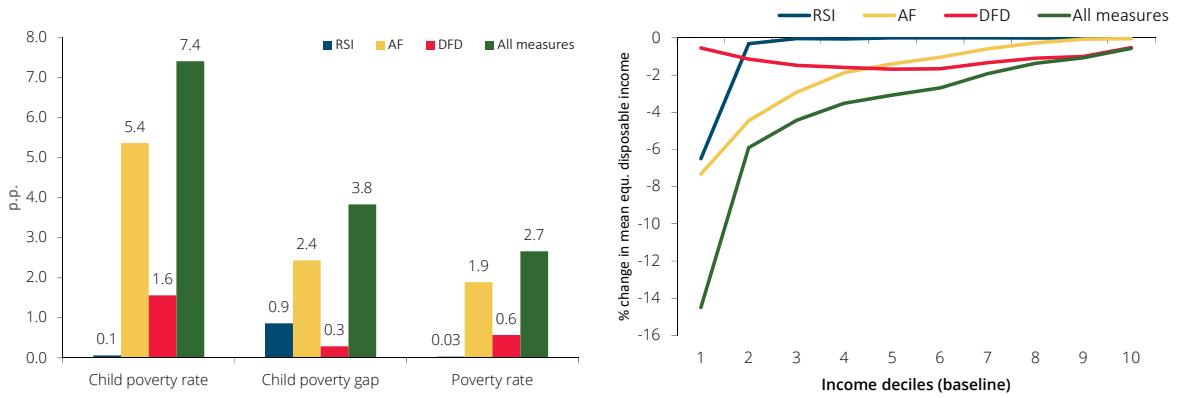
11. According to 2021 execution, including the amounts spent in protocols to promote social inclusion not included in EUROMOD, this figure reached 0.18%.

12. In this article, we use the average normalised poverty gap, one of the indicators proposed by Foster, Greer and Thorbecke (FGT), which takes the average distance of the equivalised income of all individuals to the poverty line, considering a distance of zero to all non-poor individuals. Note that this is different from the most commonly used poverty gap, which depicts the distance between median equivalised income of the poor and the poverty line, expressed as a percentage of the poverty line.

targeting (only families with children, with bonus to large families and single parents), its higher public provision (under full take-up hypothesis), as well as its progressive nature (concentrating the higher benefits on poorer families and discontinuing them for richer ones). Furthermore, the residual nature of the RSI is salient, in terms of its GDP weight, contributing to a low performance of this policy instrument in child poverty incidence reduction. Abolishing the RSI would only slightly increase the child poverty rate by 0.1 p.p., while the elimination of the DFD raises this rate by 1.6 p.p., which can be directly related to the very high difference in terms of budgetary allocation and to the different design features between the two measures (the DFD endowment is more than four times the one of the RSI and specific to families with children). However, as a top-up benefit, the RSI has a higher mitigation impact in closing the child poverty gap: in its absence, the average distance to the poverty line widens 22%, increasing the poverty intensity. Furthermore, the RSI gains more relevance in the impacts on the poverty indicators when we consider a more stringent poverty line. For instance, when considering the poverty line of 40% of the median equivalised disposable income as benchmark, the impacts of abolishing the RSI gain importance, while the ones generated by the elimination of the remaining measures are dampened (see Appendix B.2). In a nutshell, the RSI is more targeted to reduce the risk of extreme poverty but the reference income used is clearly insufficient to lift households out of poverty risk.

In distributional terms, the impact of removing all these measures is negative for all the deciles of the distribution, as shown in Figure 4B. However, this negative impact loses importance as we move from the first to the last decile of the distribution, from a drop of around 14.5% observed in the first decile, to 6% in the second and almost no change in the tenth. As expected, abolishing the RSI is clearly damaging for the individuals in the first decile of the distribution (where the great majority of its beneficiaries is placed), while abolishing the AF has a more extended negative impact across the income distribution (it persists, although in a declining trend, until the ninth decile). The DFD, as a tax deduction, affects only taxpayers and, for this reason, its negative effect is only arising from the second decile onwards, being more important for the middle deciles of the income distribution.

To deepen the understanding of the capacity of the different measures to tackle the risk of poverty, we also evaluate three efficiency indicators, developed by Matsaganis *et al.* 2006: i) the vertical expenditure efficiency (VEE), which measures the share of the additional income received by households with children below the poverty line; ii) the poverty reduction efficiency (PRE), which yields the proportion of the income shock channelled to lift families with children up to the poverty line; iii) the poverty gap effectiveness (PGE), which measures the proportion of the initial distance of families with children to the poverty line that is eliminated by the reform. All these measures are based on an anchored poverty line and on equivalised disposable income. PGE indicator is a measure of effectiveness, considering by how far poverty intensity was reduced, independent of the magnitude of the income shock, while VEE and PRE measure efficiency, as they assess which part of the additional disposable income is used to reduce poverty. In addition, PRE has a more stringent definition of efficient expenditure than



(A) Effects on poverty indicators (B) Effects by income decile

FIGURE 4: Effects of removing the RSI, AF and DFD

Source: Authors' calculations based on EUROMOD simulations and EU-SILC data.
Notes: Decile groups rank the individuals according to their equivalised disposable income in the baseline. The indicators were calculated with an anchored poverty line at the baseline scenario level. The poverty gap is based on FGT(1) the average normalised child poverty gap.

VEE, as it penalises the additional spending channelled to households below the poverty line (pre-reform) but that leads them to cross this line.

In order to apply these measures to our analysis, let us suppose now that we are introducing the RSI, the AF and the DFD into a system that did not have these measures (while maintaining the poverty line anchored at the baseline level that we used before). These results are presented in Table 1 and they reveal a more positive impact of the RSI in fighting poverty of families with children. Almost all the additional income provided by the RSI goes to previously poor households, against 46% and 6% in the case of AF and the DFD, respectively, the RSI being by far the better targeted measure. Moreover, 97% of that income is used to take households to the poverty line. The AF is the more effective instrument to narrow the poverty gap of the families with children, reducing it by around 33%, while the RSI is only able to reduce it by 15% and the DFD by 7%. Note that the AF and the DFD have a budgetary cost that more than doubles the one of the RSI. Overall, the three measures together are able to close this gap by 44%. These results are robust to changes in the OECD equivalence scale and considering a lower poverty line, as presented in Appendix B.

Indicator	Description	RSI	AF	DFD	All
VEE	% of additional income going to previously poor families	99%	46%	6%	33%
PRE	% of additional income used to achieve (but not surpass) the poverty line	97%	39%	5%	28%
PGE	% reduction in the poverty gap of families with children	15%	33%	7%	44%

TABLE 1. Efficiency and effectiveness of the RSI, AF and DFD

Source: Authors' calculations based on EUROMOD simulations and EU-SILC data.
Note: The indicators were calculated with an anchored poverty line at the baseline scenario level.

4. Impacts of scaling up existing policies

4.1. Effects on child poverty

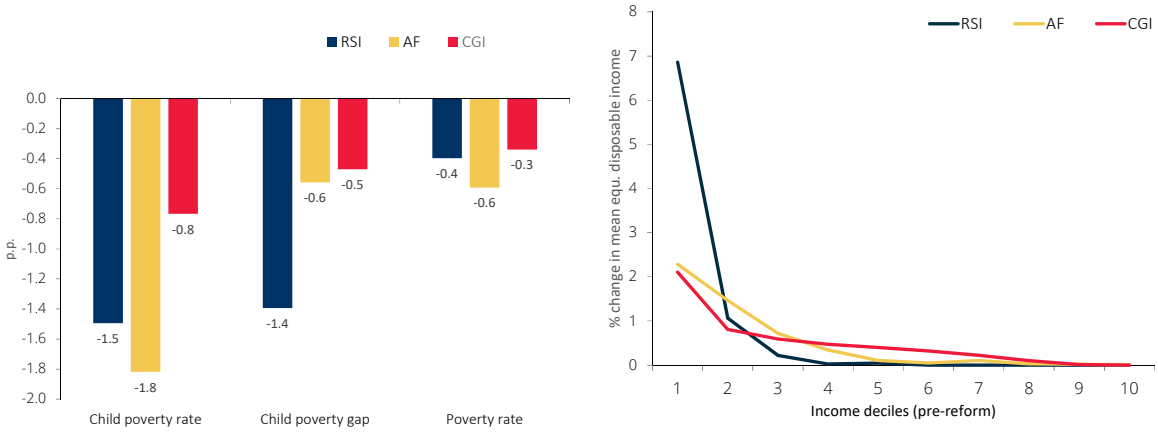
Taking into account the ambitious policy goals presented in the 2021 strategy to fight poverty, it is important to assess how the three fiscal instruments analysed in this paper could contribute to this goal. We implement a mechanical exercise that, for each of these instruments, changes the policy parameters more directly related to low or middle income families with children. The change of the parameters is calibrated in order to generate a budgetary cost for the government of 0.1% of GDP in each case. On the RSI, the child related component is increased from 94,83€ to 239.19€ per month. On the AF, all the amounts in the first and second brackets are multiplied by 1.4. Finally, the minimum amount per children considered in the refundable tax credit CGI increases from 600€ to 1316.64€ per year (each beneficiary of AF would receive this minimum amount as the sum of tax credit and AF). These scenarios are purely mechanical and designed only to discuss the impacts of simply scaling up each policy. In designing them, there was no intention to address their fairness across family types, a question which would obviously have to be considered by the policy maker[13].

Regarding the incidence of poverty, all the policies reduce this indicator and the AF is the most effective, leading to a reduction in the at-risk-of poverty rate of children by 1.8 p.p. The AF is also the policy with a stronger impact on the overall poverty rate. However, focusing on child poverty intensity, measured by the poverty gap, the RSI has a much higher impact, reducing the child poverty gap by more than twice the AF (Figure 5A). Although statistically significant, the changes to the at-risk-of-poverty rate are small in comparison with the medium term targets set in the national strategy to fight poverty. However, if we compare with the overall impacts of each policy simulated on the previous section, it is clear that these reforms substantially strengthen the role of the fiscal instruments in fighting child poverty.

The RSI reform gains are concentrated in very low incomes, lifting the household equivalised incomes of the first decile by 7%. This is consistent with the reform being particularly effective in alleviating poverty intensity. Although having a higher relative effect on incomes in the lowest decile, the other two reforms are also relevant up to the fourth decile, in the case of the AF, and up to the seventh decile, in the case of the CGI. For the CGI it is important to note that it has no impact on higher deciles because only households fulfilling the conditions to receive the AF are assumed to be eligible (Figure 5B).

When applying the efficiency measures presented in the previous section to the three policy changes in question, it is clear that the increase of the child component of RSI is the better targeted measure, as 88% of the income increase goes to previously poor households and 84% was strictly necessary for these households to become closer to the poverty line. The RSI also stands out as the policy with a higher effect on the poverty

13. For instance, the child related component of RSI is raised above the one currently set for the first adult in the household.



(A) Effects on poverty indicators (B) Effects by income decile

FIGURE 5: Effects of scaling up the policies by 0.1% of GDP

Source: Authors' calculations based on EUROMOD simulations and EU-SILC data.
Notes: Decile groups rank the individuals according to their equivalised disposable income in the baseline. The indicators were calculated with an anchored poverty line at the baseline scenario level. The poverty gap is based on FGT(1) the average normalised child poverty gap. The effects presented are not linear on the cost of the reform, meaning that an increase in the reform cost would not lead to a proportional change of its effects.

gap of families with children, reducing it by 28%. Only around half of the increase in the AF and a third of the change in the CGI go to previously poor families, and these policy changes reduce the poverty gap of households with children by around 12% and 11%, respectively (Table 2).

The main conclusions are robust to using an alternative equivalence scale which considers lower economies of scale, with slightly higher efficiency overall (Appendix B.1). Using a lower poverty line (40% of equivalised disposable income), the RSI becomes the most effective policy to reduce not only poverty intensity, but also its incidence, decreasing the poverty rate from 5% to 1.5%. The efficiency of policies is reduced, but the ranking remains, with the RSI being the most effective and efficient measure in reducing child poverty (Appendix B.2).

Acronym	Description	RSI	AF	CGI
VEE	% of additional income going to previously poor families	88%	47%	33%
PRE	% of additional income used to achieve (but not surpass) the poverty line	84%	45%	32%
PGE	% reduction in the poverty gap of families with children	28%	12%	11%

TABLE 2. Efficiency and effectiveness of the different policy changes

Source: Authors' calculations based on EUROMOD simulations and EU-SILC data.
Note: All calculations consider an anchored poverty line and take into account the equivalised disposable income.

4.2. A budget neutral scenario

All the simulations in the previous section have the same budgetary cost. Taking into account the pressure on public spending in different government areas and the need to ensure the sustainability of public finances, it is important to discuss the impacts of a budget neutral scenario. In these scenarios, the direct negative effects on public accounts are fully compensated by an alternative fiscal contractionary measure. There are many ways to ensure budget neutrality. We focus on the impacts of a change in middle and high PIT brackets, as an illustration of a potential distributional impact of budget neutral reforms. This choice is related to the ease of implementation in EUROMOD and the fact that it does not affect the lower part of the income distribution.

In order to ensure a budgetary revenue increase of around 0.1% of GDP, it would be necessary to multiply PIT marginal rates from the third bracket onwards by 1.02. For instance, the top PIT rate would have to increase from 48% to 49%. This increase would essentially penalize incomes of households from the eight decile onwards, reducing equivalised disposable income by a maximum of around 0.7% in the higher decile (Figure 6).

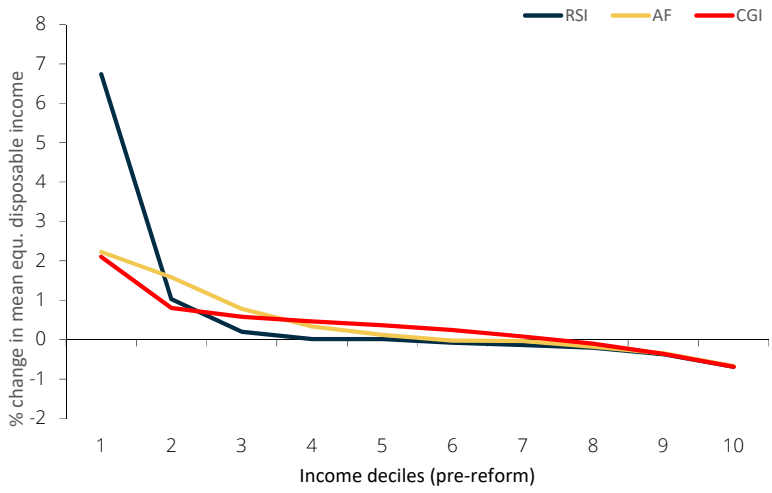


FIGURE 6: Distributional effects of ensuring budget neutrality through personal income taxation

Source: Authors' calculations based on EUROMOD simulations and EU-SILC data.
Notes: All calculations consider an anchored poverty line and take into account the equivalised disposable income.

4.3. Considering labour market incentives

In the context of the increase in the generosity of the policies analysed in this section, it is important to investigate potential incentives produced in the labour market, in terms of participation and working hours[14]. Tables 3 and 4 show the effects of scaling up the

14. The assessment of labour market incentives regarding the elimination of policies is not included in this analysis, since these were created with social objectives, encompassing other dimensions, sometimes more difficult to quantify, rather than the promotion of labour supply participation.

RSI, AF and CGI on the intensive (working hours) and extensive (labour participation) margins for employed individuals with children, by gender, type of household and across the quintiles of the income distribution.

As expected the increase in generosity would create a negative effect on labour supply, both in hours worked and in the participation on the labour market. However, these potential disincentives appear to be relatively small, in the case of the AF and CGI. For the RSI, they concentrate in single parents and in the first quintiles.

Reinforcing the RSI seems to be the policy change that generates the highest disincentives, with single women with children registering the highest negative effects, reducing their supply of hours by 4.5% and their participation in the labour market by 4.9%. The labour supply potential effects generated by scaling up the AF and CGI appear to be more modest, in general less than 1% both in terms of working hours and participation.

		Men				Women			
			Change from baseline				Change from baseline		
		Baseline	RSI	AF	CGI	Baseline	RSI	AF	CGI
Hours of work	In couple	37.7	-1.3%	-0.3%	-0.2%	31.1	-1.0%	-0.4%	-0.3%
	Single	39.9	-3.2%	-0.6%	0.0%	34.9	-4.5%	-0.4%	-0.5%
Participation	In couple	0.95	-1.4%	-0.3%	-0.2%	0.90	-1.4%	-0.4%	-0.3%
	Single	0.88	-4.0%	-0.6%	0.0%	0.85	-4.9%	-0.2%	-0.4%

TABLE 3. Labour supply changes of parents by gender and household type, for employees

Source: Authors' estimates based on EUROLAB.
Note: Children are defined as son-daughter of the decision-making unit. They are not older than 18 years, or if older, in education.

In distributional terms, we find that the highest potential disincentives are concentrated in the first and second quintiles of the income distribution and again for the RSI policy change, consistent with the targeting of this benefit. Similarly to the aggregate case, the size of the disincentives generated by increasing the AF and CGI is lower, but it is spread across the income quintiles, although the highest are registered in the first and second, again following the targeting of the policies.

In equilibrium terms, taking into account not only labour supply but also labour demand (with a demand elasticity of 0.5 with respect to wage) the aggregated effects on employment coming from the supply side are dampened for all the policy changes analysed, as shown in Table 5. The highest negative impact in equilibrium on the overall employment for employees amounts to -0.18%, leading to an increase in wage of 0.37%. In equilibrium, in the case of the RSI, inactivity[15] increases by 1.5% (1.8% if only the labour supply effect is considered).

These results must be interpreted with caution as they refer to the level of employment and not to their quality. Note that, in the case of current RSI beneficiaries,

15. In this context, the inactivity option includes both voluntary and involuntary unemployment alternatives.

		Men				Women			
			Change from baseline				Change from baseline		
	Quintiles	Baseline	RSI	AF	CGI	Baseline	RSI	AF	CGI
Hours of work	1	30.9	-4.0%	-0.7%	-0.3%	30.67	-2.7%	-0.2%	-0.3%
	2	34.0	-0.9%	-0.3%	-0.2%	33.42	-3.8%	-0.3%	-0.3%
	3	36.6	-0.1%	-0.1%	-0.1%	35.35	-1.8%	-0.1%	-0.2%
	4	38.7	0.0%	0.0%	-0.1%	36.57	-1.3%	-0.2%	-0.2%
	5	40.7	0.0%	0.0%	0.0%	36.45	-0.1%	0.0%	-0.1%
Participation	1	0.83	-4.2%	-0.6%	-0.3%	0.78	-3.7%	-0.1%	-0.2%
	2	0.91	-0.8%	-0.3%	-0.2%	0.85	-3.4%	-0.3%	-0.2%
	3	0.92	-0.1%	-0.1%	-0.1%	0.90	-1.6%	0.0%	-0.2%
	4	0.94	0.0%	0.0%	0.0%	0.89	-1.1%	-0.1%	-0.1%
	5	0.94	0.0%	0.0%	0.0%	0.87	-0.1%	0.0%	-0.1%

TABLE 4. Labour supply changes by gender and income quintiles, for employees

Source: Authors' estimates based on EUROLAB.
Note: Income quintiles are constructed based on equivalised disposable income under the baseline system.

	Labour supply effect			Partial equilibrium effect		
	RSI	AF	CGI	RSI	AF	CGI
Employment	-0.23%	0.06%	0.02%	-0.18%	0.05%	0.05%
Inactivity	1.83%	-0.45%	-0.26%	1.46%	-0.36%	-0.36%
Wages	-	-	-	0.37%	-0.09%	-0.09%

TABLE 5. Changes in employment, inactivity and wage

Source: Authors' estimates based on EUROLAB.
Note: For ease of computation, the aggregate effects presented in this table were estimated using a simplified tax function, as identification mechanism, which does not take into account all the features of the tax and benefit system embedded in EUROMOD. The equilibrium effects result from taking into account the labour supply changes and the reaction of labour demand to those changes, for all employees.

around half have not completed more than primary education (Gabinete de Estratégia e Planeamento (GEP) do Ministério do Trabalho Solidariedade e Segurança Social (MTSSS) 2019), and would most probably face challenging labour market integration. In any case this model does not take into account the fact that a significant fraction of the RSI beneficiaries follows a social integration contract containing labour market activation policies.

5. Concluding remarks

Fighting child poverty has been high on the political agenda in Portugal in recent years. This paper aims at contributing to inform the public debate on the role of social transfers and tax benefits to families in tackling child poverty taking into account their budgetary cost, efficiency targeting and labour market incentives.

We analyse the design of these policies, in particular how the amounts received depend on household composition, child age and parents gross wages. Two features of the family benefit stand out: the discontinuities on the level of transfers paid at the end of each bracket and the gap between transfers according to age. The first one could

be tackled with a budget neutral reform that creates a progressive reduction of the benefit in the levels of reference income around the brackets. This might be desirable to increase the benefit fairness, despite the increased complexity it would generate. As to the second feature, an additional convergence of the values paid to older children to the ones already paid for younger ones may increase the efficiency of this measure in fighting poverty. The recent decision to progressively phase-out family fees in some childcare facilities, especially if accompanied by an increase in availability, may reduce the difference between family costs of childcare and compulsory public education, possibly justifying a reduction of this gap.

Among the selected fiscal instruments analysed in the different scenarios, the RSI stands out as the most efficient measure to tackle child poverty, in particular, for the same cost, it better targets the poorest households and achieves a higher poverty intensity reduction. However, this benefit is currently endowed with a very low budget allocation, when compared with the AF and the DFD, and this reduces its effects on child poverty. Although the RSI is more effective in reducing poverty, its negative labour market effects are also more relevant, which favours the AF alternative. Negative labour market effects may be overestimated in this analysis which does not accounts for the effects of the social integration programmes, which could in any case be reinforced in their labour market activation component, in a context of a significant scale-up of this benefit.

In comparing different measures, take-up issues are also relevant, as benefits with more stringent means testing, as the RSI, tend to have lower take-up, compromising their coverage. This favours comparatively the AF, even more so if the recently announced plans to automatically pay this benefit are implemented.

Access to administrative data from the tax and benefit system could improve the accuracy of the analysis. Moreover, this data could also enable the implementation of quasi-experimental studies of the effects of the recent reforms, which can be a valuable input for policymaking. Furthermore, future research on the impact of inflation on the erosion of benefits could be an important piece of information to complement the findings of this paper. The inclusion of education and childcare parental costs in the estimates could facilitate a more comprehensive analysis of the age differentials currently embedded in the design of the AF and the DFD.

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Appendix A: Details on the uprating procedure and implementation of policy changes approved in 2022 in EUROMOD

In constructing the baseline scenario to assess the different policy changes analysed, we depart from the information from the EU-SILC 2020 dataset and the 2021 tax and benefit policies in EUROMOD (most recent policy system available for Portugal) and update them with information about the (projected) evolution of macroeconomic variables and announced policy changes in order to work with a tax and benefit system and data as close as possible to the ones we would face by the end of 2022.

The updating of the monetary variables in EU-SILC is applied by EUROMOD whenever the tax and benefit system is not contemporaneous of the EU-SILC dataset and is known as the uprating procedure. In our case, we uprated the EU-SILC dataset of 2020, whose income observations refer to 2019, to 2022, according to Banco de Portugal projections in June 2022 for macroeconomic variables such as the GDP, the CPI and public and private wages. The impacts of the uprating procedure on income and fiscal aggregates can be consulted in Table A.1 and the distributional impacts in Figure A.1. Pensions were updated according to the following bracket rule applied in 2022: (i) 1% for pensions until 886,40€ per month; (ii) 0.49% for pensions between 886,40 and 2659,20€ per month; (iii) 0.24% for pensions higher than 2659,20€/month; and (iv) no update for pensions higher than 5318,40€ per month. The extraordinary increase of lower pensions is not included in EUROMOD uprating mechanism and was not modelled for this paper, as its impact is deemed to be less relevant for assessing child poverty and family benefits. Nevertheless, it is worth to notice that the relatively small change observed in the first decile of the income distribution as presented in Figure A.1 can be related with the absence of the extraordinary pensions updates, as well as with the fact that the reference value for the RSI remains stable since 2019.

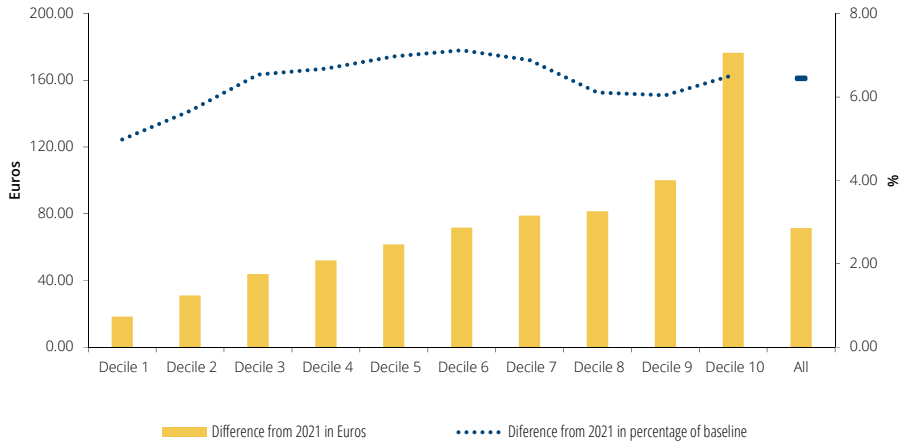

FIGURE A.1: Distributional effect of the uprating procedure

Source: Authors' calculations based on EUROMOD simulations and EU-SILC data, on June 2022 economic projections of Banco de Portugal, and on Social Security information on pensions.
Note: Decile groups rank the individuals according to their equivalised disposable income in the baseline.

	2021	Change in 2022	
	m.e.	m.e.	% baseline
Total market incomes	**87,090.94**	**9,064.14**	**10.4**
income from (self) employment	83,869.18	8,743.68	10.4
other sources	3,221.75	320.45	9.9
Government revenue from taxes and social contributions	**44,667.48**	**5,387.66**	**12.1**
direct taxes	17,528.27	2,630.69	15.0
employee social insurance contributions	8,284.48	844.06	10.2
self-employed social insurance contributions	967.75	90.51	9.4
Government expenditure on social transfers	**31,792.54**	**214.38**	**0.7**
by target group			
unemployment benefits	897.06	47.24	5.3
family and education benefits	1,238.81	-55.05	-4.4
social assistance and housing benefits	467.59	-25.45	-5.4
pensions, health and disability benefits	29,189.08	247.64	0.8
by benefit design			
means-tested non-pension benefits	1,399.82	-101.29	-7.2
non-means-tested non-pension benefits	1,759.95	132.95	7.6
pensions	28,632.77	182.71	0.6
Net fiscal impact	**12874.94**	**5173.28**	**40.2**

TABLE A.1. Budgetary effects of the uprating procedure

Source: Authors' calculations based on EUROMOD simulations and EU-SILC data, on June 2022 economic projections of Banco de Portugal, and on Social Security information on pensions.

On top of the uprating of monetary variables, we have also introduced the main tax and benefit policy changes approved in 2022. Although some of the changes would only have full effects as of 2023, they were fully implemented in the baseline. Regarding policies for families with children, we have introduced a minimum amount of 100€ per month of AF for children below an extreme poverty bracket set at 35% of the Social Support Index, a complementary transfer for families with children ensuring that, between the AF and the DFD, every family receives a minimum amount per child (600€ per year) and we have updated the AF the amounts according to Table A.2. In addition, we have implemented the announced changes in the personal income tax (PIT) schedules for 2022 and increased the tax deduction for the second child up to 6 years-old to 900€ a year. Finally, we updated the Social Support Index, from 438,81€ to 443,20€.

Bracket	Age	2021	2022	2023
1st	3 to 6 years old	49.95	50	50
	More than 6 years old	37.46	41	50
2nd	3 to 6 years old	41.23	50	50
	More than 6 years old	30.93	41	50

TABLE A.2. Changes in AF monthly amounts, in Euros

Source: Social Security and 2022 Portuguese State Budget.

Appendix B: Additional results

B.1. Using a different equivalence scale to compare households

As discussed in the introduction, the weight given to different household members in calculating household equivalised disposable income is not straightforward. We present our main results using the previous OECD equivalence scale, that considers lower economies of scale, attributing a higher weight to additional members of the household aged 14 or above (0.7 instead of 0.5) and to children lower than 14 years-old (0.5 instead of 0.3) than the OECD modified scale (Table B.1).

	Eliminating/Introducing policies				Scaling up policies		
Indicator	RSI	AF	DFD	All	RSI	AF	CGI
child poverty rate change (p.p.)	0.1	4.6	2.0	6.1	-1.1	-1.3	-0.7
child poverty gap change (p.p.)	0.8	2.6	0.4	4.0	-1.4	-0.7	-0.5
VEE (%)	100.0	40.9	5.0	27.1	94.3	52.8	37.0
PRE (%)	98.5	34.8	4.0	22.2	89.9	49.7	35.9
PGE (%)	13.1	24.8	4.4	32.7	24.9	12.8	10.8

TABLE B.1. Effects on poverty indicators using the original OECD equivalence scale

Source: Authors' calculations based on EUROMOD simulations and EU-SILC data.
Notes: All calculations consider an anchored poverty line and take into account the equivalised disposable income.

B.2. Defining a lower at-risk-of-poverty line

In order to assess the robustness of our findings to a different poverty line, we present the results setting the poverty line at 40% of the median equivalised income (instead of the 60% threshold used in the main results) in Table B.2.

	Eliminating/Introducing policies				Scaling up policies		
Indicator	RSI	AF	DFD	All	RSI	AF	CGI
child poverty rate change (p.p.)	0.6	3.8	0.3	4.1	-3.6	-0.5	-0.9
child poverty gap change (p.p.)	1.1	1.4	0.0	2.9	-0.7	-0.2	-0.3
VEE (%)	92.8	20.4	0.5	16.3	56.1	13.9	14.9
PRE (%)	87.7	15.5	0.3	13.8	33.8	13.2	13.3
PGE (%)	51.1	55.9	2.5	71.7	71.8	25.8	30.0

TABLE B.2. Effects on poverty indicators using the 40% poverty line

Source: Authors' calculations based on EUROMOD simulations and EU-SILC data.
Notes: All calculations consider an anchored poverty line and take into account the equivalised disposable income.

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Banco de Portugal Economic Studies, Vol. VIII, No. 4

Non-technical summary

October 2022

A multidimensional poverty indicator for Portugal

Nuno Alves

Poverty is a multifaceted reality. In recent decades, the economic literature has presented indicators that aim to capture the different dimensions of living in poverty or in social exclusion. This article develops a multidimensional poverty indicator applied to Portugal, based on the methodology of Alkire and Foster (2011). Taking into account information from the Statistics on Income and Living Conditions, conducted by Statistics Portugal, the indicator aggregates 21 variables that reflect situations of deprivation and social exclusion, including dimensions such as labor market participation, education, material deprivation, social deprivation, health and housing.

In 2020, the proportion of the population in multidimensional poverty, defined as those individuals deprived of at least five of the 21 variables analyzed, stood at 15.4%. The individuals in severe multidimensional poverty, that is, those deprived of at least eight of the variables, corresponded to 5.8% of the population. The multidimensional poverty rate declined continuously between 2014 and 2020 (Figure 1). In the European context, Portugal stands at an intermediate position, with a multidimensional poverty rate close to that of Belgium, France and Italy, lower than that of Spain and Greece, and higher than that of Germany, Finland and the Netherlands.

This multidimensional approach identifies individuals who are not captured in the usual poverty and social exclusion indicators. These segments of the population have particularly adverse living conditions and a low degree of subjective well-being. In this sense, there is informative value in adopting a multidimensional approach in the analysis of poverty. This conclusion also reinforces the importance of designing policies that seek to act on the various dimensions of poverty in Portugal.

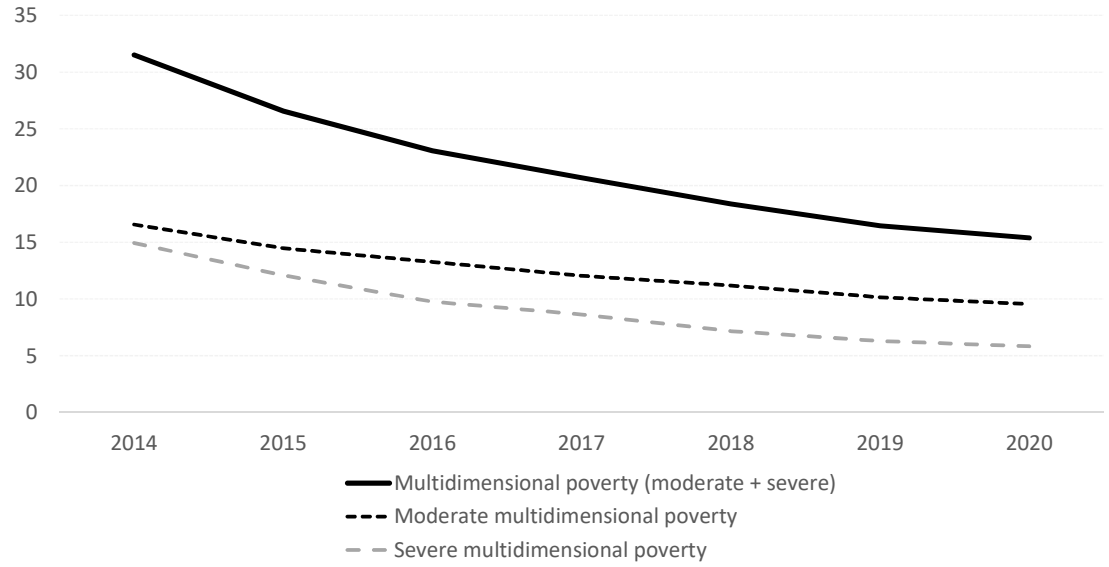

FIGURE 1: Evolution of the multidimensional poverty rate in Portugal (% of the population)

Note: The individuals living in multidimensional poverty are deprived of at least five of the 21 variables included in the analysis. The individuals in severe multidimensional poverty are deprived of at least eight of the variables.

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A multidimensional poverty indicator for Portugal

Nuno Alves
Banco de Portugal

October 2022

Abstract
This article proposes a multidimensional poverty indicator applied to Portugal, based on the methodology of Alkire and Foster (2011). The indicator aggregates 21 variables that cover dimensions such as participation in the labor market, education, material deprivation, social deprivation, health and housing. According to this methodology, multidimensional poverty in Portugal has declined continuously since 2014. In 2020, the proportion of the population in multidimensional poverty was 15.4% (5.8% in severe poverty). A multidimensional approach allows identifying individuals who are not included in the usual indicators of poverty and social exclusion in Portugal. These segments of the population have particularly adverse living conditions and a low degree of subjective well-being. (JEL: I31, I32)

"Peace, the bread
housing
health, education"
[own translation]
Liberdade (Freedom) (1974), Sérgio Godinho

1. Introduction

Poverty has a multifaceted nature. Everyday reality shows how the trajectories and experiences of people in poverty have multiple dimensions. In 1984, the Council of the European Union defined the poor as "persons, families and groups of persons whose resources (material, cultural and social) are so limited as to exclude them from a minimal acceptable way of life in the Member State in which they live" (Council, 1985). This definition is both absolute (the exclusion of an acceptable way of life) and relative (since the assessment depends on the reality of each country). Additionally, it considers that deprivation of both monetary and non-monetary resources is at the

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E-mail: njalves@bportugal.pt

root of exclusion. This complexity has been gradually incorporated into the European statistical system, with the progressive inclusion of new indicators aiming to encompass the different faces of poverty (Fusco et al., 2010 and Guio et al., 2012). This is ongoing work (Aaberge and Brandolini, 2015).

In order to complement the traditional measures of poverty and social exclusion in the European Union, several multidimensional indicators were proposed in recent years (see, for example, Nolan and Whelan, 2010, Whelan et al., 2014, Alkire and Apablaza, 2017, Alkire et al., 2021). This article contributes to this literature and presents a new multidimensional poverty indicator, which is applied to the Portuguese economy. This indicator encompasses dimensions such as participation in the labor market, material deprivation, social deprivation, health and housing. Individuals identified as poor in this multidimensional perspective do not coincide with those identified in the standard indicators used in the European Union. In this sense, there is value in adopting a multidimensional perspective in the analysis of poverty. This conclusion also reinforces the importance of designing policies that seek to act on the various dimensions of poverty in Portugal. This multidimensional approach thus complements recently published analyses for understanding poverty in Portugal, of a quantitative and qualitative nature (see, for example, Rodrigues et al., 2016, and Diogo et al., 2021).

The article is organised as follows. Section 2 presents a brief analysis of the poverty indicators commonly used in the European Union. Section 3 describes the database and the variables used in defining multidimensional poverty. Section 4 presents the Alkire and Foster's (2011) methodology for building a multidimensional poverty indicator and applies it to the Portuguese reality. Section 5 presents a socio-economic characterization of individuals experiencing multidimensional poverty and section 6 describes some representative indicators of their living conditions. Section 7 presents the main conclusions of the article.

2. An analysis of the main poverty and social exclusion indicators in the European Union

The main indicator for monitoring poverty and social exclusion in the European Union is the population at risk of poverty or social exclusion (abbreviated as AROPE). This is an aggregate indicator, made up of three sub-indicators:

- The population at risk of poverty (AROP), which corresponds to the population whose equivalised disposable income[1] is below the poverty line, defined as 60% of the median equivalised disposable income in the country.

1. Equivalised income is obtained dividing total household income by the number of "equivalent adults", using the OECD modified equivalised scale. Here, the first adult has a weight of 1.0, the remaining adults have a weight of 0.5 and children until the age of 14 get a weight of 0.3. For example, in case of a household with two adults and two children, the household income would be divided by 2.1. This equivalised income would then be attributed to each household member.

- The population in severe material and social deprivation, which, in the new definition adopted in 2021, corresponds to the population experiencing an enforced lack of at least seven of the following thirteen items: a) Capacity to face unexpected expenses (without resorting to a loan); b) Capacity to afford paying one week of vacation, per year, away from home; c) Capacity to avoid arrears; d) Capacity to have an adequate diet; e) Ability to keep the home adequately heated; f) Have access to a car; g) Replace worn-out furniture; h) Replace worn-out clothes; i) Have two pairs of properly fitting shoes; j) Spend a small amount of money each week on him/herself; k) Participate regularly in leisure activities; l) Meet friends/family for a drink/meal at least once a month; m) Have an internet connection.
- Population living in households with very low per capita work intensity: persons under the age of 65 who, in the income reference period, lived in households in which the persons aged 18 to 64 reported having worked, on average, less than 20% of their total work-time potential (excluding students and retirees).

A person is at risk of poverty or social exclusion if she meets at least one of the conditions described above, that is, if she lives at risk of poverty or in severe material and social deprivation or in households with very low per capita work intensity. Figure 1 shows the distribution of the population at risk of poverty or social exclusion in Portugal in 2020. These figures were calculated with data from the Survey on Income and Living Conditions of Households (INE, 2021). The figure highlights several important traits, which are also observed in other European countries (see Rodrigues and Andrade, 2010 and Fusco et al., 2010). Firstly, the results calculated with the union of the three sub-indicators are radically different from those that would be obtained with their intersection. In the Portuguese case, in 2020, around 2 million individuals were at risk of poverty or social exclusion, but less than 100,000 lived in households where the three sub-indicators were simultaneously observed. Second, individuals at risk of poverty constitute the vast majority of those at risk of poverty or social exclusion. In the Portuguese case, more than 1.2 million individuals were at risk of poverty without experiencing severe material and social deprivation or low work intensity. Third, a significant fraction of individuals experiencing severe material and social deprivation do not live either at risk of poverty or in households with low work intensity. In Portugal, this fraction amounts to 42%.

This low intersection between the three poverty indicators is related to several factors (see Perry, 2002 and Fusco et al., 2010). First, monetary income may not reflect the true capability of individuals to have access to economic resources or to translate those resources into a full participation in the life of society (Sen, 1983). The existence of past savings, access to non-monetary sources of income or the possibility of resorting to loans or support from family and friends limit the contemporary relationship between low income and material deprivation. Second, while the information on material and social deprivation refers to the year of the survey, data on household income and work intensity refer to the year prior to the survey, so they do not necessarily reflect the contemporaneous situation of individuals. This lag is important as there are significant transitions to and from poverty or deprivation. On average in the European Union,

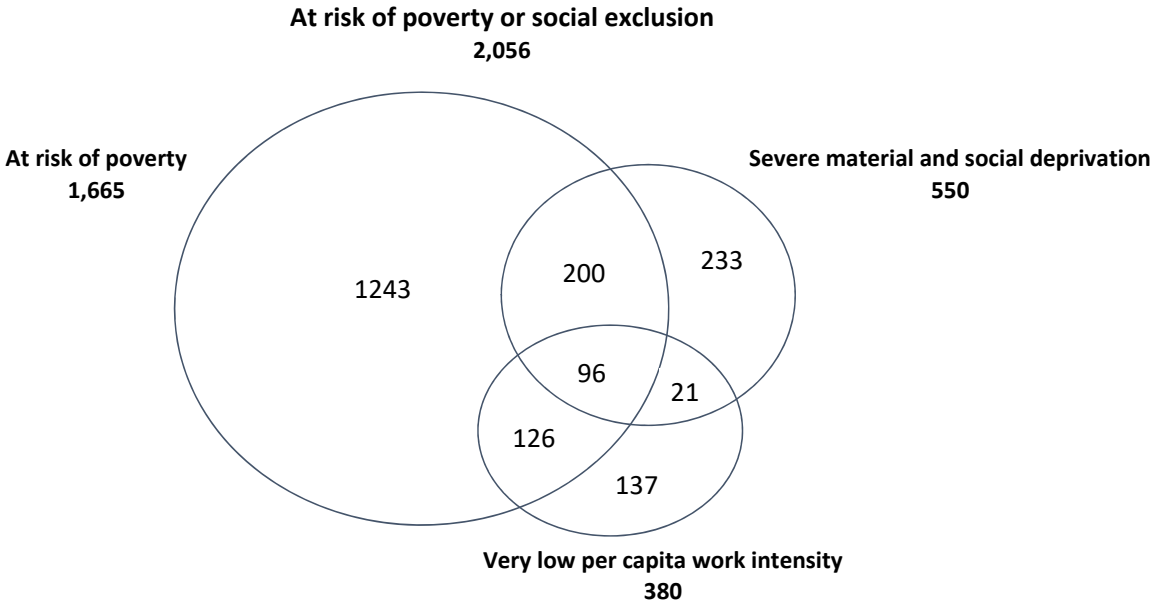

FIGURE 1: Breakdown of the population at risk of poverty or social exclusion (Portugal, 2020). Thousands of individuals.

Source: Eurostat.
Note: The size of the circles is merely illustrative and is not drawn to scale.

only around 30% of individuals who are at risk of poverty in a given year remain at poverty for four years. A similar percentage is recorded for individuals in severe material deprivation (Alkire et al., 2021). Third, there are known measurement errors in the reporting of monetary earnings, namely at the extremes of the distribution (Fusco et al., 2010). At the same time, the assessment of deprivation is anchored on subjective perceptions, which can be biased, particularly in case of very persistent deprivation situations. The combination of these measurement errors in the various indicators can contribute to the low overlap between them.

Finally, it is important to mention that the at-risk-of-poverty indicator has an eminently relative nature, that is, an individual is explicitly compared with the median of the income distribution in the respective country. In this sense, it fails to explicitly capture situations of deprivation or exclusion, which are more related to permanent income and the ability to translate that income into an effective participation in the life of society. These situations of absolute deprivation tend to be more reliably captured by the indicator of severe material and social deprivation (for a discussion of the relationship between absolute and relative concepts of poverty, see Sen, 1983).

3. A multidimensional approach based on EU-SILC information

The risk of poverty or social exclusion indicator is calculated with the union of the three sub-indicators that compose it. It thus aggregates individuals with very different situations of deprivation and exclusion. Additionally, it does not cover several

dimensions of households' living conditions whose importance is unquestionable. Some of these dimensions are present in the European Union Statistics on Income and Living Conditions (EU-SILC) database, which is used to calculate poverty and inequality statistics in the European Union. This database aggregates, at a European level, the various surveys conducted by national statistical institutes (in the Portuguese case, the *Inquérito às Condições de Vida e Rendimento das Famílias*, ICOR,[2] conducted by INE). The wealth of information available in the EU-SILC survey creates an opportunity to complement the current indicators with a multidimensional analysis of a broader scope.

Table 1 presents the 21 variables used in this article to calculate the multidimensional poverty indicators. The choice of variables is anchored in the information available in EU-SILC and seeks to encompass dimensions whose deprivation corresponds to an effective exclusion in the Portuguese society. For each variable, a criterion was defined to determine the individuals who are in a situation of deprivation, inspired by the literature and the categorization available in the database. Taken in isolation these variables do not necessarily reflect poverty situations; it is the combination of a significant number of deprivations that will make it possible to identify individuals in multidimensional poverty. For ease of exposition, the indicators were aggregated into 5 dimensions: (i) labor market participation, (ii) material deprivation, (iii) social deprivation, (iv) health and (v) housing. These dimensions are interdependent and therefore should not be considered in isolation. The microeconomic data that allow these calculations are available for the period 2014-2020. Table 1 includes, in the last column, the percentage of individuals in a situation of deprivation in each of the variables in 2020.

Participation in the labor market is an important dimension determining a situation of multidimensional poverty, not only for the dignity that this participation confers to each individual, but also for the potential to generate monetary income, essential for a full participation in the life of society. This dimension includes the (in)ability to work associated with health limitations, the prevalence of unemployment situations in a household (with more than half of the adults in this condition) and the individual's level of education. For the definition of exclusion associated with education, the broad criterion used was the completion of compulsory education prevailing at the time the individual was of school age. Unfortunately, the information in the database does not allow the identification of individuals with 6 completed years of schooling, which limits the application of this criterion to a significant part of the population, given that this was the compulsory schooling prevailing between 1964 and 1985. In these cases, a strict version of exclusion was chosen, considering that completion of primary education would be a sufficient indicator of non-exclusion. Even under this strict view, around 10% of the population is identified as being deprived of education in 2020.

In the case of material deprivation, almost all of the indicators are already present in the official indicator of material and social deprivation. It should be noted that, in all cases, material deprivation explicitly results from an enforced lack, not being

2. In 2020, the ICOR surveyed 11367 households, corresponding to 27698 persons, whose results can be extrapolated to the population as a whole through survey weights.

Domain		Indicator	Deprivation criteria	% of deprived population in 2020
Labor market participation	(1)	Ability to work	The individual spent 12 months (in the previous year) unable to work due to long-standing health problems	1.5
	(2)	Unemployed households	Households where more than half of the adults are in unemployment	3.6
	(3)	Education	Individual between 17 and 19 years-old only with primary school, between 20-29 only with lower secondary, between 30-49 only with primary school and over 49 without primary school completed.	10.2
Labor market participation	(4)	Capacity to face unexpected expenses	Without capacity to face unexpected expenses amounting to the poverty line (without taking a loan)	30.7
	(5)	Capacity to afford paying holidays away from home	Without capacity to afford paying for one week annual holiday away from home, supporting all expenses for all household members	38.0
	(6)	Capacity to being confronted with payment arrears	Arrears on mortgage or rental payments, utility bills, hire purchase instalments or other loan payments, due to economic difficulties.	5.4
	(7)	Food	Without capacity to afford a meal with meat, chicken, fish or vegetarian equivalent every second day	2.5
	(8)	Own car	Without capacity to afford access a car/van for personal use	4.4
	(9)	Clothing and footwear	Without capacity to afford replacing worn-out clothes by some new ones or having two pairs of properly fitting shoes	8.5
	(10)	Computer	Without capacity to afford a computer	5.8
Social deprivation	(11)	Spending a small amount of money each week on him/herself	Without capacity to afford spending a small amount of money each week on him/herself	10.5
	(12)	Having regular leisure activities	Without capacity to afford having regular leisure activities	11.1
	(13)	Getting together with friends/family	Without capacity to afford getting together with friends/family for a drink/meal at least once a month	7.7
	(14)	Having internet connection at home	Without capacity to afford having internet connection	3.5
Health	(15)	General health	Self-perceived general health is "very bad"	3.0
	(16)	Limitation in activities because of health problems	"Severe limitations" in activities beacause of health problems	7.6
	(17)	Unmet medical or dentist examination	Unmet medical or dentist examination because "could not afford to"	8.4
Housing	(18)	Warm home	Without capacity to afford keeping home adequately warm	17.4
	(19)	Pollution	Existence of pollution, grime or other environmental problems in the neighborhood	13.2
	(20)	Crime	Existence of crime, violence or vandalism in the neighborhood	6.6
	(21)	Overcrowding	Overcrowded household (Eurostat definition)	8.9

TABLE 1. Variables used in the computation of the multidimensional poverty indicator
Source: Calculations based on ICOR 2020.

associated with a free choice of individuals. This dimension includes the inability to pay an unexpected expense (an amount close to the monthly monetary poverty line), the inability to pay for a week's vacation away from home, the inability to meet financial commitments, the inability to have adequate food, the unavailability of an own car, the inability to replace clothing or footwear (in this case aggregating these two variables of the official Eurostat deprivation indicator) and deprivation of a computer due to economic difficulties (this being the only variable not included in the official indicator). With regard to the social deprivation dimension, the indicators used are also found in the material and social deprivation indicator calculated by Eurostat. Specifically, social deprivation is measured based on the ability to spend a small amount of money each week, participating in leisure activities, being able to meet regularly with friends and family and having access to the internet at home. In all these cases, once again, deprivation must result from financial reasons and not from an unrestricted choice.

Limitations in health are fundamental as they condition an individual's full participation in society (Sen, 1983). In this dimension, the indicators analysed are the

global perception of health (with deprivation identified only in cases where perceived health is "very bad"), the existence of strong limitations to the development of daily activities for health reasons and the lack of access to medical or dental care due to financial reasons. Finally, in the housing dimension, deprivation is associated with the inability to keep the house adequately warm – an indicator also present in the calculation of material and social deprivation –, the existence of pollution or crime problems in the area where the household lives, and overcrowding, defined on the basis of Eurostat criteria.

The individual information from the EU-SILC survey only covers the population aged 16 and over. Thus, in the case of variables that focus on the household as a whole, the situation of the household was applied to all members, regardless of age. In the case of individual-related deprivation indicators, children under the age of 16 in a given household were considered to be deprived if more than half of the individuals aged 16 and over in the household were deprived.[3]

A conspicuous absence from the list of indicators in Table 1 is a variable that explicitly reflects the family's monetary income. This absence contrasts with most studies on multidimensional poverty and with the official indicator of poverty and social exclusion in the European Union described in Figure 1.[4] This choice is anchored in three main arguments. Firstly, if monetary income is a source of exclusion for individuals, this fact is already reflected in most of the indicators described above. Note that the deprivation reported by individuals is always due to financial constraints. In this sense, monetary income is already explicitly considered in the analysis. If low income does not translate into a situation of exclusion - for example because it is temporary or due to past savings or the existence of non-monetary income - then the level of income should not be reflected in the multidimensional poverty indicator. Secondly, as mentioned above, monetary income is observed with a time lag compared to the deprivation indicators described in Table 1. In this sense, the multidimensional indicator resulting from the aggregation of the 21 variables will more reliably reflect the situation of individuals in the year of the inquiry. Thirdly, including the level of monetary income would raise questions about the appropriate income threshold to consider. The poverty line used in official statistics is tied to the evolution of median income, which may not reflect the evolution of situations of deprivation and exclusion in the population.

3. The exceptions to this rule were indicators (1) and (15), referring to the individual's inability to work and global health perception. The results of these indicators were not extrapolated to children.

4. All qualitative results reported in the following sections would be robust to the inclusion of a 22nd indicator, corresponding to individuals identified as being at risk of poverty according to the Eurostat definition. In quantitative terms, the changes would not be substantial. These results are made available by the author upon request.

4. A multidimensional poverty indicator for Portugal, based on Alkire and Foster (2011)

Equipped with a set of indicators that portray various facets of poverty, the question that arises is how to coherently combine these different variables in an aggregate indicator (see Aaberge and Brandolini, 2015). A direct solution would be to adopt a criterion of union or intersection of the indicators, that is, to assess how many individuals are deprived of at least one indicator and how many individuals are deprived of all indicators (Atkinson, 2003). However, as is well known, these criteria result in implausible levels of multidimensional poverty rates. For Portugal, in 2020, the union criterion calculated based on the 21 indicators would identify 64% of the population as poor, while the intersection criterion would identify 0% of the population as poor.

In this context, an appealing solution for the calculation of multidimensional poverty indicators is the methodology proposed by Alkire and Foster (2011). This methodology has a lot of flexibility and allows exogenously defining the cut-offs from which an individual is considered to be in deprivation (for each variable) and in multidimensional poverty (for the full set of variables).

The methodology will be briefly presented here (for a formal description, see Alkire and Foster, 2011a). Starting from a set of variables that describe the domains of deprivation, it is first necessary to define the cut-offs that determine, for each variable, whether an individual is in deprivation. Table 1 describes in the third column the cut-offs adopted in this article for each of the 21 variables. Then, for each variable, a value of 1 or 0 is assigned to each individual, reflecting whether or not the individual is deprived. These values are summed for each individual, weighting the different variables with a set of appropriate weights. Here, in line with most of the literature, each of the 21 variables will be weighted equally (below it will be shown that the results are robust to alternative formulations of these vectors of weights). If that sum exceeds a certain cut-off, designated k, the individual is considered to be poor. The proposed multidimensional poverty indicator is called M_0 and results from the product of two scalars: (i) the proportion of individuals who are multidimensional poor (H) and (ii) the average deprivation share of those individuals. The indicator satisfies several desirable axiomatic properties, as demonstrated in Alkire and Foster (2011).[5]

To implement the methodology, four elements are thus necessary: (i) the list of variables that make up the multidimensional poverty indicator; (ii) the cut-offs that define, for each variable, whether an individual is in deprivation; (iii) the weights used to weight the different indicators; (iv) the cut-off k that determines whether a given individual lives in a situation of poverty.

Figure 2 presents the multidimensional poverty indicator M_0 for different values of k, for three years: 2014, 2017 and 2020.[6] Figure 3 presents, for each of the years,

5. The indicator M_0 satisfies, among others, the following axioms: replication invariance, symmetry, poverty focus, deprivation focus, weak monotonicity, normalisation and subgroup decomposability (see Alkire and Foster, 2011).

6. The calculations were implemented with the command mpi in Stata (see Pacifico and Pöge, 2015).

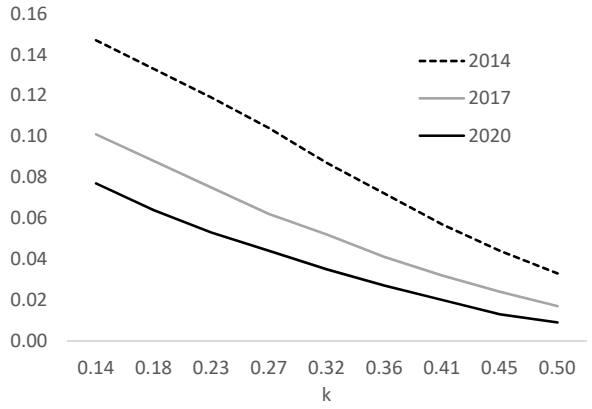

FIGURE 2: M_0 for different poverty cut-offs k

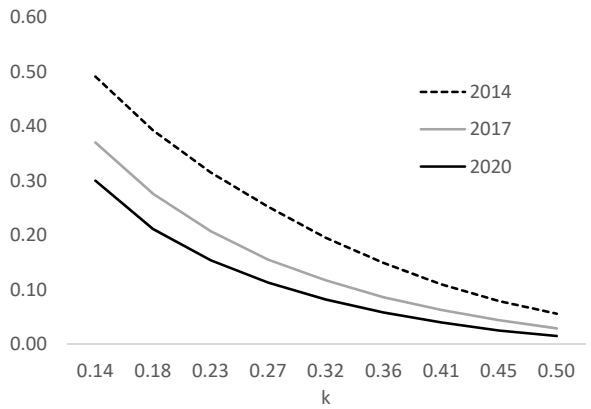

FIGURE 3: Multidimensional poverty rate (H) for different poverty cut-offs k

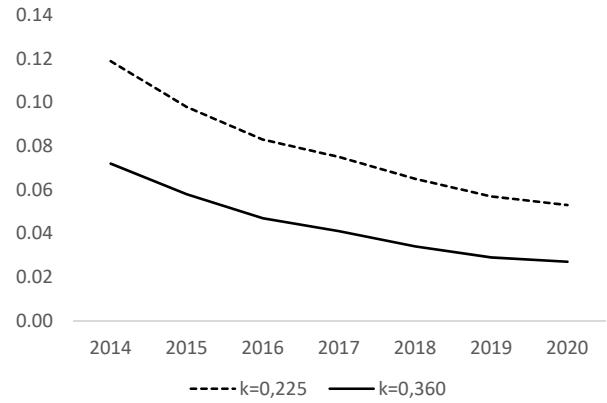

FIGURE 4: Evolution of M_0 for two selected poverty cut-offs k

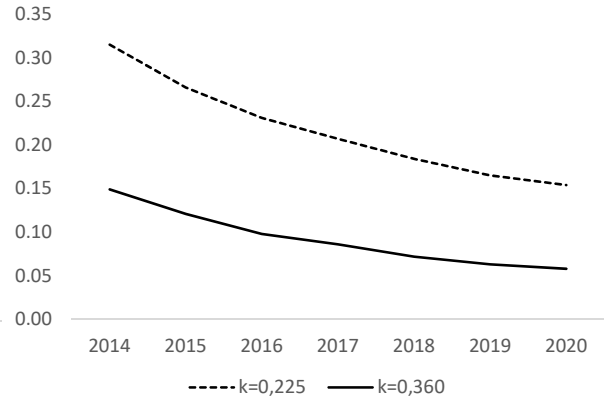

FIGURE 5: Evolution of the poverty rate (H) for two selected poverty cut-offs k

Source: Calculations based on ICOR data.
Notes: M_0 is the multidimensional poverty indicator, based on the methodology of Alkire and Foster (2011). H is the proportion of individuals living in multidimensional poverty. k is the cut-off beyond which an individual is considered poor in multidimensional terms.

the proportion of individuals living in multidimensional poverty (H), which can be called the multidimensional poverty rate. To guide the reading of these figures, we can take the cut-off k=0.32 as an illustration. This cut-off implies that individuals with an accumulated sum of deprivations (weighted with equal weights) greater than 0.32 would be identified as poor. In 2014, with this cut-off, the multidimensional poverty index was 0.087 and about 19.5% of the population would be identified as living in multidimensional poverty. By 2020, these values had dropped to 0.035 and 8.2%, respectively. Looking at all the information in the different curves, it can be concluded that there was an unambiguous decrease in multidimensional poverty in Portugal between 2014 and 2020, regardless of the poverty cut-off used.

Figure 4 shows the evolution of the M_0 indicator for two selected k cut-offs, equal to 0.225 and 0.360. In the base version with identical weights for each of the 21 variables, these thresholds correspond to identifying as poor those individuals with at least 5

deprivations or at least 8 deprivations, respectively.[7] This calibration will be useful for the exercises developed in the next section of this article. The figure reinforces the conclusion that multidimensional poverty decreased continuously from 2014 to 2020. This profile was observed not only in the multidimensional poverty indicator but also in the associated poverty rate (Figure 5). This improvement was not concentrated in a subset of variables. In fact, over this period, there was a decline in the percentage of the population in deprivation in all 21 variables that make up the indicator.

Since the multidimensional poverty indicator is decomposable, it is possible to verify the most relevant dimensions determining multidimensional poverty. In 2020, for k=0.225, the contributions of each of the dimensions described in Table 1 to determine multidimensional poverty were the following:[8] participation in the labor market (6%), material deprivation (43%), social deprivation (22%), health (10%), housing (19%). These relative contributions have not changed substantially since 2014. This result confirms that the material and social deprivation indicators used by Eurostat represent the largest contributions to the identification of situations of multidimensional poverty, which is also not surprising because they correspond to the majority of the variables in the analysis. Nevertheless, the remaining indicators also present non-negligible contributions, which suggests there is added value in expanding the conceptual scope of the official indicator of material and social deprivation.

The M_0 indicator can also be used to make international comparisons of multidimensional poverty in the European Union. This assessment should be carried out with some caution, given that the calibration of some variables – for example the one relating to education – explicitly took into account the Portuguese reality and does not necessarily reflect the norm in other countries. Within the framework of the methodological options adopted, it is possible to assess whether there is a clear dominance in the different measures of poverty among the various countries. Figures 6 and 7 show the results for selected euro area countries.[9] In this set of countries, Greece stands out with the highest multidimensional poverty and Spain also presents relatively high figures. At the opposite extreme are Finland, the Netherlands and Germany. Portugal is in an intermediate position, with levels of multidimensional poverty similar to Italy, France and Belgium. This grouping of countries is consistent with that obtained in the official indicators of poverty or social exclusion. Note that in some cases there is no clear dominance in the distributions. For example, compared with Belgium, the multidimensional poverty indicator in Portugal is higher for low values of k and lower for values of k greater than 0.35.

An important issue when computing multidimensional poverty indicators is the way in which the different variables are weighted. In a sense, this weighting corresponds to the relative value assigned to each of the variables in determining a situation of multidimensional poverty. The difficulty in defining these weights is particularly strong

7. Note that, in the first case, 4/21=0.190 and 5/21=0.238. In the second case 7/21=0.333 and 8/21=0.381.

8. These percentages are very close for different values of k.

9. The results for Germany and Italy refer to 2019, which is the last year for which the microeconomic data are currently available.

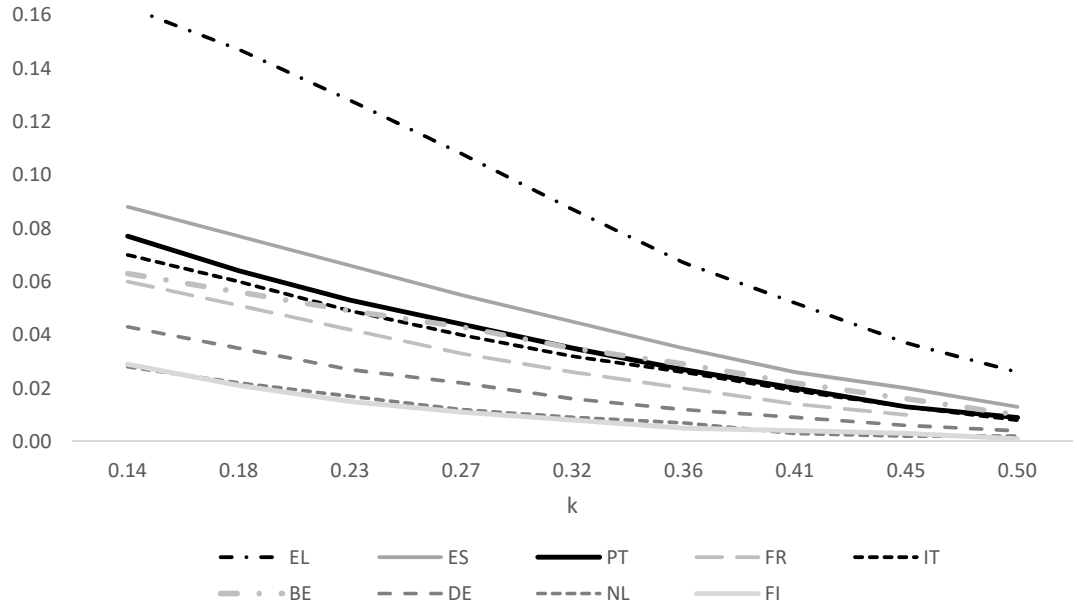

FIGURE 6: M_0 for different poverty cut-offs k

Notes: Calculations based on EU-SILC data. M_0 is the multidimensional poverty indicator, based on the methodology of Alkire and Foster (2011). H is the proportion of individuals living in multidimensional poverty. k is the cut-off beyond which an individual is considered poor in multidimensional terms.

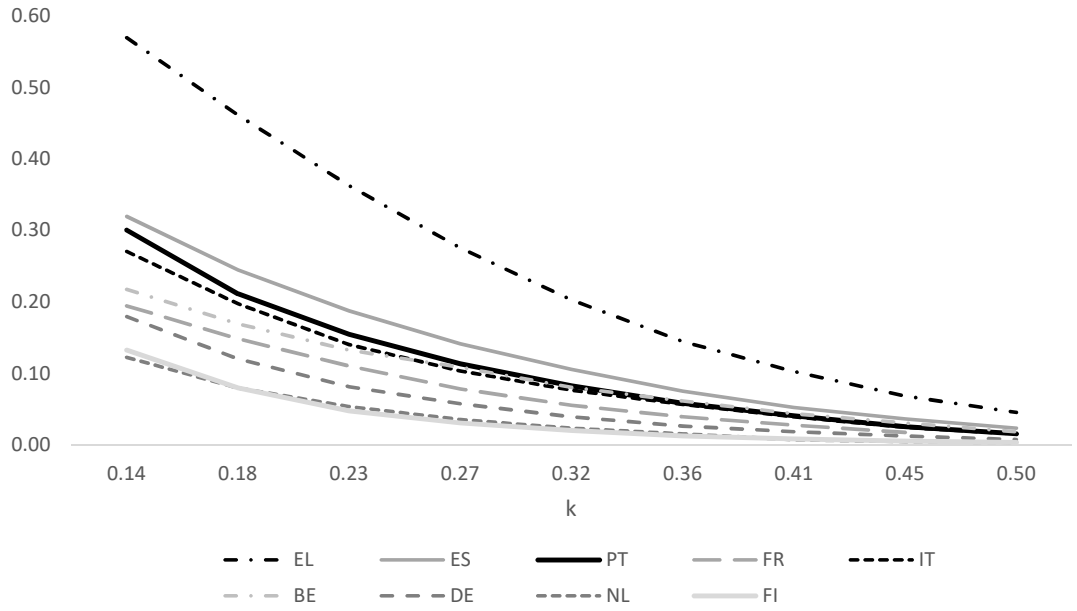

FIGURE 7: Multidimensional poverty rate (H) for different poverty cut-offs k

Notes: Calculations based on EU-SILC data. M_0 is the multidimensional poverty indicator, based on the methodology of Alkire and Foster (2011). H is the proportion of individuals living in multidimensional poverty. k is the cut-off beyond which an individual is considered poor in multidimensional terms.

when the dimensions are very heterogeneous (for example, when we want to value in relative terms variables referring to the individual's health and variables referring to the participation in the labor market). Additionally, the fact that there is an interconnection – direct or indirect – between the various deprivations makes this exercise of relative weighting very subjective. These difficulties underlie the usual option of assigning the same weight to all the variables that make up the multidimensional poverty indicators.

Even so, several authors use different vectors of weights, with three main options proposed in the literature. A first option is to assign identical weights to each of the dimensions identified in Table 1. In this case, each of the 5 dimensions would have a weight of 0.2 in the computation of the indicator and each of the indicators within each dimension would have an identical weight (this is for example the approach in Alkire and Apablaza, 2017). In our analysis, this solution avoids any bias that may arise from the fact that the number of material deprivation indicators is higher than the number of indicators in the other dimensions. However, this type of weighting is debatable considering that all dimensions contribute in an interconnected way to situations of multidimensional poverty. A second option is to weight each of the indicators inversely with their prevalence in the population. The idea here is to give greater weight to the rarer facets of deprivation which, in this sense, may be more relevant to the identification of true deprivation and exclusion situations. A third option is to assign weights taking into account how society perceives the different deprivations (Guio et al., 2009 and Dickes et al., 2010). Unfortunately, there are no surveys that allow this latter solution to be implemented here, given the large scope of the indicators used in the current analysis.

In order to assess the robustness of the results, we evaluated whether a different choice of weights alters the set of individuals identified as poor. Specifically, we started from the baseline methodology, with equal weights for all indicators, and identified the multidimensional poor for a given value of k. Then, we calculated the same percentage of poor individuals using two alternative weighting methods: (i) identical weights for each deprivation dimension and (ii) weights inversely proportional to the population frequency. Finally, we assessed the concordance across vectors of weights, that is, whether they identify the same individuals as being poor or not poor. The procedure was repeated for several plausible levels of k. The conclusion of this exercise is that the different vectors of weights basically identify the same individuals as poor and non-poor. The level of agreement is typically greater than 98% and, in various combinations, greater than 99%. This conclusion supports the adoption, in the next section, of a procedure in which identical weights are assigned to all variables.

5. A characterization of multidimensional poverty in Portugal

This section seeks to characterize the individuals classified as poor in Portugal in a multidimensional perspective. Who are these poor? What are their socioeconomic characteristics? Are they significantly different from the population at risk of poverty or social exclusion?

Number of deprivations	% of the population	Cumulative % of the population	Taxonomy
0	35.9	35.9	
1	21.3	57.2	
2	12.9	70.1	
3	8.9	78.9	
4	5.7	84.6	
5	4.1	88.7	**Moderate multidimensional poverty**
6	3.1	91.8	
7	2.4	94.2	
8	1.8	96.0	
9	1.5	97.5	
10	1.0	98.5	**Severe multidimensional poverty**
11	0.7	99.1	
12	0.4	99.5	
13	0.2	99.8	
14	0.1	99.9	
15	0.1	100.0	
16	0.0	100.0	
17	0.0	100.0	

TABLE 2. Breakdown of the Portuguese population, by degree of multidimensional poverty (2020)

Source: Calculations based on ICOR 2020.
Note: In 2020, there were no individuals with at least 18 deprivations simultaneously.

The focus thus shifts to the individuals in poverty. Here, it is important to recall the result obtained in the last section that the computation of multidimensional poverty with a vector of identical weights for the different deprivations broadly identifies the same individuals vis-à-vis other plausible weighting methods. This allows us to move directly from the threshold k of the methodology proposed by Alkire and Foster (2011) to the number of deprivations experienced by each individual. For example, in a database with 21 indicators, all k's greater than 0.190 (=4/21) and lower than 0.238 (=5/21) correspond to identifying as poor those individuals deprived of at least 5 indicators.

In the space defined by the number of deprivations experienced by each person, it is still necessary to define the number of deprivations above which an individual is identified as multidimensional poor. In this article, we propose a breakdown of multidimensional poverty into two groups, according to the number of deprivation indicators: the population living in moderate multidimensional poverty (between 5 and 7 deprivation indicators) and the population living in severe multidimensional poverty (8 or more indicators of deprivation). deprivation). This way of assessing the intensity of multidimensional poverty allows making a bridge with the official indicators of material and social deprivation. Table 2 presents the taxonomy adopted, as well as the distribution of the population by number of deprivations.

It would be possible to classify individuals differently, altering at the margin the number of deprivations that determine the multidimensional poverty thresholds. A simple way to assess the plausibility of choosing these thresholds is to randomly choose 5 or 8 indicators from the list of 21 variables used in the analysis. We argue that this identification always leads to cases that effectively reflect situations of exclusion in the

Portuguese society. It should be underlined that this subjective assessment includes elements of an absolute nature – since we are evaluating the absolute exclusion from a set of indicators – and relative, since the plausibility of the thresholds must be framed in the reality of the country under analysis. In this sense, this application is close to the definition of the Council (1985) presented in the beginning of this article.

It is also important to assess the extent to which the individuals identified in multidimensional poverty are deprived in variables pertaining to each of the five dimensions defined in Table 1. These dimensions are interconnected and an individual in multidimensional poverty would be expected to live with deprivation in several dimensions simultaneously. The results of the analysis point precisely in this direction. In 2020, all individuals in multidimensional poverty were deprived in at least two dimensions of the analysis (9.3% in two, 40.1% in three, 39.4% in four and 11.2% in the five dimensions). In the case of individuals in severe multidimensional poverty, almost all report deprivations in at least three dimensions (20.9% in three, 54.9 in four and 23.5% in five).

The multidimensional poverty rate calculated using these criteria is somewhat lower than the official indicators of poverty and exclusion in Portugal. The individuals identified as poor also differ between concepts. Table 3 seeks to summarize the degree of overlap of the individuals identified with five concepts: the at-risk-of-poverty rate (AROP), the at-risk-of-poverty or social exclusion rate (AROPE), the material and social deprivation rate,[10] the severe material and social deprivation rate, the multidimensional poverty rate and the severe multidimensional poverty rate.[11] The table shows that the degree of overlap between the multidimensional poverty rate and the AROP and AROPE indicators is relatively low. In 2020, 15.4% of individuals were in multidimensional poverty, but only 6.5% were simultaneously multidimensional poor and at risk of poverty (AROP) and only 9.3% were simultaneously multidimensional poor and at risk of poverty or social exclusion (AROPE). In contrast, the multidimensional poverty rate shows a relatively high degree of overlap with the material and social deprivation rate, which is not surprising given that they share a significant number of underlying indicators. However, even in this case, the individuals identified do not coincide (the intersection corresponds to 11.9% of the population, which compares with a material and social deprivation rate of 12.9% and with a multidimensional poverty rate of 15.4%). A similar conclusion emerges when comparing the severe multidimensional poverty rate and the severe material and social deprivation rate, with the intersection covering 4.4% of the population, which compares

10. The material and social deprivation rate corresponds to the share of the population experiencing at least five of the thirteen items used to compute the severe material and social deprivation rate.

11. Note that the material and social deprivation rate and the at-risk-of-poverty or social exclusion rate calculated in this article differ slightly from the official statistics. This discrepancy, always below 0.2 pp, may be associated to the fact that in this article we use all individuals, including those that did not answer specific questions relevant to our analysis. It was assumed that the non-response corresponds to an absence of deprivation.

	At risk of poverty rate (AROP)	At risk of poverty or social exclusion rate (AROPE)	Material and social deprivation rate	Severe material and social deprivation rate	Multidimensional poverty rate	Severe multidimensional poverty rate
At risk of poverty rate (AROP)	**16.2**	16.2	5.8	2.9	6.5	3.2
At risk of poverty or social exclusion rate (AROPE)		**20.2**	8.5	5.5	9.3	5.1
Material and social deprivation rate			**12.9**	5.5	11.9	5.7
Severe material and social deprivation rate				**5.5**	5.5	4.4
Multidimensional poverty rate					**15.4**	5.8
Severe multidimensional poverty rate						**5.8**

TABLE 3. Breakdown of the population, according to the different concepts of poverty (2020). In percentage

Source: Calculations based on ICOR 2020.
Reading notes: The main diagonal shows the proportion of the population that meets the criteria for each of the definitions. For example, 12.9% of the population was in material and social deprivation (3rd line of values). Cells off the main diagonal represent the intersection between the various groups. For example, 2.9% of the population was simultaneously at risk of poverty (1st line of values) and in severe material and social deprivation (4th column of values).

with a severe material and social deprivation rate of 5.5% and a severe multidimensional poverty rate of 5.8%.

In the previous section, it was concluded that multidimensional poverty in Portugal declined continuously and robustly since 2014. Figure 8 again shows the evolution of multidimensional poverty in Portugal between 2014 and 2020, with a breakdown by degree of multidimensional poverty, as defined above. The information in this figure is basically identical to that in Figure 5 and shows that the decrease in multidimensional poverty in Portugal was more pronounced in its most severe facet.

In turn, Figure 9 compares the evolution of the multidimensional poverty rate with that of official poverty indicators. The message that emerges from reading the various indicators is mixed. While the at-risk-of-poverty rate shows a slight fall over the period, which was interrupted in 2020, the remaining indicators suggest a stronger decline, which lasted in 2020. It should be noted that the profile of the multidimensional poverty rate follows closely the trend in the rate of material and social deprivation.

Table 4 presents the multidimensional poverty rate according to the region, degree of urbanization, gender, age, schooling, household composition and activity status. The table includes the breakdown into moderate and severe poverty and, for comparison, the corresponding statistics for the at-risk-of-poverty rate (AROP), the poverty or social exclusion rate (AROPE) and the material or social deprivation rate. In 2020, the multidimensional poverty rate, defined as the proportion of the population experiencing at least five of the 21 deprivations under analysis, was 15.4%. The severe multidimensional poverty rate, defined as the proportion of the population experiencing at least eight of the 21 deprivations, was 5.8%. Thus, about 1.5 million people lived

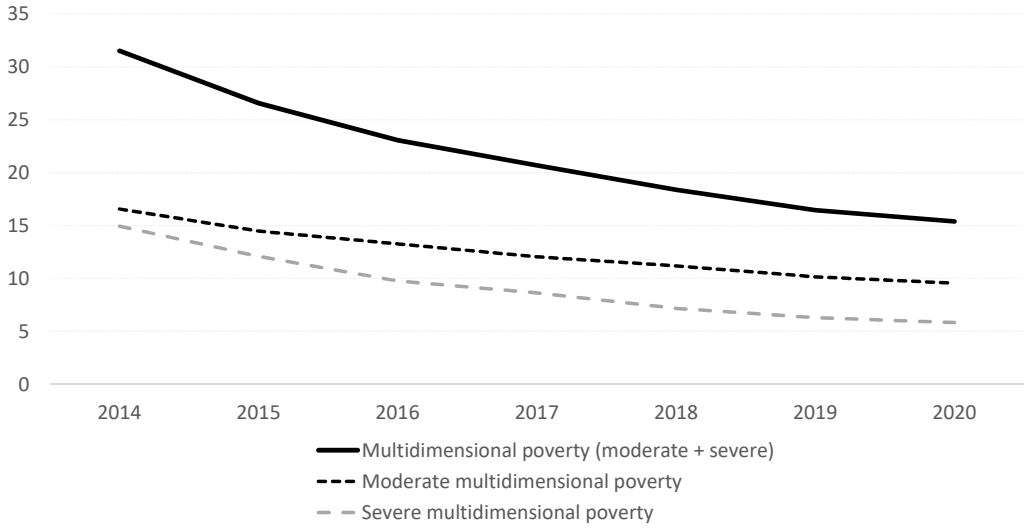

FIGURE 8: Evolution of the multidimensional poverty rate in Portugal (% of total population)
Source: Calculations based on ICOR 2020.

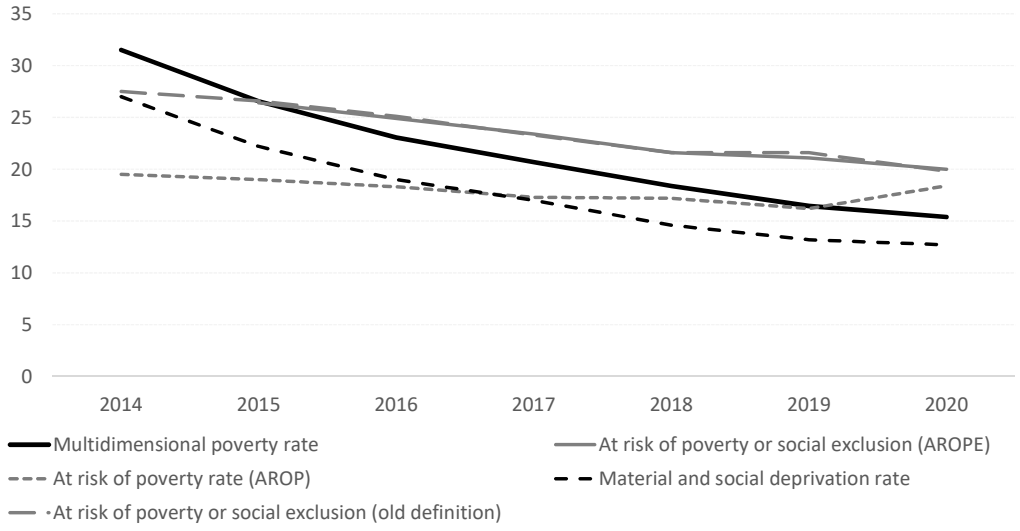

FIGURE 9: Evolution of several poverty indicators in Portugal (% of total population)
Source: INE and calculations based on ICOR 2020.

in multidimensional poverty, of which about 600,000 were in severe multidimensional poverty.

The highest multidimensional poverty rate was recorded in the Autonomous Regions and the lowest rate in Lisbon. In the case of severe multidimensional poverty, the lowest rates are in the Centre, Lisbon and Alentejo, and the highest rates in the Algarve and the Autonomous Regions. In terms of the degree of urbanization, it is in rural areas that the greatest multidimensional poverty is observed. With regard to gender, the multidimensional poverty rate is higher for women.

	Multidimensional poverty			For memory		
	Moderate	Severe	Total	AROP	AROPE	Material and social deprivation
Total	**9.6**	**5.8**	**15.4**	**16.2**	**20.2**	**12.9**
Region						
North	9.8	5.8	15.5	18.1	22.0	13.5
Center	10.3	5.0	15.3	16.6	20.4	12.5
Lisbon	7.5	5.0	12.5	11.1	14.9	10.1
Alentejo	9.3	5.5	14.8	16.9	20.1	11.5
Algarve	11.1	10.0	21.1	17.7	23.9	17.6
Azores	15.4	12.0	27.4	28.5	33.7	24.4
Madeira	15.9	10.9	26.8	26.3	33.0	24.2
Degree of urbanization						
Dense	8.6	5.0	13.6	13.3	17.0	11.4
Intermediate	9.5	6.3	15.7	16.6	20.8	13.6
Low	11.4	6.9	18.3	21.1	25.4	14.7
Gender						
Male	8.9	5.2	14.1	15.6	19.3	11.6
Female	10.2	6.4	16.6	16.7	21.0	14.0
Age						
0-17	6.9	3.9	10.9	19.1	21.6	10.1
18-34	8.6	5.6	14.2	13.9	17.9	11.5
35-64	8.9	5.6	14.5	15.3	19.8	12.4
>=65	13.7	7.8	21.5	17.5	21.5	17.0
Schooling						
Below secondary	14.3	9.7	24.0	21.9	27.2	19.4
Secondary	7.0	3.0	10.0	11.5	15.5	9.0
Terciary	2.2	0.8	3.0	4.7	6.7	2.9
Household composition						
Households with only 1 individual	12.6	11.0	23.5	24.1	29.4	19.2
Other households without children	10.9	6.4	17.2	13.7	18.9	14.3
Households with 1 adult and children	9.8	7.7	17.5	25.5	32.1	16.2
Households with several adults and children	7.7	4.2	11.9	16.1	18.4	10.0
Working condition (age>=18)						
Employed	6.9	2.7	9.6	9.9	11.8	8.1
Employees	7.1	2.8	9.9	7.7	9.8	8.3
Self employment	5.7	1.6	7.3	28.4	28.7	6.2
Unemployed	15.8	16.8	32.6	33.1	43.3	28.8
Retired	12.7	7.3	20.0	15.7	20.4	15.9
Other inactive	14.0	11.9	25.9	27.7	37.4	20.5

TABLE 4. Characterization of multidimensional poverty in Portugal in 2020 (% of total population)

Source: Calculations based on ICOR 2020.

In terms of age, multidimensional poverty has an increasing profile, with a higher incidence in the elderly. The multidimensional poverty rate in children differs from the evidence obtained with the AROP and AROPE indicators, but is also revealed in the material and social deprivation indicators. The higher incidence of multidimensional poverty among the elderly is partly related to the greater material and social deprivation of older populations, as well as to the impact of the new dimensions covered in this study, in particular health. In turn, the lower incidence among the youngest may be related to the fact that the material and social deprivation indicators are not designed

to cover the specific situation of children. This situation is expected to change soon, based on the conclusions of the special module of EU-SILC dedicated to children, which started in 2021 (Guio et al., 2012).

With regard to schooling, its impact on multidimensional poverty is indisputable. Of the individuals (over 16 years old) with higher education, only 3% lived in a situation of multidimensional poverty and 0.8% in severe poverty. With regard to the household composition, the greater vulnerability of families with only one individual (where the elders prevail) and of single-parent families stands out, as in the official poverty indicators.

Finally, in terms of activity status, the highest rates of multidimensional poverty (severe and total) are recorded among the unemployed and other inactive individuals. About a third of the unemployed live in a situation of multidimensional poverty and 16.8% in a situation of severe poverty. In turn, 9.6% of employed individuals also live in multidimensional poverty (2.7% in severe poverty). The incidence of multidimensional poverty is higher among employees than among the self-employed, in contrast to the evidence obtained with the AROP and AROPE indicators. Participation in the labor market mitigates but does not eliminate the probability of living in a situation of poverty (Diogo, 2021). In fact, when we break down individuals over 18 years living in multidimensional poverty by activity status, 31% are employed, 16.7% are unemployed, 32.6% are retired and 19.7% are other inactive (in the case of severe poverty, these percentages are, respectively, 22.6%, 22.6%, 31.2% and 23.6%).

6. The living conditions and well-being of the poor in Portugal

In this section, we analyze the living conditions of the poor in the following dimensions: the quality of the individuals' health, the ability to achieve their goals, the ability to keep the house warm, to buy clothes and to have adequate food, digital inclusion, home ownership and equivalent adult income. This characterization is not exhaustive, but aims to be a first exploration of the wealth of information in the EU-SILC database. Table 5 presents the indicators of living conditions for the total population (column (1)), for individuals in multidimensional poverty, broken down by degree of multidimensional poverty (columns (2) to (4)), as well as for individuals at risk of poverty (column (5)), at risk of poverty or social exclusion (column (6)) and in material and social deprivation (column (7)).

In terms of perceived health status, 30.4% of individuals in multidimensional poverty report living with "poor" or "very poor" overall health, which compares with 11.3% of the total population. This percentage rises to 37.6% in the case of severe poverty. In the case of AROP, AROPE or materially and socially deprived individuals, these percentages are equally high, but lower than those for multidimensional poverty (19.0%, 20.3% and 26.6%, respectively).

With regard to the ability to achieve their goals ("make ends meet"), 65.4% of individuals in multidimensional poverty report having a lot of difficulties in this aspect (80% in the case of severe poverty), which compares with 20.5% of the total population.

This percentage is higher than that observed in AROP and AROPE individuals (42.5% and 45.1%, respectively) and close to individuals in material and social deprivation.

With regard to the ability to have an adequately heated home, to replace clothes and shoes and to have adequate nutrition, the same pattern arises, with very high percentages of deprivation in the multidimensional poor, much higher than in the AROP and AROPE populations, and close to those in material and social deprivation. The reality is particularly dire for individuals in severe multidimensional poverty. 70.2% of these individuals are unable to keep their home adequately warm, 71.6% are unable to replace clothes or shoes and 21.6% are deprived of basic nutritional needs.

An increasingly relevant dimension of inclusion in contemporary societies, and which has been accentuated by the recent pandemic, is the ability to digitally participate in the life of society. When assessing the degree of digital exclusion (computer ownership or internet access), 36.2% of the population in multidimensional poverty is digitally excluded, which compares with 7.5% in the population as a whole. More than half of the population in severe multidimensional poverty is digitally excluded.

With regard to homeownership, about 60% of the population in multidimensional poverty owns their home. This percentage is lower than the average of the population in Portugal and globally close to the one obtained for the remaining concepts of poverty and social exclusion.

Finally, in terms of income per equivalent adult, individuals at risk of poverty are, by definition, those with the lowest annual income per equivalent adult in the population. On average, the poor from a multidimensional perspective earn an equivalent annual income of €7561.1 (€6743.4 in the case of severe multidimensional poverty). This value compares with €4643.3 for the population at risk of poverty. Many households with monetary income above the poverty line are thus in multidimensional poverty. More specifically, around 57% of individuals in multidimensional poverty have incomes above the poverty line, which amounted to €6480 in Portugal in 2019. On the other hand, around 60% of individuals below the poverty line are not in multidimensional poverty. These facts attest that being below the monetary poverty line is neither a necessary nor a sufficient condition for an individual to live in poverty.

This conclusion is reinforced when we analyse the individuals who are identified as poor according to the AROP and AROPE criteria, but who are not in multidimensional poverty (columns (8) and (9)). According to Table 3, these individuals correspond, respectively, to 9.7% and 10.9% of the population. In the set of indicators in Table 5, these individuals are indistinguishable from the average of the population as a whole. The deprivation and social exclusion prevailing in the AROP and AROPE population are thus concentrated in the segments that we have identified as multidimensional poor. This conclusion is not so pronounced in the case of individuals in material and social deprivation who are not in multidimensional poverty (column (10)), who represent only 1.0% of the population. This result suggests that material and social deprivation indicators can provide a reasonable approximation to individuals in multidimensional poverty.

Information from the EU-SILC ad hoc module on well-being indicators, conducted in 2018, also contains relevant data to this discussion. In this module, individuals over

16 years of age were asked about their well-being perceptions and about their emotions. Table 6 presents some selected results based on this ad hoc module, and is organized with the same structure as Table 5. The main conclusion that emerges from the table is that there is a strong negative association between the degree of multidimensional poverty and the degree of subjective well-being of individuals. People living in poverty have lower life satisfaction, less trust in others, feel more depressed and alone, and are less able to ask for material or non-material help from people outside the household. The indicators for the population in severe multidimensional poverty (column (3)) are always more adverse compared to those in moderate multidimensional poverty (column (2)) and to the overall population. For example, on a scale of 0 to 10, people in severe multidimensional poverty reported an average happiness rating of 4.1, which compares with 6.7 across the total population. In another example, only 65% of people in severe multidimensional poverty reported being able to ask for material help, compared to 87% of the total population.

The AROP or AROPE population excluding individuals in multidimensional poverty again presents values close to the population mean. This conclusion reinforces the idea that multidimensional poverty more reliably captures the core of situations of absolute deprivation and need in the Portuguese population. Once again, this dichotomy exists, but is less pronounced, in the case of individuals in material and social deprivation.

		Total population	Multidimensional poverty			AROP	AROPE	Social and material deprivation	Excluding population in multidimensional		
			Moderate	Severe	Total				AROP	AROPE	Social and material deprivation
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Percentage of the population		100.0	9.6	5.8	15.4	16.2	20.2	12.9	9.7	10.9	1.0
With general health "bad" or "very bad"	% in each group	11.3	26.0	37.6	30.4	19.0	20.3	26.6	11.9	11.5	11.9
With great difficulty (1 or 2) to "make ends meet"	% in each group	20.5	56.5	80.0	65.4	42.5	45.1	65.3	24.0	22.9	31.6
Without ability to keep home adequately warm	% in each group	17.4	47.5	70.2	56.1	33.8	37.2	60.2	16.8	15.9	48.2
Without capacity to have new clothes or shoes	% in each group	8.5	31.9	71.6	46.9	24.8	29.5	55.0	3.9	3.5	25.7
Without capacity to regularly afford a decent meal	% in each group	2.5	6.5	21.6	12.2	7.2	8.1	13.8	1.1	1.0	4.1
Digitally excluded (without computer or internet) for financial reasons	% in each group	7.5	23.4	57.2	36.2	20.5	23.0	38.2	6.1	5.5	10.0
Homeowner	% in each group	77.3	67.3	46.9	59.6	67.4	66.6	57.2	76.1	77.3	63.9
Equivalent income	euros	12696.1	8060.0	6743.4	7561.1	4643.3	5754.3	7403.9	4708.7	5522.9	8447.8
Average number of deprivation indicators	number	2.1	5.8	9.7	7.3	4.3	4.8	7.5	1.9	1.9	4.0

TABLE 5. Living conditions of individuals in poverty

Source: Calculations based on ICOR 2020.

		Total population	Multidimensional poverty			AROP	AROPE	Social and material deprivation	Excluding the population in multidimensional poverty		
			Moderate	Severe	Total				AROP	AROPE	Social and material deprivation
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Overall life satisfaction: 0 (not at all satisfied) - 10 (completely satisfied)	Average in each group	6.7	5.3	4.1	4.8	5.6	5.5	4.8	6.6	6.7	6.2
Trust in others: 0 (no trust) - 10 (full trust)	Average in each group	5.2	4.5	4.1	4.3	4.7	4.6	4.3	5.5	5.1	4.7
Feeling down or depressed: 1 (always) - 5 (never)	Average in each group	3.7	3.2	2.7	3.0	3.3	3.3	3.0	3.7	3.7	3.7
Feeling lonely: 1 (always) - 5 (never)	Average in each group	4.3	3.9	3.5	3.7	3.9	3.9	3.7	4.3	4.3	4.5
Being able to ask for material help	% in each group	86.9	77.0	64.5	72.0	80.0	78.4	69.9	90.5	90.2	81.3
Being able to ask for non-material help	% in each group	94.4	88.9	80.7	85.6	90.1	88.9	83.9	96.2	96.1	89.7

TABLE 6. Well-being indicators (2018)

Source: Calculations based on the *ad hoc* module in ICOR 2018.

7. Conclusions

This article proposed a multidimensional poverty indicator applied to the Portuguese reality. This indicator aggregates 21 variables that cover dimensions such as the participation in the labor market, material deprivation, social deprivation, health and housing. According to this methodology, multidimensional poverty in Portugal decreased continuously between 2014 and 2020. In 2020, the proportion of the population in multidimensional poverty stood at 15.4%, with 5.8% of the population living in severe multidimensional poverty. In the European context, Portugal is in an intermediate position, with a multidimensional poverty rate close to that of Belgium, France and Italy, lower than that of Spain and Greece, and higher than that of Germany, Finland and the Netherlands.

This multidimensional approach identifies segments of the population that are not captured in the usual indicators of poverty and social exclusion. Nonetheless, the official indicators of material and social deprivation are a good approximation of the living conditions of the population in multidimensional poverty.

This article characterized some dimensions of the quality of life of the population living in multidimensional poverty. The results reveal situations of great fragility in important segments of the Portuguese population. Absolute exclusion is also associated with negative subjective perceptions regarding personal well-being. It is the actual freedom to participate effectively in the life of society that becomes restricted (Sen, 1984). The indicator now presented is experimental in nature. In this sense, it intends to be a seed for new research, aimed at improving the conceptual robustness in terms of the choice of variables and the relative weights applied to the different indicators. Ultimately, a multidimensional view of poverty can be a useful complement to the current indicators defined in the European framework, not only in the identification of the population in poverty but also in the design of policies for its eradication.

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Banco de Portugal
Banco de Portugal Economic Studies, Vol. VIII, No. 4

Non-technical summary

October 2022

Firm lifecycles

Nicholas Kozeniauskas, Pedro Moreira, António R. dos Santos, Laszlo Tetenyi

Firm growth is at the center of many macroeconomic questions being considered by both researchers and policy makers. For some time governments have been interested in promoting the creation and growth of firms, and research has recently focused on the link between the dynamics of firms and aggregate economic growth. Understanding the drivers of firm growth is essential to these endeavors. A second area of interest has been support policies for firms during recessions. Understanding the dynamics of firms is useful for improving the formulation of such policies.

We investigate two particular issues that are important to our understanding of firm dynamics. The first question is to what extent a firm's outcomes are determined by their initial conditions or their post-entry shocks. This helps us to evaluate the impact of frictions in the economy, such as frictions in the accumulation of demand and financial frictions. It is also potentially relevant for policies aimed at promoting firm creation as a way of driving economic growth. If firm outcomes are largely determined by post-entry shocks, then a policy-maker may want to encourage a high level of firm creation, and exit among the less successful firms. If, instead, initial conditions are very important, then a better policy might focus on encouraging the entry of firms that are strong from the start.

The second question is about the relevance of different frictions to firm growth. There are theories under which firm growth is a result of frictions to the accumulation of capital and labor. However, evidence on the relative importance of these types of frictions is limited. If one wants to design policies to encourage firm creation and growth, or support firms in a downturn, then understanding the frictions that firms face matters.

To address these questions we provide a simple theory of firm production over the lifecycle. We use the model to derive empirical predictions that allow us to distinguish between the initial conditions and post-entry shocks of firms, and also to disentangle labor market frictions from frictions to capital accumulation. These predictions are then tested with data on Portuguese firms.

The empirical analysis provides evidence for the important role of initial conditions in determining firm outcomes. In the data we see considerable persistence in relative firm size. This is informative about the importance of initial conditions compared

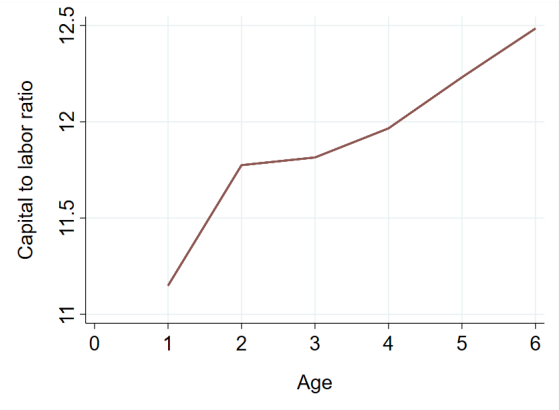

FIGURE 1: Capital to labor ratio by age for firms that live at least six years.

Notes: This figure presents the average capital to labor ratio by age for firms that live to at least age six, measured in euros per hour worked. Values are winsorized at 98%.

to post-entry shocks because the more important initial conditions are, the more persistence relative firm size is.

To distinguish between capital and labor market frictions we look at how capital to labor ratios evolve with firm age. In the data we see a clear pattern of the capital to labor ratio increasing with firm age (see Figure 1). For a standard production function, this ratio is constant over time for firms. If there are frictions to capital accumulation then capital is depressed when firms are young, and grows gradually over time, generating an increasing capital to labor ratio. The opposite is true when there are frictions in the labor market. The data therefore suggests that that frictions to capital are dominant. This finding provides motivation for further investigation into the nature of these frictions, and whether there are ways to ease them.

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Nicholas Kozeniauskas
Banco de Portugal

Pedro Moreira
Banco de Portugal

António R. dos Santos
Banco de Portugal
Nova School of Business and Economics

Laszlo Tetenyi
Banco de Portugal

October 2022

Abstract
The factors determining firm size and growth are central to understanding aggregate economic growth, and the design of firm-level government policies that aim to promote growth, and smooth business cycles. Motivated by this we study the relative importance of initial conditions versus post-entry shocks in determining firm outcomes, and the relative size of capital and labor market friction that firms face. Using detailed Portuguese firm data and a simple model to aid interpretation, we find that initial conditions play an important role in determining firm outcomes, and that capital market frictions are larger than labor market frictions. (JEL: D24, E22, E23, E24, J23)

1. Introduction

Firm growth is at the center of many macroeconomic questions being considered by both researchers and policy makers. For some time governments have been interested in promoting the creation and growth of firms, and research has recently focused on the link between the dynamics of firms and aggregate economic growth (e.g. Klette and Kortum 2004; Akcigit and Kerr 2018). Understanding what drives firm growth, and what hinders it, is essential to these endeavors. A second area of interest has been support policies for firms during recessions. These featured during the Great Recession, for example with the US government bailing out major car companies, and were adopted on a large scale in response to the initial impact of Covid-19. Understanding the dynamics of firms is useful for improving the formulation of such policies.

We investigate two particular issues that are important to our understanding of firm dynamics. The first question is to what extent a firm's outcomes are determined by

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E-mail: nkozeniauskas@bportugal.pt; pmoreira@bportugal.pt; ammsanto@bportugal.pt; ltetenyi@bportugal.pt

their initial conditions or their post-entry shocks. Sterk *et al.* (2021) have shown that the answer to this question is important for understanding the impact of frictions in the economy, such as frictions in the accumulation of demand and financial frictions. It is also potentially important for policies aimed at promoting firm creation as a way of driving economic growth. If firm outcomes are largely determined by post-entry shocks, then a policy-maker may want to encourage a high level of firm creation, and exit among the less successful firms. If, instead, initial conditions are very important, then a better policy might focus on encouraging the entry of firms that are strong from the start.

The second question is about the relevance of different frictions to firm growth. There are theories under which firm growth is a result of a range of frictions, including adjustment costs to capital (e.g. Clementi and Palazzo 2016), financial frictions (e.g. Cooley and Quadrini 2001; Moll 2014; Midrigan and Xu 2014), labor market frictions (e.g. Kaas and Kircher 2015; Bilal *et al.* 2022), and frictions in demand accumulation (e.g. Gourio and Rudanko 2014). However, evidence on the relative importance of these theories is limited. If one wants to design policies to encourage firm creation and growth, or support firms in a downturn, then understanding the frictions that firms face matters.

To study these issues we start with a simple two period model of the firm lifecycle. In each period firms pay a fixed cost to operate and hire capital and labor to produce. Firm productivity is determined by a permanent component that grows as the firm ages, and a transitory shock each period. The permanent component is a firm's initial condition, and the transitory component is its post-entry shocks. We study the decisions of firms for three versions of the economy: a frictionless economy in which firms can choose their optimal levels of capital and labor in both periods; an economy with frictions that constrain capital choice when firms are young; and an economy in which frictions constrain labor choice when firms are young. We are agnostic about the sources of capital and labor constraints, modeling them in a general way that can capture many potential sources.

The model has several empirical predictions that are useful for addressing our two questions. Regarding the distinction between initial conditions and transitory post-entry shocks, we focus on two predictions. The first relates to the persistence of firm size rankings, in a similar spirit to Sterk *et al.* (2021). When productivity is purely determined by transitory post-entry shocks, there is no correlation between the size of firms when young and old. In the transition matrix for firm size rankings, all elements are equal. The greater the role of initial conditions, the closer this transition matrix is to being diagonal. The second prediction is about the correlation between the size of firms when young, and their exit probability when old. If productivity is determined purely by transitory post-entry shocks, then this correlation is zero, and there is no persistence in size and profitability. Initial conditions with permanent effects generate such persistence, causing a negative correlation between these moments, that is stronger the more important initial conditions are. We show that these predictions hold in all three versions of the economy that we consider.

For understanding the sources of firm growth, our first prediction describes the relationship between productivity growth, and capital and labor growth, in the frictionless version of the economy. This is useful as a way to consider how much the

economy departs from a benchmark without frictions on capital and labor accumulation by young firms. The second prediction shows that the evolution of the capital to labor ratio with firm age differs across the three versions of the economy. This ratio is flat in the frictionless economy, increasing when there is a capital constraint on young firms, and decreasing when the constraint is on labor. The intuition for this is simple. When capital is constrained, firms use less capital than would be optimal when young, and compensate with more labor. This depresses the capital to labor ratio, causing it to increase when firms outgrow their constraint. For a constraint on labor, the intuition is analogous.

To evaluate these predictions we use panel data on the balance sheets of the universe of Portuguese firms. We focus on cohorts born in 2009–12 and track the same firms over time. This has the advantage of ensuring that, conditional on age, firms have been subject to the same conditions during their life, so that age effects are not contaminated by different cohorts having experienced different economic histories.

The data provide clear evidence of the importance of initial conditions. Transition matrices for both labor and capital rankings between ages one and six have heavy diagonals, and there is a clear correlation between the size of firms at age one, and their probability of surviving to age six. This evidence is in line with the results of Sterk *et al.* (2021), which are based on the evolution of employment of US firms. Our results on the relationship between initial size and exit are consistent with Geroski *et al.* (2010).

In assessing the extent to which firm growth is a result of productivity growth, a key component is the returns to scale in production. Our results illustrate that the predicted paths for capital and labor in a frictionless economy are very sensitive to the value of returns to scale. Estimates for this parameter vary widely in the literature depending on the methodology, making it difficult to confidently estimates the size of frictions. The paths for capital, productivity and labor in the data suggest returns to scale in the region of 0.8, if frictions to inputs are not large, and less than this otherwise. For the capital to labor ratio, the data clearly show that this moment increases with age, on average. We infer from this that frictions on capital are *relatively* larger than those on labor. This result is particularly interesting since Portugal has relatively rigid labor markets, implying that the capital market frictions are significant.

The remainder of the paper is organized as follows. Section 2 introduces the model and presents the theoretical results. Section 3 describes the data and Section 4 contains the empirical analysis. Section 5 concludes.

2. Model

For guiding our approach to the data we start with a simple model of firm production. A firm exists for up to two periods and each period can produce using the following production function:

$$y_t = (\lambda a_t + (1-\lambda) z_t) k_t^{\varphi\alpha} l_t^{\varphi(1-\alpha)}. \tag{1}$$

$a_t > 0$ is the predictable component of the firm's productivity that captures permanent differences between it and other firms. There will be no uncertainty about this once

a firm is born, so we will refer to this as a firm's "initial condition" or "permanent productivity." z_t is the transitory component of productivity that is realized each period after entry, $\lambda \in [0,1]$ determines the relative importance of initial conditions and post-entry shocks, k_t and l_t are the capital and labor inputs, $\varphi \in (0,1)$ determines the returns to scale, and $\alpha \in (0,1)$ determines the relative weights on capital and labor as production inputs. In the extreme case of $\lambda = 0$, productivity is purely transitory and has no persistence. A firm draw a new value of productivity each period. In the other extreme in which $\lambda = 1$, a firm draws a value of a_t at birth and has this constant value of productivity for its whole life. A higher value of α implies that capital has more weight in production than labor. A value around 0.3 is typical, as this implies a labor share that is similar to the data. For φ, a higher value results in firms being larger because they produce more for any given level of inputs. This value also determines the profit share of firms. Values around 0.9 are commonly used in the literature (e.g. Atkeson and Kehoe 2005). For present purposes, the exact value of φ and α within the specifies ranges are not material for the results.

To simplify notation wherever the distinction between the temporary and permanent components of productivity is not important, let $\tilde{z}_t \equiv \lambda a_t + (1-\lambda) z_t$. To operate each period the firm needs to pay a fixed costs $\gamma > 0$, which must be covered by current period profits.[1]

There is a continuum of firms. Each period they receive a draw of z_t. These draws are i.i.d. across firms and over time, are independent of a, and their distribution satisfies $\mathbb{E}[z_t] = 0$. At birth, each firm draws a permanent productivity factor $a > 0$, which determines the value of a_t each period in the following way:

$$a_t = (1+\psi)^{t-1} a,$$

where $\psi > 0$ is the growth rate of the permanent component of productivity between periods one and two.

The term *productivity* should be interpreted loosely. It is not intended to captured purely technological factors determining the relationship between capital and labor, and physical output. Rather, it should be interpreted to capture all factors that affect the sales of a firm beyond these two inputs. This includes changes in demand side factors like the number of customers or prices. This point will be particularly important when the model is taken to the data.

The two periods represent the two halves of a firm's life. In the first period, a firm is young and may be subject to constraints on its input choices (which we will be specific about shortly). In the second half it is mature and is assumed to have outgrown any constraints or frictions, so that it can choose the optimal level for its inputs. To simplify the analysis we assume that both capital and labor can be rented period by period, at exogenous prices $r > 0$ and $w > 0$, respectively.

1. We are ruling out the possibility of firms borrowing, in the expectation of profits in period 2, to cover the fixed cost in period one. This simplifies the analysis of the extensive margin decision of whether to operate each period or not.

In order to think about the effects of frictions on firms, we consider three cases for the firm's problem. In case one the economy is frictionless. In both periods, so long as profits are large enough to cover the fixed cost, the firm's problem is to choose capital and labor to maximize profit:

$$\max_{k_t,l_t} \tilde{z}_t k_t^{\varphi\alpha} l_t^{\varphi(1-\alpha)} - k_t r - l_t w. \tag{2}$$

In case two, there is assumed to be a friction or constraint affecting the capital choice in period one. We model this as an upper bound on the capital choice. The problem of the firm for period one in this case is:

$$\begin{aligned} &\max_{k_1,l_1} \tilde{z}_1 k_1^{\varphi\alpha} l_1^{\varphi(1-\alpha)} - k_1 r - l_1 w, \\ &\text{s.t. } k_1 \leq \bar{k}, \end{aligned}$$

and in period two the problem is the same as in equation (2). In case three, the constraint is on labor rather than capital, with the production problem in period one being

$$\begin{aligned} &\max_{k_1,l_1} \tilde{z}_1 k_1^{\varphi\alpha} l_1^{\varphi(1-\alpha)} - k_1 r - l_1 w, \\ &\text{s.t. } l_1 \leq \bar{l}. \end{aligned}$$

Again, there is no constraint in period two and the problem is given by equation (2). For some of the analysis we will need to specify a level for the constraint on capital or labor. For these cases we assume that the constraint is proportional to each firm's optimal input choices in the frictionless world. Where distributional assumptions for productivity are needed, we assume normality.[2]

In this framework we are interested in thinking about the predictions of the model for firm behavior, which we can test in the data. The analysis focuses on addressing two questions. The first is how important are initial conditions for the success of firms, compared to post-entry shocks. A popular way to model firm dynamics is to assume that firms have idiosyncratic productivities that evolve stochastically over time. Furthermore, all heterogeneity is typically due to transitory shocks, so that in the long run all firms expect to have the same productivity, regardless of their initial productivity level. In the present model, this corresponds to $\lambda = 0$ so that productivity is purely transitory. In the opposite extreme, initial conditions determine everything when $\lambda = 1$.

The second question is about the frictions that firms need to overcome to grow to their optimal size. There is a wide range of theories about frictions that impede firm growth. Ideas include that firm face financial constraints, that there are non-linear adjustments

2. See the Appendix B for the formal statements of these assumptions. The first assumption is useful for analytical tractability but is more restrictive than is necessary. The only condition that the constraint needs to satisfy is that it does not change the firm size ranking. Similarly, the results will hold for other distributions of the productivity shocks, but normal distributions simplify the analysis. It is true that, under this distributional assumption, it is possible for firms to have negative productivity. This is not a problem because such firms will choose to exit.

cost for capital, that labor market frictions mean that it takes time to accumulate the right workers, that there is imperfect information that takes time to resolve, and that there are frictions to accumulating customers. While there is some evidence in support of all of these, we do not have a clear idea of their relative quantitative importance. While it is beyond the scope of this paper to investigate this question in general, we make a contribution to this by investigating the relative importance of frictions impeding the accumulation of capital, and those impeding the growth of labor.

To start we consider what the evolution of capital and labor with firm age tells us about initial conditions and post-entry shocks. We focus on the transition matrix of firm size rankings for this purpose.

PROPOSITION 1. *If productivity is permanent ($\lambda = 1$) then the transition matrix for firm size (measured with labor or capital) rankings between periods one and two is diagonal. If productivity is transitory ($\lambda = 0$), every element of the transition matrix is identical. This holds for all three cases that we consider.*

The intuition for this result is as follows. If productivity is fully determined at birth ($\lambda = 1$), then firms that are larger in period one will also be larger in period two. If there is a constraint on labor or capital choice in period one, then decisions in that period will be distorted. However, since the constraint applies proportionally to all firms, it does not disturb the firm size ranking. If productivity is purely transitory ($\lambda = 0$), then productivity rankings in period one are uncorrelated with productivity rankings in period two. Whether or not there are constraints on period one input choices, firm size is monotonically increasing in productivity in both periods, so the independence of productivity between periods one and two carries over to firm size. Therefore the distribution of weights in the transition matrix are informative about the relative importance of initial conditions and post-entry shocks.

Next consider the relationship between firm size in period one and the probability of exiting in period two.

PROPOSITION 2. *If productivity is transitory ($\lambda = 0$), then, for firms that operate in period one, there is no correlation between size in that period and exit probability in period two. If productivity has a permanent component ($0 < \lambda < 1$) the correlation is negative.*

Exit in period two is determined by whether or not a firm can cover the fixed operating cost with its period two profits. These are determined by the firms productivity. Productivity also determines firm size. If productivity is purely transitory, then productivity is uncorrelated between periods one and two. It follows that firm size in period one is independent of whether the firm operates in period two. As λ increases towards one, the persistence of productivity increases. With more persistence, there is a greater correlation between size in period one, and size and profits in period two. This generates a negative correlation between size in period one and the probability of exit in period two. This proposition allows us to make inferences about the strength of initial conditions from the correlation between the size of firms at birth and their exit rates.

We next turn to considering the effects of frictions on firm growth.

PROPOSITION 3. *In the frictionless case capital and labor are proportional to a measure of productivity adjusted for returns to scale ($\tilde{z}^{\frac{1}{1-\varphi}}$).*

In the frictionless case, labor and capital inputs are fully determined by productivity. This proposition summarizes exactly how capital and labor would evolve over time for a firm that is experiencing productivity growth. This is useful because, given a value for φ and a measure of productivity, it can be used to quantify how much firm growth departs from the frictionless case. Alternatively, given a path for labor or capital, and a path for productivity, the proposition implies a value for φ that would be consistent with this behavior in a frictionless world. The difference between this value of φ and the true value, is a measure of the size of frictions to input accumulation. Given that measuring returns to scale and productivity is difficult, there will be limitations to implementing this proposition, but we will nevertheless make some use of it for interpreting the data.

A second implication for firm growth focuses on predictions for the evolution of the capital to labor ratio.

PROPOSITION 4. *If productivity has a permanent component ($\lambda > 0$) and capital is restricted in period one, then the capital to labor ratio increases with firm age. If labor is restricted, the opposite is true. In a frictionless economy this ratio is constant in firm age.*

In the frictionless case, the capital to labor ratio is independent of firm productivity. This implies that this ratio will be constant over the life of each firm. This is not the case if capital or labor are restricted in period one. If capital is restricted, then firms compensate by hiring more labor, pushing the capital to labor ratio below its frictionless value. Consequently, when the firm ages out of its constraint, the capital to labor ratio rises. If it is labor that is restricted, the same process plays out, except that it is capital that is higher in period one. So, the capital to labor ratio decreases with firm age.[3] The evolution of the capital to labor ratio with firm age is therefore informative about the strength of the frictions to accumulating these inputs.

3. Data

For the empirical analysis we use the financial statements reported under the fulfillment of the Simplified Corporate Information – IES (Informação Empresarial Simplificada). These statements generate a dataset, Central Balance Sheet Database (CBS), that covers the population of all Portuguese non-financial corporations. Firms report non-consolidated mandatory annual economic, financial, and accounting information, and the CBS is available for 2006 to 2019.

This dataset allows us to follow non-financial firms from the year in which they are born until the end of the dataset or until they close. In constructing our sample we

3. For consideration of capital and labor market frictions jointly see David and Venkateswaran (2019). While that paper studies these frictions in the cross-section, the present paper evaluates how they evolve with firm age.

only consider firms that have employees and capital. We define the birth year to be the first year in which a firm has employees and capital, and their exit year to be the last year in which this condition is satisfied. We define the sample, and the entry and exit points in this way since we want to exclude firms that may only exist for accounting, taxation or administrative purposes, and to exclude very small firms that do not matter much for aggregate economic outcomes. We impose two additional restrictions on the sample. First, a firm is only be included in the sample if it has positive labor and capital within its first three years in the dataset. We allow three years since firms may take some time to raise capital and hire workers after it is formal established. For firms that have more than two years without capital and labor, we are concerned about what their economic purpose is, and whether we would be defining their age accurately. Second, we exclude firms that have gaps in employment and capital (i.e. cases where a firm has zero employees or no capital at an age > 0, and then returns to having employees and capital) since they represent a very small share of firms or any economic outcome.

We focus the analysis on cohorts born in 2009–12 so that we can track the same firms over time. We limit our sample to firms that were created after 2009, since there was a change in the Portuguese Generally Accepted Accounting Principles (GAAP) at this time, that could create time series breaks in some variables. We do not include firms born after 2012, so that we have firms with at least eight years of data. For all of the analysis we omit the observations of all firms in the first and last years, to avoid partial year effects. As an example, if one firm is born on January 1^{st} and another firm is born on December 1^{st}, then the first firm will have 12 times the sales of the second firm, all else being equal. By ignoring data for the first and last year, we ensure that we have full years for all firm-year observations. Our age convention will be that firms are aged zero in the year in which they are born, so that the first observation that we use for each firm is at age one.

Since 2009–12 was a particularly volatile period for the Portuguese economy, the reader should be careful in extrapolating the results to other periods. This period includes part of the global financial crisis that started in 2008, and the sovereign debt crisis. While there are data limitations that affect our ability to extend the analysis to firms born in earlier years, we provide analysis to confirm some of the results for firms born in 2005–08.

Throughout the article we analyze how the productivity, capital and labor of firms changed over time. Labor is measured as the total hours worked by paid employees. Since there is a large mass of employment equal to either one or two employees, hours worked brings more variation and granularity to the data. To measure the capital stock we follow Hsieh and Klenow (2009) and use the average book value of capital from the start and end of each period. The book value of capital includes intangible assets, fixed tangible assets and productive biological assets. In order to measure productivity, we follow the approach of Foster *et al.* (2001) and Foster *et al.* (2016) by assuming a Cobb-Douglas production function with labor, capital and materials as inputs and measure the TFP of firm i in sector s as:

$$\ln TFP_i = \ln Y_i - \alpha_K^s \ln K_i - \alpha_L^s \ln L_i - \alpha_M^s \ln M_i. \tag{3}$$

Y_i is the value of output, K_i is the value of capital stock, L_i is hours of paid employees and M_i is the value of intermediate inputs (i.e., cost of goods sold and supplies and external services). The weights on the inputs in equation (3) are measured for the 224 sectors (three digit CAE code) present in the data. Given the assumption of a Cobb-Douglas production function, the weights are equal to the share of revenue spent on each input. Specifically, α_L^s is the total wage bill as a share of output in sector s; α_M^s is the total cost of intermediates as a share of output; and, assuming constant returns to scale, $\alpha_K^s = 1 - \alpha_L^s - \alpha_M^s$.[4] We estimate these using sector cost shares.[5]

Table 1 provides descriptive statistics for the firms born in 2009–12 in our sample against a pre-cleaning sample (a sample containing all firms born in this period, regardless of the values for labor and capital). Turning to the characteristics of the sample, our cleaning removes approximately 55% of firms. It covers approximately 73% of total sales, 81% of labor (hours worked and number of workers) and 54% of capital. The low number for capital is mostly a result of 20% of the capital stock being held by firms that do not produce.[6] The median sales and hours worked of firms are €117,000 and 4,400, respectively, compared with €56,000 and 2,100 for the pre-cleaning sample. The industry composition of the two samples is similar, with the main difference being that manufacturing and wholesale are slightly overrepresented (14.1% and 42.2.% of total sales compared to 12.8% and 40.0% for the pre-cleaning sample, respectively) and construction and real estate activities are slightly underrepresented (9.5% of total sales compared to 11.4% for the pre-cleaning sample).

4. Empirical results

This section provides empirical tests of the propositions presented in Section 2. We find evidence supporting the importance of initial conditions, investigate the relevance of productivity growth in accounting for increases in firm size, and show that capital market frictions appear to be more prevalent in the data than labor market frictions.

4.1. Proposition 1

The first proposition from the model is that if initial conditions are more important for firms, then firm size rankings are more stable over time. To investigate this, we compute a firm-size transition matrix. We restrict the sample to firms that live to at least age six, so that we track the same firms over time. We treat their observations at age one as the period in which they are "young," and their observation at age six as when they are

4. We assume constant returns to scale for simplicity, since measuring returns to scale is difficult. If capital to labor ratios are similar across firms within a sector, the productivity rankings – which are what we use in the analysis – should not be affected much by this assumption.

5. The weights are estimated using all firms with employees and capital and with a production value at least half of the sum of the value of the intermediate inputs and employee expenses, which prevents unreasonable reported values from significantly impacting the estimates.

6. Specifically, these are firms that have zero sales and zero employees.

	Our Sample	Pre-cleaning Sample
Firms	48,355	107,275
Sales (thousands of €)		
Average	337	220
Median	117	56
Sample share (%)	73	
Labor (thousands of hours)		
Average	8.3	5.2
Median	4.4	2.1
Sample share (%)	81	
Capital (thousands of €)		
Average	75	66
Median	15	7
Sample share (%)	54	

TABLE 1. Descriptive statistics.

Notes: This table presents descriptive statistics for the firms born in 2009–12 in our sample and in the pre-cleaning sample. The pre-cleaning sample considers all firms born in this period, regardless of the values for labor and capital. Except for the number of firms, both samples exclude first and last years values for each firm such that all measures are comparable. The data used to compute the average is winsorized at 98% to prevent the effect of outliers.

"old."[7] Given this sample, we sort firms into size deciles (size will be measured with labor or capital) at ages one and six, and compute the transition matrix between deciles at these two ages. A typical element (i, j) of the matrix is therefore the probability that a firm in decile i at age one, transitions to decile j at age six. In Figure 1 we show the transition matrix when size is measured with capital. According to Proposition 1, the closer that this matrix is to the identity matrix, the more important initial conditions are for firms. In contrast, the closer the matrix is to having all elements with the same value, the more important transitory post-entry shocks are.

Figure 1 provides the transition matrix for capital. Values are sequentially colored in red, with lighter colors corresponding to smaller probabilities and darker colors to larger ones. If shocks were purely transitory, then every value would be equal to 10%. The matrix shows clear departures from this. Values are larger the closer they are to the main diagonal. All values on the main diagonal and the adjacent elements are above 10%. Moreover, there is particularly high persistence for small and large firms. Firms born in the smallest capital decile have a 59% chance of remaining in the smallest 30% of firms when they reach age six. The top of the distribution is even more stable: firms born in the top decile have a 95% chance of staying in the top 30% of firms at age six. When we look at the transition matrix for labor (Figure 2), we find that it has even greater persistence, with virtually all of the diagonal elements being larger than for capital.

7. Ideally we would have more years of data so that we can track firms until they stop growing, as this would be closest to firms reaching their unconstrained size in the model. We are restricted by the time period that the data is available for, so we use the oldest observation for each firm that is in our sample. Our robustness exercises in Appendix A extend the analysis for labor to firms born in 2005–08, so that we can track firms to age 10. The results hold for this sample.

Age 1 \ Age 6	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
D1	**30**	17	12	12	9	7	5	3	3	2
D2	21	**21**	15	12	10	7	6	4	3	2
D3	16	18	**16**	14	11	9	6	5	4	2
D4	12	13	16	**15**	13	11	7	6	5	3
D5	9	12	14	14	**14**	11	9	7	6	3
D6	5	9	12	13	15	**14**	12	8	7	4
D7	3	6	8	11	15	17	**15**	13	9	4
D8	2	3	5	7	10	15	20	**18**	13	7
D9	1	1	1	2	3	8	17	29	**23**	15
D10	0	0	0	0	0	1	3	8	29	**58**

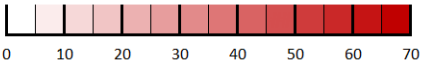


FIGURE 1: Transition matrix for capital.

Notes: This figure presents the firm-size transition matrix computed using firms' capital deciles at age 1 and age 6. Deciles range from D1 (decile one) to D10 (decile ten). Element (i, j) of the matrix is the probability that a firm in decile i at age 1, transitions to decile j at age 6. Values are sequentially colored in red, where lighter colors correspond to smaller transition probabilities and darker colors to larger values.

Labor also has particularly strong persistence in the tails of the size distribution. Firms in the top decile, for example, have nearly 90% probability of remaining in the top two deciles of the size distribution at age six. Overall, the message from these matrices is that the initial conditions for firms play an important role in determining their future outcomes.

To provide statistical evidence about persistence, we test whether the matrix is distinguishable from the extreme cases discussed in the theory: the matrix with identical elements, and the identity matrix. Formally, we perform a joint significance test for whether each element in the empirical transition matrix equals to the element of the relevant matrix in the hypothesis. Standard errors are based on Taylor-linearized variance. The data is able to reject both cases, indicating that $\lambda \in (0, 1)$ so that productivity contains both permanent and transitory components (see Appendix C.1 for additional details).

4.2. Proposition 2

The second prediction of our theory is about the correlation between the size of young firms and their exit probability. If shocks are purely transitory then firm size when young has no correlation with the exit rate. Persistence of productivity across periods leads to a negative correlation between size and the exit rate.

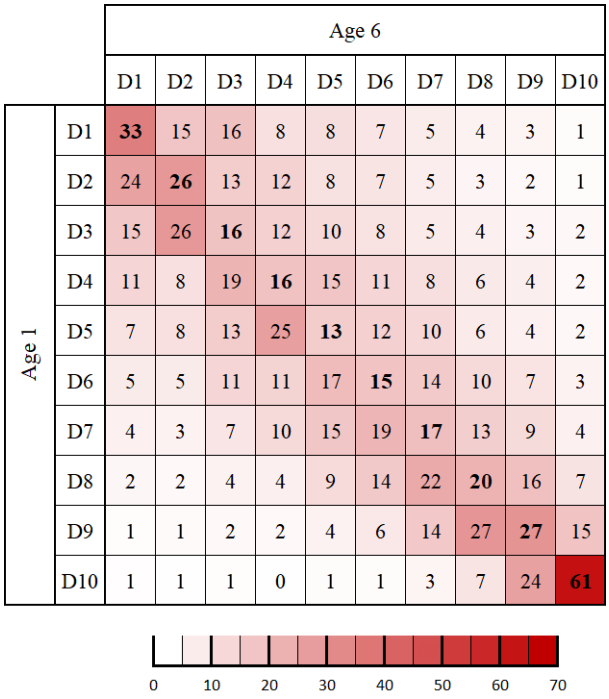


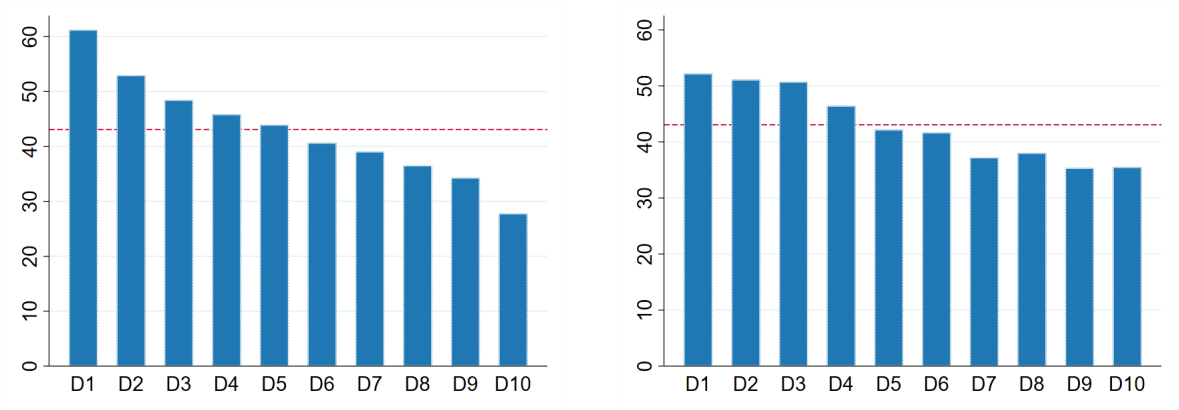
FIGURE 2: Transition matrix for labor.

Notes: This figure presents the firm-size transition matrix computed using firms' labor (hours worked) deciles at age 1 and age 6. For details on how to read the figure, see Figure 1.

To assess the relationship between initial size and exit rates, we start by dividing the firm size distribution into deciles at age one. For each decile we then compute the exit rate between ages 1 and 6. The results for the case in which size is measured with capital are presented in Figure 3a. The exit rate monotonically decreases with initial size. Firms in the smallest decile experience a 33 percentage point higher exit rate than firms in the highest decile. Formal tests reject the null hypothesis that all exit rates are the same (see Appendix C.2 for details). When we measure size with labor in Figure 3b, we find results that are qualitatively the same, but with smaller differences across the size distribution. For this case the difference between the exit rates of the lowest and the highest deciles is 17 percentage points. Since a large mass of firms have only one or two employees (which implies a lower variability of hours worked) the difference between the exit rate of some adjacent deciles is not as pronounced as for capital.

These results share some similarities with those of Geroski *et al.* (2010). Using data for Portuguese firms that lived between 1983 and 1993, that paper shows, *inter alia*, that there is a negative relationship between initial employment and the subsequent exit rates of firms. We confirm that this remains a feature of the economy approximately twenty years later, despite the changes in the business environment of Portuguese firms, and show that the result holds when size is measured with capital instead of labor. The agreement between the results also partially addresses the concern that the result from our sample could be specific to the particular years of data that we are working with.

To provide another angle on the relationship between size and exit, and also to introduce the data on firm growth that will be the focus of the rest of the analysis,



(A) Capital (B) Labor

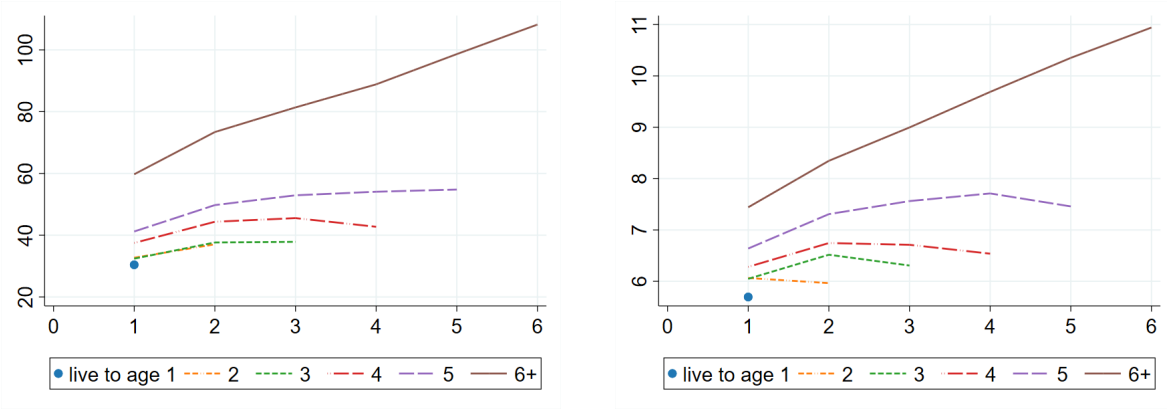
FIGURE 3: Exit rate (percentage) by size decile at age one.

Note: The exit rate is the share of firms at age 1 that close by age 6, measured in percentage. Panel (A) reports the values for each capital decile. Panel (B) reports the values for each labor (hours worked) decile. Deciles range from D1 (decile one) to D10 (decile ten). The dashed red line represents the average exit rate.

we now consider how the survival of firms is related to their initial size and their subsequent growth. Specifically, in Figure 4a we show the evolution of average capital stock conditional on how long firms live for. Firms are divided up into six groups, determined by how many years they live for, and the figure reports the average value at each age for firms in each group. For example, the blue dot is the average capital stock at age one for firms that die at age two, the orange line is the average capital stock at ages one and two for firms that die at age three, *et cetera*. The figure clearly shows that firms that live for longer start larger, that these differences are persistent, and that all groups of firms grow in size on average. This also holds when size is measured with labor, as shown in Figure 4b.

We perform a number of robustness exercises to address questions about what is driving these results. One possibility is that there could be differences in the composition of firms in each group with respect to their sector or year of birth, such that the results are at least partially a result of between group effects rather than true age effects. The results could also be contaminated by time series trends, causing all firms to grow over the period being studied. To address these concerns we perform regression analysis that allows us to control for year, year of birth and sector of activity. The results hold for the inclusion of these controls individually and jointly.[8] A related concern may be that the growth of firms is only present in sectors with relatively large firms, like manufacturing, and not in sectors with small firms, like services. To assess this we replicate the analysis in Figure 4 for these two sectors separately. While firms in manufacturing are significantly bigger than services firms, the pattern that firms that live longer start larger, and stay larger, is present in both sectors. Full results are in Appendix D.

8. See Appendix D for the details of the regression specification.



(A) Capital, thousands of euros (B) Labor, thousands of hours worked

FIGURE 4: Average capital and labor by firm age, conditional on survival.

Notes: This figure presents the average capital and labor by firm age for six groups of firms. The blue dot represents the average value at age 1 for firms that "live up to age 1" and close at age 2. The brown line represents the average value at each age for firms that live up to age 6 and might or might not close at age 7 - "live up to age 6+". The dashed lines represent the average value at each age for firms that "live up to age t" and close at age $t+1$ ($t = 2, 3, 4, 5$). Panel (A) reports the values for capital, measured in thousands of euros. Panel (B) reports the values for labor, measured in thousands of hours worked. Values are winsorized at 98% within each age of each firm group.

As a final check, we consider the possibility that the results are particular to the years that we are studying. To address this we have repeated the analysis for labor using firms born in 2005 to 2008, and find very similar results.[9] Firms that are larger at age one are generally less likely to have exited by age 10, and the patterns in Figure 3b hold: firms that live longer tend to start out larger, and these size differences are persistent.

Overall, the empirical results for Propositions 1 and 2 provide consistent evidence of the important role that the initial conditions of firms play in determining their outcomes. This has implications that warrant consideration in the design of policies related to firm creation and growth. A common policy is to encourage the creation of firms in order to promote economic growth. If initial conditions of firms are important for their outcomes, then the types of firms that enter matters. A policy that subsidizes firm entry, for example, and encourages the creation of relatively small firms may not contribute much to the economy since, on average, these firms don't grow much. One might be particularly concerned about this since subsidies may be most attractive to small marginal firms.

4.3. Proposition 3

Proposition 3 tells us that capital and labor should be proportional to $\tilde{z}^{\frac{1}{1-\varphi}}$ over time if there are no frictions. By comparing the implied paths with the actual paths for capital and labor provides a measure of the size of frictions in the economy. To the extent that there are frictions to an input, it will grow at a faster rate than is implied by productivity

9. See Appendix A for the details of the 2005–2008 cohort.

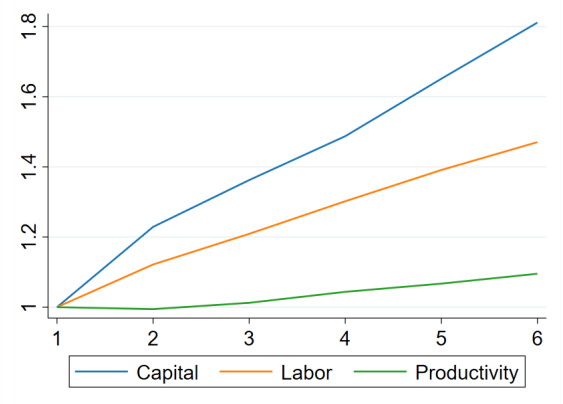


FIGURE 5: Average values by firm age relative to age 1.

Notes: This figure presents the average values for capital, labor and productivity by firm age relative to its respective value at age 1. The sample only includes firms that live to at least age six, so that we track the same firms over time. Values are winsorized at 98% within each age.

growth. Therefore, in the data, we need a measure of productivity, $\tilde{z}$, and a measure of the returns to scale of the production technology, φ, to measure frictions.

The difficulty with implementing this exercise in practice is that the returns to scale parameter is difficult to estimate, and the results are very sensitive to it. For example, consider two plausible values for φ, 0.8 and 0.9, that cover a reasonably narrow range relative to the breadth of empirical estimates. For these values, consider the effect of a 10% increase in productivity. $\varphi = 0.8$ implies a 60% increase in k and l, whereas $\varphi = 0.9$ implies a 160% increase in them. These two values will therefore imply very different levels of frictions in the economy.

Given this issue we perform a more modest exercise. We start by plotting the evolution of average capital, labor and productivity for firms that live until at least age six in Figure 5. Taking the value of these paths at age six, we can infer the values of φ that would be implied by the paths for capital and labor if they were observed in a frictionless economy. This produces $\hat{\varphi} = 0.85$ for capital and $\hat{\varphi} = 0.76$ for labor. These estimates suggest that there are relatively more frictions impeding capital when firms are young, than labor, because capital is growing faster. We explore this more in relation to Proposition 4 in the next subsection.

4.4. Proposition 4

The final part of the empirical analysis focuses on assessing the relative strengths of frictions to labor and capital. Based on Proposition 4, we study how the capital to labor ratio evolves with firm age. We interpret an increase in this ratio with age as evidence of capital being relatively more constrained than labor, and a decrease as evidence of labor being relatively more constrained.

Figure 6 presents the evolution of the capital to labor ratio in the same format as the results for capital and labor in Figure 4. That is, we separate firms into groups determined by how long they live for, so that age effects are not contaminated by selection effects due to exit. The figure shows that the capital to labor ratio tends to

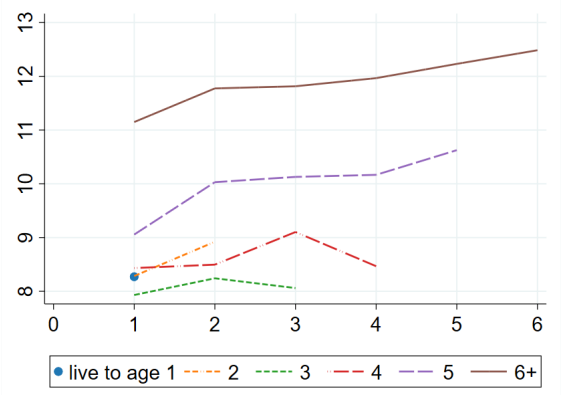


FIGURE 6: Capital to labor ratio by firm age, conditional on survival.

Notes: This figure presents the average capital to labor ratio by firm age for six groups of firms, measured in euros per hour worked. The figure is constructed in the same way as Figure 4.

increase over time, on average. Firms that live longer, in particular those that live for at least 5 or 6 years, clearly increase the relative size of their capital input. This result suggests that frictions to capital accumulation are *relatively* large compared to those on labor. Given that Portugal has quite rigid labor markets, this suggests that frictions to capital accumulation are significant.[10]

To check the robustness of these results we perform the same regression analysis as we did for the results for capital and labor growth in Figure 4, and assess whether the patterns are different in manufacturing and services. From the regressions we find that controlling for birth year, year and sector do not affect the results. Regarding manufacturing versus services, one might think that capital market frictions would be more important in the former. However, the results are quantitatively similar for these sectors.[11]

An additional interesting feature of Figure 6 is that firms that live for longer tend to have higher capital to labor ratios, and these differences are persistent. In the frictionless version of the model, all firms have the same capital to labor ratio. An extension to the model that would generate variation in these ratios is if firms have production technologies with different capital intensities, as determined by α. Interpreted in this way, the data suggest that firms that live for longer choose more intensive capital technologies. Another possible extension is that firms that live for longer are less financially constrained (higher values of θ), allowing them to start with more capital. However, if this were true, then the model says that the capital to labor ratio will grow

10. For evidence on the relative flexibility of labor markets across countries see OECD (2020) and Institute (2019). In OECD (2020) Portugal ranks in the lower half of OECD countries for most measures of labor market flexibility. In Institute (2019) Portugal ranks 38 out of 41 for employment flexibility among the EU and OECD countries studied.

11. See Appendix D for details.

more, in percentage terms, for firms that start with a lower ratio.[12] While there is some evidence of this in Figure 6 with the ratio growing more for firms that live to age five than firms that live to age six or beyond, the figure does not provide clear support for this theory.

One limitation of the analysis that is important to note is that we are measuring capital with the stock of owned capital. This excludes rented capital. This could be playing a role in the increasing capital to labor ratio if younger firms systematically rent a higher share of their capital. To investigate this we have measured the ratio of expenses on rented capital to the value of the stock of capital, and assessed how it evolves with firm age. We find that younger firms do have a higher value for this ratio, indicating that this issue is worth considering further.[13] There are several measurement issues with quantifying the effect of this, including estimating a suitable implied rental rate for owned capital, which we leave to future research.

5. Conclusion

Firm behavior is central to answering many modern macroeconomic questions, including the role of firms is driving aggregate growth, the design of government policies to promote growth, and what type of support a government should provide firms during a recession, if any. This paper contributes to our understanding of firms by studying the relative significance of initial conditions vs post-entry shocks for firm outcomes, and by evaluating the relative importance of capital versus labor market conditions.

We present a simple theory of firm production over the lifecycle that provides a number of predictions to disentangle initial conditions from post-entry shocks, and to distinguish labor market frictions from frictions to capital accumulation. We find evidence for the important role of initial conditions from the persistence of firm size and the relationship between initial firm size and exit rates. The evolution of capital to labor ratios are shown to be informative about the relative sizes of frictions to capital and labor, and the evidence points to capital market frictions being relatively more important.

While the analysis does not explicitly consider policies, the results have suggestive implications. The role of initial conditions in firm outcomes raises the question of whether a general policy promoting firm creation to drive economic growth will be effective, or whether it is important to consider the types of firms being created. The finding that frictions affecting capital are larger than those affecting labor provides motivation for further investigation into the nature of these frictions, and whether there are ways to ease them.

12. In the model, capital to labor ratio in period two divided by the capital to labor ratio in period one, in the case in which capital is constrained, is $\theta^{-(1-\varphi)/(1-\varphi(1-\alpha))}$.

13. See Appendix E for more details.

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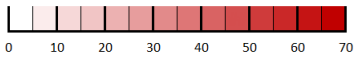
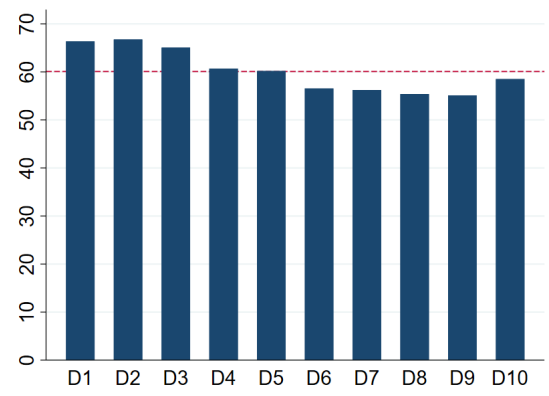
Appendix: Labor for 2005–08 cohort

This section replicates the analysis performed in Sections 4.1 and 4.2 for firms born in 2005-–08. Since 2005 is the first year of the dataset, we need to take a different approach to defining the birth year of firms for this analysis. We define a firm to be born in year t if this is the year in which the firm was constituted, it is the first year that the firm is in the data, and the firm has at least one employee in this year. For this sample we can follow firms up to age 10 instead of age 6.

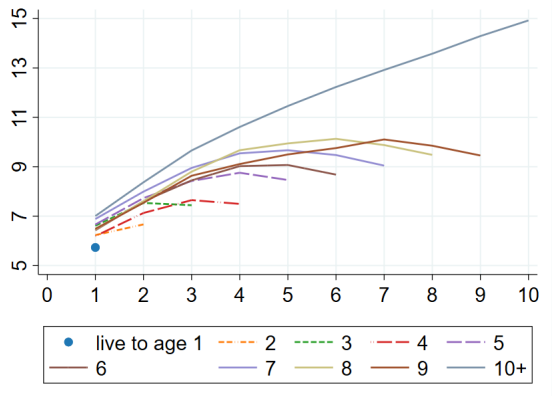
Age 1 \ Age 10	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
D1	**30**	19	14	9	8	6	5	4	3	2
D2	19	**27**	13	12	8	7	5	4	3	2
D3	13	13	**17**	14	12	9	8	6	4	3
D4	11	12	17	**18**	13	9	8	5	4	2
D5	9	10	13	16	**14**	12	9	7	5	3
D6	6	6	11	12	17	**16**	11	10	8	4
D7	5	4	7	8	12	16	**17**	13	10	6
D8	4	4	4	6	9	14	18	**17**	15	8
D9	2	2	3	3	5	8	14	23	**25**	15
D10	2	1	1	2	2	2	4	9	22	**55**



(A) Transition matrix in the data for labor.



(B) Exit rate (percentage) by size decile at age one.



(C) Labor by firm age, conditional on survival.

FIGURE A.1: Labor figures for 2005–08 cohort.

Notes: This figure repeats the analysis in Sections 4.1 and 4.2 for labor using firms born in 2005 to 2008. Panel (A) This figure presents the firm-size transition matrix computed using firms' labor deciles at age 1 and age 10. Panel (B) presents the share of firms at age 1 that close by age 10, measured in percentage. Panel (C) presents the average labor ratio (hours worked) by firm age for ten groups of firms, measured in thousands of hours. The figure is obtained after controlling of year fixed effects. For details on how to read the figures, see Figures 1, 3 and 4.

Banco de Portugal
Banco de Portugal Economic Studies, Vol. VIII, No. 4

Non-technical summary

October 2022

A circular business cycle clock for Portugal

Nuno Lourenço, António Rua

The analysis and monitoring of the business cycle have always been of major interest to policymakers and economic agents in general. Several international organisations that monitor economic conditions regularly have thus devoted a lot of effort to develop tools to assess the current state of the economy. A widely proposed tool to depict the cyclical stance of the economy concerns the so-called business cycle clock, in which the cyclical component of selected series is displayed through a four-quadrant representation.

Drawing on a novel methodology, a business cycle clock for Portugal resorting to circular statistics is proposed. This approach not only retains the appealing features of a clock representation, but also allows handling the information content embedded in large datasets that are now widely available. As individual series may point to different directions regarding the business cycle momentum, those signals are summarised in a single direction. In particular, the clock reads counterclockwise, where 90 degrees (270 degrees) denotes the peak (trough) of the business cycle and the different signals are summarised by the mean direction (red arrow). The dispersion of these signals is represented by the circular histogram, where the heigth of each blue bar denotes the number of indicators that have the corresponding direction falling within a 10 degrees range. Moreover, the confidence intervals associated with the mean direction are also depicted through an arc around it.

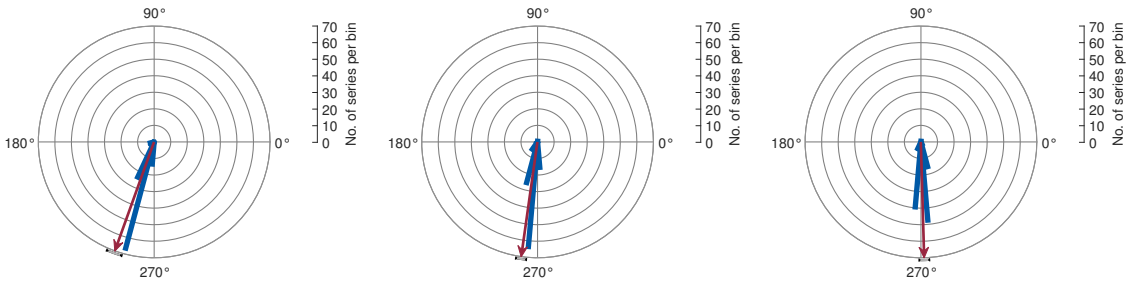


FIGURE 1: Business cycle clock during the trough following the COVID-19 shock.

Taking as an illustration the onset of the COVID-19 pandemic, we present in Figure 1 the clock for the months around the business cycle trough in 2020. We report the business

cycle clock for the month identified by the OECD as a trough (May-2020) as well as for the previous and subsequent months. One can see that the mean direction points to the bottom (270 degrees), thus signalling a trough in economic activity in this time period.

In general, we find that such tool is quite informative to gauge peaks and troughs in economic activity as well as tracking the overall business cycle. The performance of the business cycle clock is also assessed in a pseudo real-time context during the turning points, corroborating its usefulness in identifying such challenging episodes.

A circular clock for the year-on-year growth rate is also put forward, given the previous work in tracking yearly changes in the Portuguese economy. The results also point to a timely and reliable identification of turning points in economic activity.

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A circular business cycle clock for Portugal

Nuno Lourenço
Banco de Portugal

António Rua
Banco de Portugal
Nova SBE

October 2022

Abstract
The assessment and tracking of business cycles have always played an important role in policymaking and economic decisions in general. In this respect, the use and development of business cycle clocks have long attracted a lot of attention among national and international organisations. Building on circular statistics, a novel approach is pursued to depict the business cycle momentum in Portugal resorting to a large monthly dataset. We show that such approach allows for a timely and reliable tracking of business cycle developments, namely during peaks and troughs which typically constitute a challenge for economic monitoring. In addition, a circular clock for the year-on-year growth rate cycle is put forward. (JEL: C30, C55, E32.)

1. Introduction

Understanding how an economy evolves over time is essential to derive sound economic policies. This is why the analysis of the business cycle stance is considered a critical instrument not only to identify the current state of the economy, but also to formulate macroeconomic policies to influence prospects for economic growth.

In fact, the seminal contributions by Burns and Mitchell (1946) for the United States laid down the foundations for the empirical assessment of the business cycle stance. In particular, it was acknowledged the pervasive nature of economic fluctuations, thus motivating the assessment of a wide range of economic indicators. The increasing data dissemination by statistical authorities has made this comprehensive assessment easier, as a wide range of disaggregated indicators are now regularly published, resulting in the so-called data-rich environments.

In the past few decades, a lot of attention has been devoted to the development of tools to enhance the visualisation of the cyclical stance of selected or economy-wide indicators. In this regards, a widely proposed instrument concerns the so-called business cycle clock, which serves as basis for many economic analyses of national and international institutions that monitor economic conditions regularly.

Note: The analyses, opinions and conclusions expressed herein are the sole responsibility of the authors and do not necessarily reflect the opinions of Banco de Portugal or the Eurosystem.

E-mail: nalourenco@bportugal.pt; antonio.rua@bportugal.pt

Previous work on business cycle clocks dates back to the 1990s, when the Ifo institute developed a business cycle clock by plotting the current business situation of German firms against their expectations for the next six months (see Nerb (2004) and Abberger (2006) for a critical review).

As the amount of statistical data released has become progressively larger, new tools to visualise the cyclical stance of a wide range of indicators have been proposed. In this spirit, the Statistics Netherlands developed a tool named the business cycle tracer consisting of the graphical display of thirteen lagging, coincident and leading indicators for the Dutch economy (see Ruth *et al.* (2005) for details).

Advancing on the initially proposed survey watch, the European Commission has been using for several years in its regular publications an economic climate tracer (Gayer (2008)).[1] This draws on principal component analysis of balance series stemming from the monthly business and consumer surveys conducted by the European Commission. Other examples of business cycle clocks include Destatis (2010) for Germany or Statistics Denmark (2013) for Denmark.

Drawing on the novel methodology introduced by Lourenço and Rua (2022), we develop a business cycle clock for Portugal relying on circular statistics. This approach allows taking on board a large number of series. As each individual series may potentially point to a different direction regarding the business cycle momentum, it is also important to summarise those signals in a single direction. Hence, the proposed circular business cycle clock not only depicts the circular histogram providing information on the dispersion of the signals, but also displays the mean direction along with its corresponding confidence interval. Such features allow for a more encompassing assessment of the cyclical stance of the economy than previous approaches.

Resorting to a large monthly dataset for the Portuguese economy, we assess the behaviour of the circular business cycle clock, namely during the turning points in economic activity. Such episodes are of particular interest from a policymaking point of view and constitute a challenge in terms of macroeconomic monitoring. We also assess its overall performance vis-à-vis other alternative procedures in tracking the business cycle. The results are supportive of its informational content, even in a pseudo real-time context.

Furthermore, we develop a circular clock for the growth rate cycle given the past interest in tracking yearly changes in the Portuguese economy. We find that the circular clock performs well during the turning points in economic activity and can constitute a valuable tool for tracking current economic developments.

The remainder of this paper is organised as follows. Section 2 introduces the methodology underlying the circular business cycle clock. Section 3 describes the dataset. In Section 4, the business cycle clock and the economic growth clock for Portugal are presented. Finally, section 5 concludes.

1. The survey watch relied on the representation of manufacturers' current business perceptions against their production expectations for the next three months.

2. Methodology

The idea underlying the business cycle clock is to depict the cyclical stance of economic activity through a four-quadrant representation, based on the cyclical component of selected series. This is often obtained as the deviation from its long-term trend, with the resulting level being plotted against its month-on-month change (Figure 1). Thus, it is possible to evaluate if a given indicator lies above or below its long-term trend, while assessing if it is improving or worsening in the short-run. The business cycle clock has a counterclockwise reading along the four phases of the business cycle, where the peaks are identified at the top centre of the diagram and the troughs at the bottom centre.

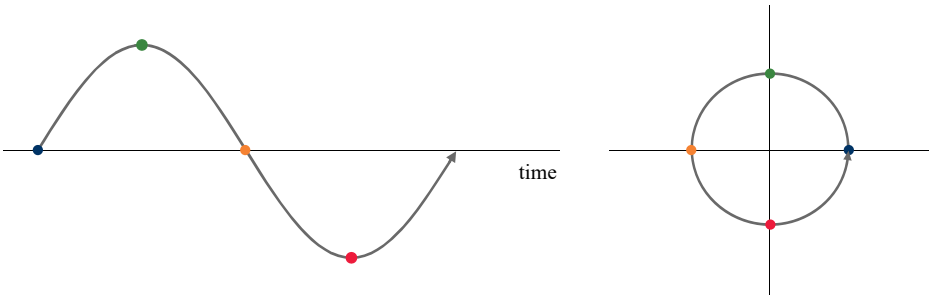

FIGURE 1: Stylised business cycle and corresponding clock.

Recently, Lourenço and Rua (2022) proposed a novel business cycle clock resorting to circular statistics. The use of circular statistics in this context seems natural given the recurrent nature of the business cycle. In contrast with previous literature, where the business cycle momentum is displayed in the Cartesian coordinate plane, Lourenço and Rua (2022) suggest its representation through polar coordinates. In fact, any point displayed in the Cartesian plane can be defined by a distance from the origin and an angle θ_i (Figure 2).

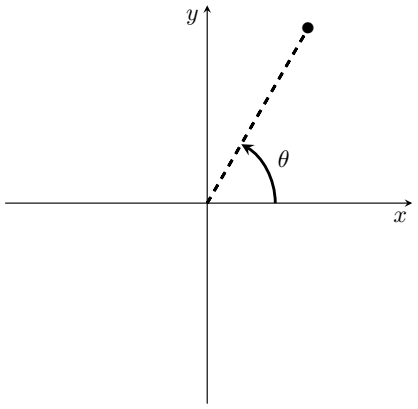

FIGURE 2: Illustrative angle computation.

Given N indicators, one ends up with N directions defined by the corresponding angle associated with each indicator. This implies that we have N possible indications about the current stance of the business cycle. In a data-rich environment, where dozens or hundreds of indicators are available, it becomes critical to summarise those

indications in a single direction. Hence, the circular business cycle clock proposed by Lourenço and Rua (2022), besides displaying the histogram for the sample of angles which provides information on the dispersion of the directions, also conveys the mean angle along with its corresponding confidence interval.

Succinctly and following Lourenço and Rua (2022), consider a random angle θ and a sample of N angles, $\theta_1, \theta_2, ..., \theta_N$. The sample uncentred p^{th} trigonometric moment is given by

$$t_{p,0} = \frac{1}{N}\sum_{i=1}^{N}\left(\cos p\theta_i + i \sin p\theta_i\right) = a_p + ib_p, \tag{1}$$

where $a_p = \frac{1}{N}\sum_{i=1}^{N}\cos p\theta_i$ and $b_p = \frac{1}{N}\sum_{i=1}^{N}\sin p\theta_i$.

The sample centred p^{th} trigonometric moment reads as

$$t_{p,\overline{\theta}} = \frac{1}{N}\sum_{i=1}^{N}\left[\cos p\left(\theta_i - \overline{\theta}\right) + i \sin p\left(\theta_i - \overline{\theta}\right)\right] = \overline{a}_p + i\overline{b}_p, \tag{2}$$

where $\overline{a}_p = \frac{1}{N}\sum_{i=1}^{N}\cos p\left(\theta_i - \overline{\theta}\right)$, $\overline{b}_p = \frac{1}{N}\sum_{i=1}^{N}\sin p\left(\theta_i - \overline{\theta}\right)$ and $\overline{\theta}$ denotes the mean angle. A confidence band for the mean angle is given by $\pm z_{\frac{\alpha}{2}}\sqrt{\frac{1-\overline{a}_2}{2N\overline{R}^2}}$, where $\overline{R} = \sqrt{a_1^2 + b_1^2}$ and $z_{\frac{\alpha}{2}}$ denotes the upper quantile $\frac{\alpha}{2}$ of the $N(0,1)$ distribution.

3. Data

The monthly dataset for Portugal used in the empirical application draws extensively on previous research on forecasting or business cycle dating in a data-rich environment (Dias *et al.* (2015), Rua (2017) and Dias *et al.* (2018b)). It covers the period from January 1995 up to December 2021 and comprises both hard and soft data, amounting to 126 series overall.

The panel of series includes the following broad categories: industrial production, turnover in industry and services, retail trade sales, employment, hours worked and wage indices in industry and services, overnight stays in tourist accommodation establishments, car registrations, cement sales, vacancies and registered unemployment, energy consumption, international trade of goods, real effective exchange rate, Portuguese stock market index, ATM/POS series and business and consumer surveys. The latter conveys sectoral information (e.g. assessment of recent and future trends in production) in the industry (manufacturing), services, retail trade and construction, as well as consumers, who are asked, inter alia, about their spending and savings intentions.

As followed by the European Commission in the business and consumer surveys compilation, the series on the unemployment over the next 12 months (consumers survey) and on the assessment of stocks (manufacturing and retail trade surveys) were sign-inverted. The registered unemployment and the unemployment rate series have also been sign-adjusted. Finally, excluding the survey data and the unemployment rate, all series were log-transformed.

4. Empirical results

4.1. The circular business cycle clock

As alluded before, the development of business cycle clocks has been centred on the concept of growth cycles, that is, deviations from a long-term trend. In this respect, it has been current practice in previous work on business cycle clocks to use the well-known Hodrick and Prescott (1997) filter for detrending and smoothing the economic indicators.

Following Lourenço and Rua (2022), to assess the usefulness of the resulting business cycle clock for Portugal in tracking turning points in economic activity, we resort to the monthly growth cycle chronology put forward by the OECD.[2] One should note that the focus herein is on the growth cycle and not the classical cycle, which draws on the evolution of the level of economic activity. For dating classical business cycles for Portugal see, for example, Rua (2017). To make such comparison feasible, we adopt the same approach pursued by the OECD embedded in dating the growth cycle namely by using the HP filter as a band-pass filter. In particular, the HP filter is run twice, firstly to remove the trend and secondly to smooth the series by discarding the high frequencies. This implies using a high value for the HP parameter λ in the first step and a small value in the latter stage. In particular, such values are chosen so that one retains the cycles with duration between 12 and 120 months.[3] In practice, it corresponds setting λ to 133107.94 and 13.93, respectively. One should mention that, as stressed by Lourenço and Rua (2022), the circular business cycle clock can be computed with any filtering method which renders series stationary.[4]

The circular business cycle clocks for Portugal around all the turning points since 2003 are reported in Figure 3. Each row in Figure 3 corresponds to a turning point, either a peak or a trough, and for each turning point, we present the business cycle clock for the month identified by the OECD as a peak or a trough as well as for the previous and subsequent months. Each business cycle clock displays the histogram of the sample angles, where the histogram bins are plotted as blue straight bars with a width of 10 degrees. That is, the heigth of each blue bar denotes the number of indicators that have the corresponding direction falling within a 10 degrees range. Hence, the sum of the height of all blue bars corresponds to the number of series. The red arrow represents the mean direction which corresponds to the average of the directions given by all the indicators. On top of that, the corresponding confidence intervals are shown on the outside edge of the circle as arcs. In particular, the gray and black lines indicate the 95 and 99 per cent confidence intervals, respectively.

2. See `https://www.oecd.org/sdd/leading-indicators/CLI-components-and-turning-points.csv`

3. Although the business cycle literature, in particular for the United States, tends to consider cycles of duration between 1.5 and 8 years, there is evidence that business cycles may last longer in Europe as argued by the OECD.

4. In this respect, we also considered the band-pass filter suggested by Christiano and Fitzgerald (2003) and the results are similar.

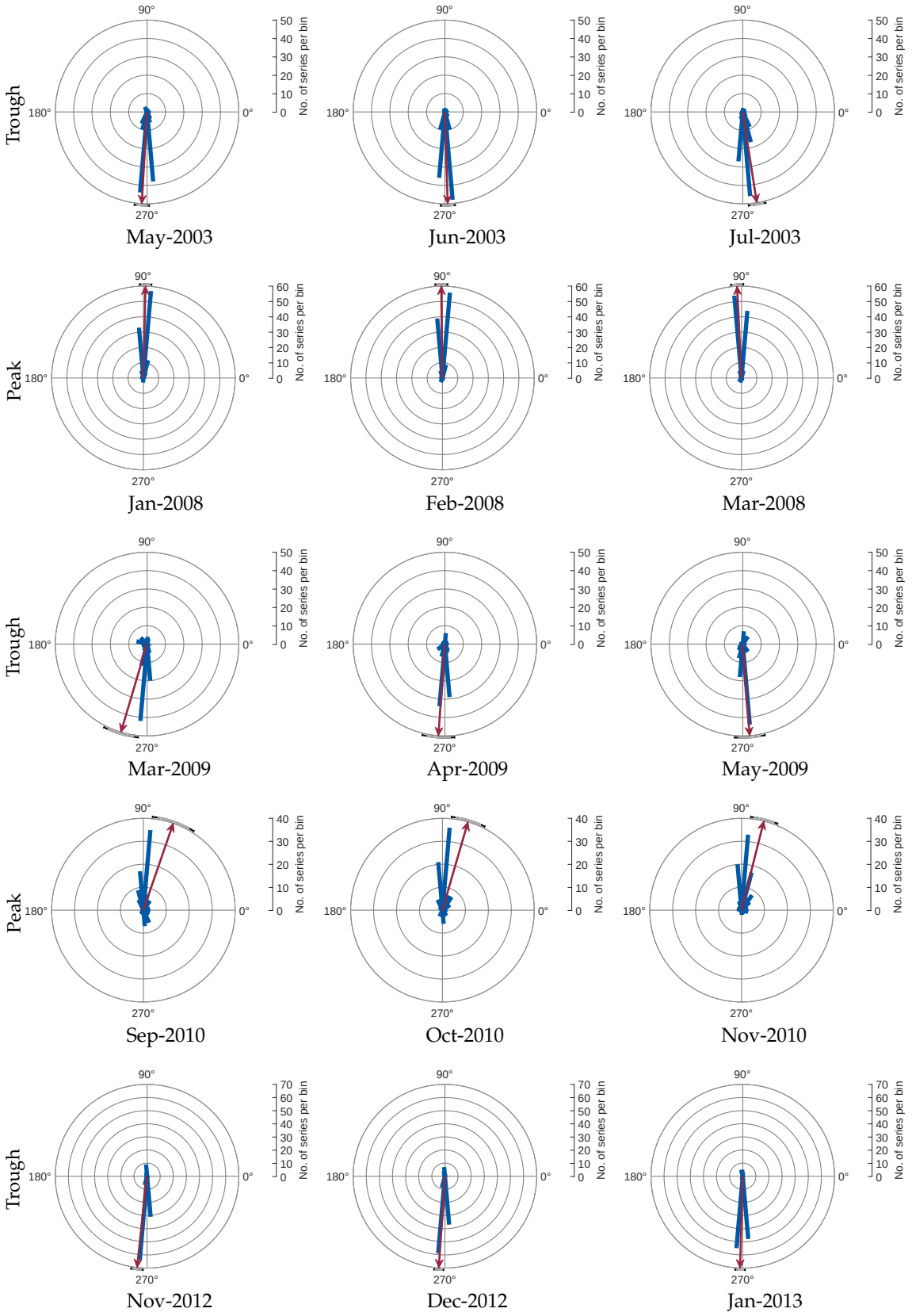

FIGURE 3: Business cycle clock around the turning points.

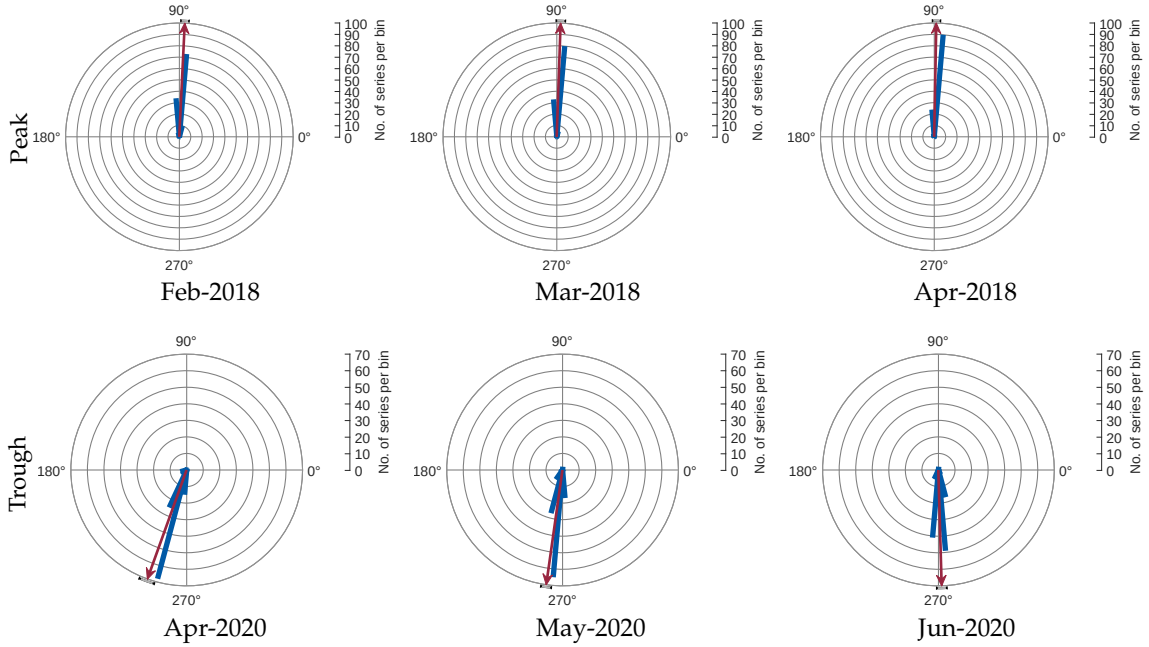

FIGURE 3: Business cycle clock around the turning points (continued).

One can conclude that, in general, the mean direction always points clearly to the bottom (270 degrees) during the troughs and to the top (90 degrees) during the peaks as desired. In detail, one can see that both in the trough in 2003 and in the peak in 2008, the circular business cycle clock reading coincides with the OECD chronology. During the Great Recession in 2009, the mean direction crosses the 270 degrees direction between April and May. In both months, based on the confidence interval, one cannot reject that the trough has been attained, although the mean direction is closer to 270 degrees in April, which matches the OECD monthly dating. Regarding the peak at the end of 2010, the business cycle clock readings suggest that the peak has been reached a few months after the month identified by the OECD. According to the OECD chronology, the peak was reached in October 2010 whereas the mean direction points to February 2011 (although one cannot reject that the peak could also have been reached in January 2011). Concerning the trough at the end of 2012, the circular business cycle clock points to its occurrence at the beginning of 2013 while the peak in 2018 cannot be rejected to have occurred in March. In what concerns the trough during the COVID-19 pandemic, the mean direction points to June, which corresponds to one month after the month in the OECD chronology.

The above analysis has been focused on the evaluation of the behaviour of the circular business cycle clock during the turning points. Such analysis can be complemented with the assessment of the informational content of the mean direction regarding the overall evolution of the business cycle. That is, instead of focusing solely on turning points, this type of analysis provides further insights on how the mean direction tracks business cycle developments every month. To conduct such evaluation, a monthly measure of the business cycle for Portugal is required. A proxy can be obtained by resorting to the monthly coincident indicator for the Portuguese economic activity which has been

released by Banco de Portugal on a monthly basis since 2004 (see Rua (2004, 2015)). The monthly coincident indicator for the economic activity is a composite indicator that merges information from quarterly real GDP as well as from higher frequency variables and is available at a monthly frequency. Taking its trend-cycle format, one can apply the same filtering procedure discussed earlier to obtain the cyclical component.[5]

The correlation between such cyclical component and the mean direction can be computed by

$$r_{z\theta} = \sqrt{\frac{r_{zc}^2 + r_{zs}^2 - 2r_{zc}r_{zs}r_{cs}}{1 - r_{cs}^2}} \tag{3}$$

where $r_{zc} = corr(z, \cos\theta)$, $r_{zs} = corr(z, \sin\theta)$ and $r_{cs} = corr(\cos\theta, \sin\theta)$, with $corr$ denoting the usual Pearson correlation coefficient.

In Figure 4, we report the contemporaneous correlation as well as the correlation for the leads and lags up to 6 months. One can see that the correlations are basically symmetric around the contemporaneous one, supporting the coincident nature of the proposed business cycle clock. To provide a term of comparison to the performance of the mean direction, we considered two alternative approaches. Firstly, instead of the mean direction we computed the median direction. That is, instead of using the average of the sample angles, we consider the corresponding median. Secondly, we resorted to a factor model to extract the common factor underlying the dataset and computed the corresponding direction. The results are also displayed in Figure 4. One can conclude that the clock based on the factor outperforms the median direction but both are worse than the mean direction.

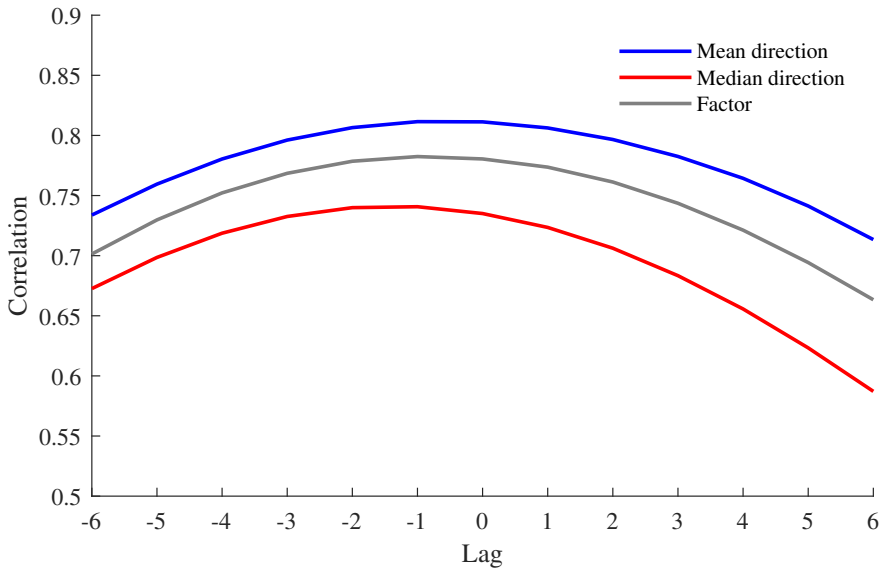

FIGURE 4: Correlations with the cyclical component of the monthly coincident indicator.

5. Alternatively, one could take the quarterly GDP series and perform a monthly disaggregation with to the well-known Chow-Lin method, as pursued by Lourenço and Rua (2022). We find that the results are qualitatively similar.

As extensively discussed in the literature, the use of any filtering method entails revisions namely at the end of the sample. In fact, decomposing a series in trend, cycle and irregular components is particularly challenging at the end of the sample and only as time goes by such distinction can be made more reliable and less prone to revisions. Being an issue for any statistical filter, it also applies to the HP filter. In the current context, we assess how such revisions affect the circular business cycle clock namely during the turning points where the reading is more critical. To assess the reliability of the reading of the business cycle clock during the turning points, we computed the clock for every month using data only up to that month, thus mimicking a pseudo real-time exercise. Furthermore, as revisions can be mitigated by extending the series prior to filtering as suggested in related literature, we extend the series resorting to a univariate autoregressive process. In this respect, Nilsson and Gyomai (2011) show that extending the series for a couple of months when applying the HP filter delivers the best performance in terms of revisions around the business cycle turning points.

Figure A.1 in the Appendix displays the circular business cycle clock in a pseudo real-time context to illustrate the impact of the revisions induced by the filtering procedure. Despite the inherent difficulties in detecting the turning points in real-time, we find that the readings in pseudo real-time are in general similar to the ones presented in Figure 3. In fact, the mean absolute revision during such episodes is close to eight degrees.

4.2. A circular clock for the growth rate cycle

In the case of Portugal, there has been a long tradition to put forward tools that allow tracking and monitoring the year-on-year evolution of the economy. In this respect, one should mention the early work by Dias (1993) who proposed a quarterly coincident indicator for the Portuguese economy, followed by Gomes (1995) who resorted to the same approach to deliver a composite indicator for private consumption. The compilation and release of these two indicators have been replaced by the monthly coincident indicators developed by Rua (2004, 2005) drawing on the methodology proposed by Azevedo *et al.* (2006). More recently, a daily economic indicator for the year-on-year evolution has been put forward by Lourenço and Rua (2021). In what concerns short-term forecasting the Portuguese economy, there is also a body of work devoted to forecasting year-on-year growth rates. See, for example, Esteves and Rua (2012) for a GDP bottom-up approach forecast, Dias *et al.* (2018a) for forecasting exports of goods and Lourenço *et al.* (2021) for tourism forecasting.

As stressed earlier, the suggested circular approach can be applied to any filtering technique, including the yearly difference.[6] Hence, in the detrending step, instead of using a HP filter, we consider the yearly difference. On top of that, as discussed by Gayer (2008), it is desirable to smooth the series so as to remove erratic fluctuations and improve the reliability of the business cycle clock. In particular, likewise Gayer

6. If the variable is expressed in logs, the yearly difference basically corresponds to the year-on-year growth rate.

(2008), we apply the HP filter to remove short-term movements of duration less than 18 months.[7]

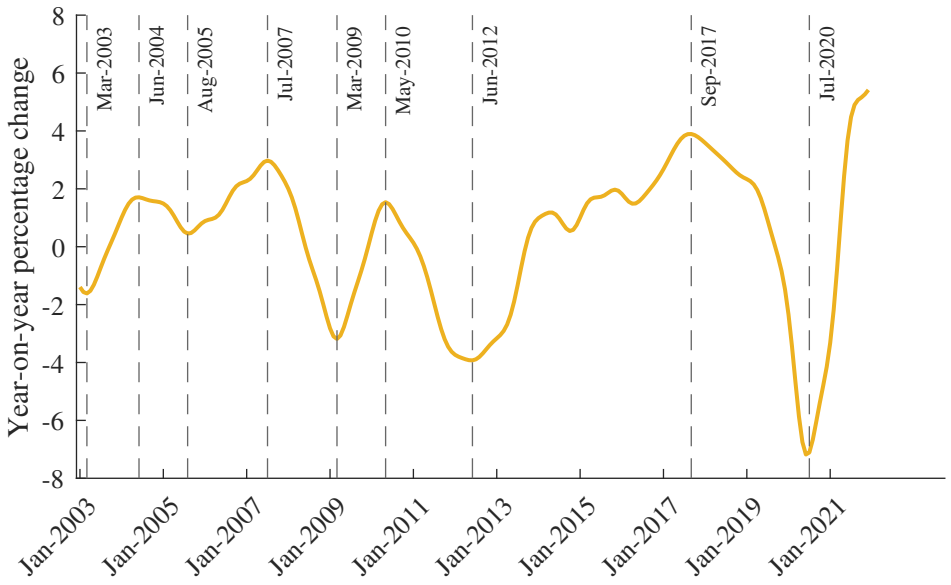

FIGURE 5: Monthly coincident indicator for economic activity.

7. Note that the removal of those short-term fluctuations is also present in the methodology underlying the monthly coincident indicator which is used as term of comparison.

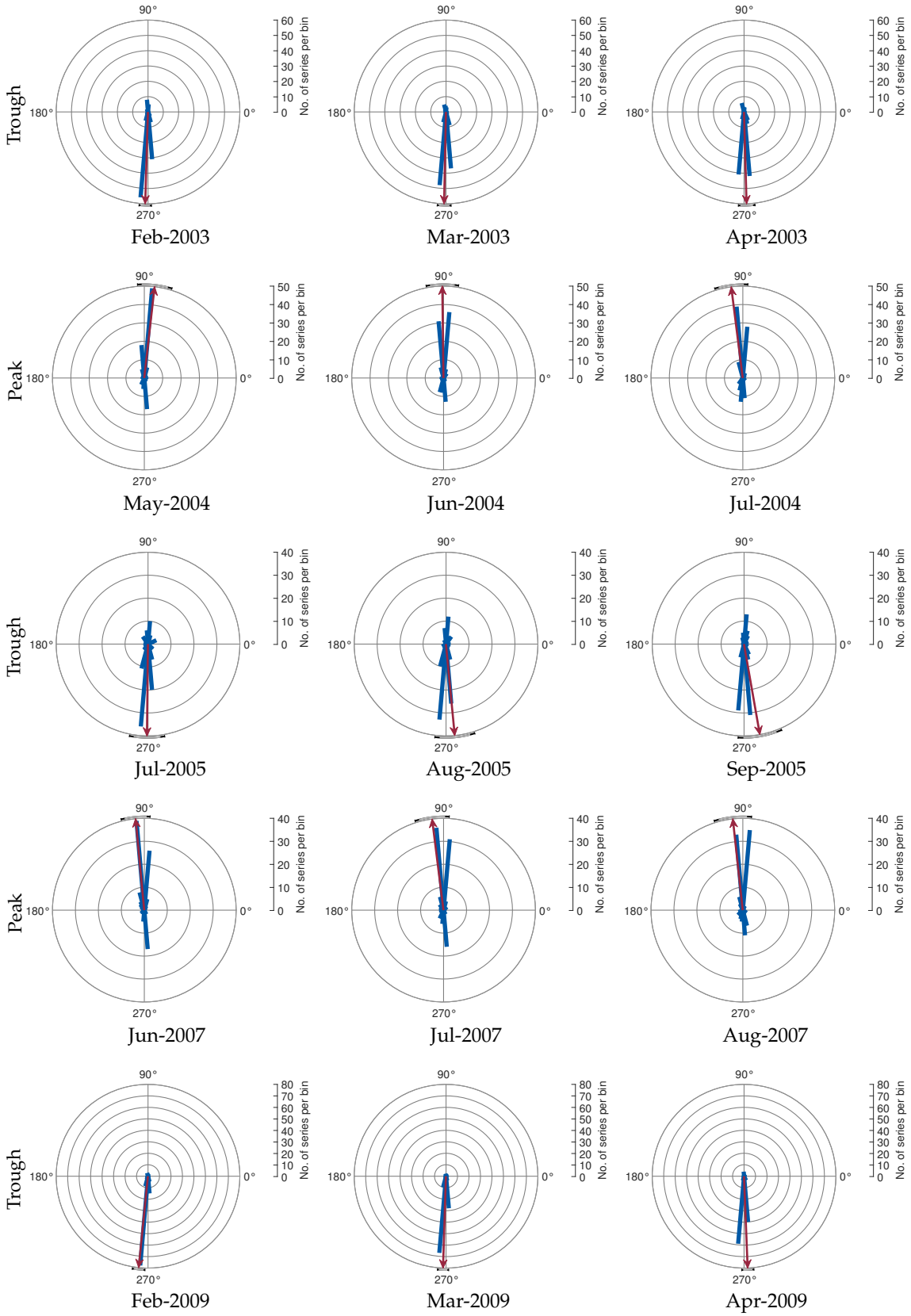

FIGURE 6: Circular clock for the growth rate around the turning points.

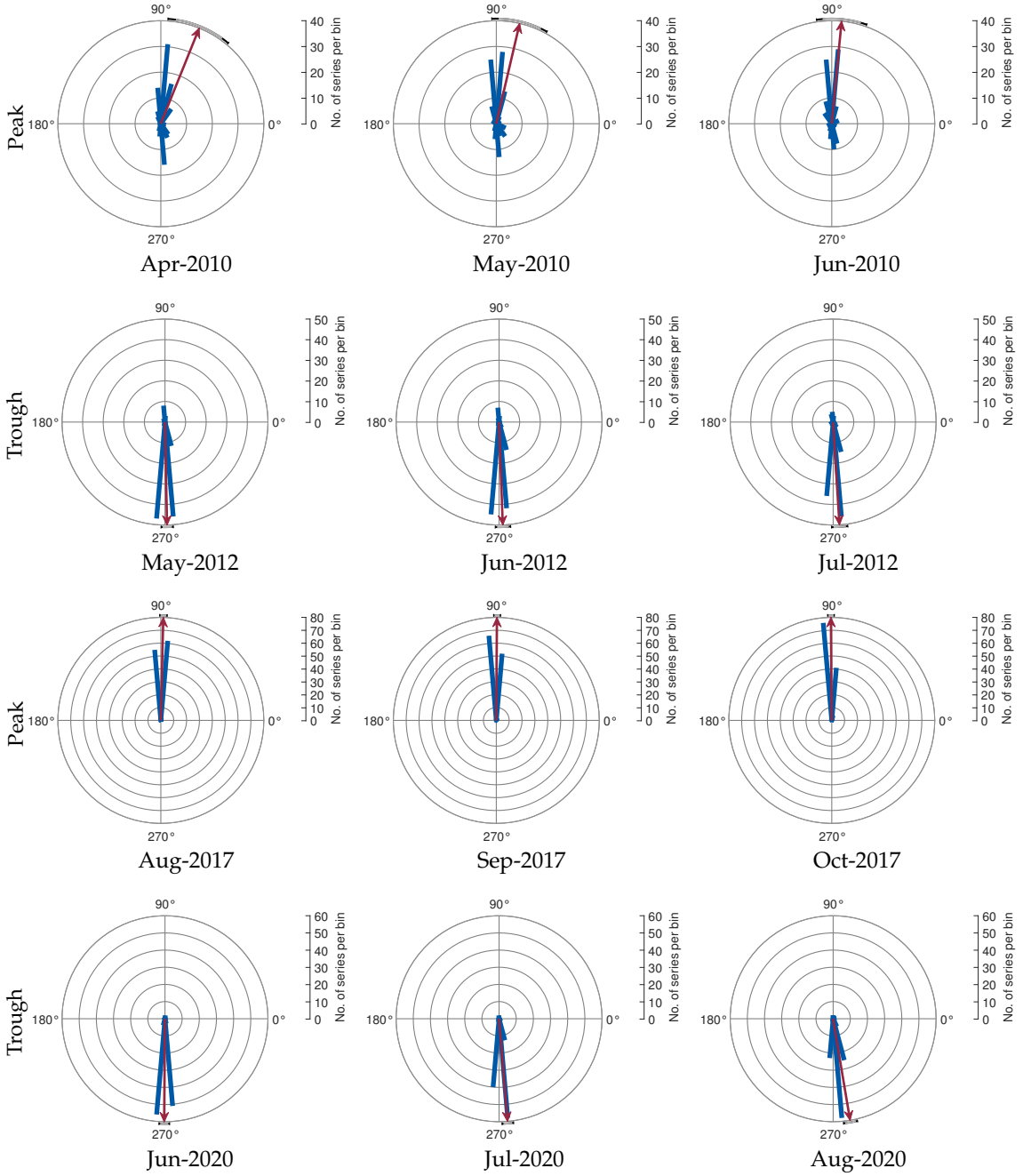

FIGURE 6: Circular clock for the growth rate around the turning points (continued).

As the reference series, we take again the monthly coincident indicator for the Portuguese economy, but now as it is released to the general public, that is, on a year-on-year format, and assess the resulting clock around the corresponding turning points. In particular, the months corresponding to the turning points of the monthly coincident indicator since January 2003 are highlighted in Figure 5, while the clocks for those months as well as for the previous and following months are reported in Figure 6. One can see that for eight out of the nine turning points, the circular clock does not reject the timing of those turning points. That is, the confidence interval includes either the 90 degrees in the case of a peak or the 270 degrees in the case of a trough. Only in the case

of the trough during 2020, the circular clock suggests a different month, namely June instead of July.

In a similar fashion to the analysis conducted earlier, we also consider as alternative procedures the median angle as well as the factor model. In Figure 7, we present the contemporaneous correlation as well as the correlation for the leads and lags up to 6 months vis-à-vis the monthly coincident indicator. The results seem to suggest a slightly leading behaviour of the mean angle but one should note that the correlations for lags between -4 and 0 are all very close to 0.75. More noteworthy is the fact that the correlations for the mean angle are always higher than those obtained with the median and the factor model.

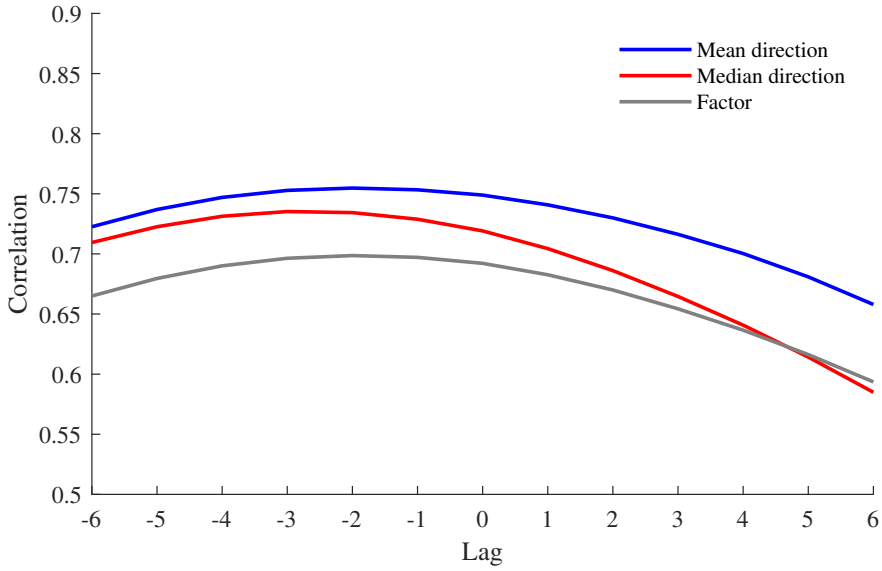

FIGURE 7: Correlations with the monthly coincident indicator.

Although the yearly difference filter does not imply any revisions to the circular clock, the smoothing of the series may lead to revisions. In line with the procedure described earlier, these revisions can also be reduced by extending the series prior to smoothing. Figure B.1 in the Appendix presents the corresponding pseudo real-time clocks. Again, we find that the readings in pseudo real-time are broadly unchanged. In fact, the revisions in this case are lower than in the case of the circular business cycle clock discussed above. In particular, the mean absolute revision around the turning points is less than five degrees.

5. Concluding remarks

The analysis and monitoring of the current business cycle momentum have always been at the core of economic analysis. For instance, this led to the development of the so-called business cycle clocks, which have been used regularly in publications by several national and international organisations. In particular, the business cycle clock depicts the cyclical stance of the economy through a four-quadrant visualisation, based on the cyclical component of selected series.

Building on previous work, we propose a business cycle clock resorting to circular statistics. Such an approach retains the appealing features of the clock representation, while making it possible to depict numerous indicators in a data-rich environment. In fact, the circular clock enables such information to be succinctly displayed by conveying the circular histogram and the mean direction along with its confidence interval.

We find that the resulting business cycle clock is quite informative regarding the peaks and troughs in economic activity as well as business cycle developments in general. We also document its behaviour in a pseudo real-time context during the turning points to assess its reliability in such challenging episodes.

Furthermore, in a similar fashion, we also lay out a circular clock for the year-on-year growth rate cycle given the interest on such developments when monitoring the Portuguese economy. We also find that the circular clock enables a timely and reliable tracking of economic developments, namely during the turning points.

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Appendix A: Pseudo real-time business cycle clock

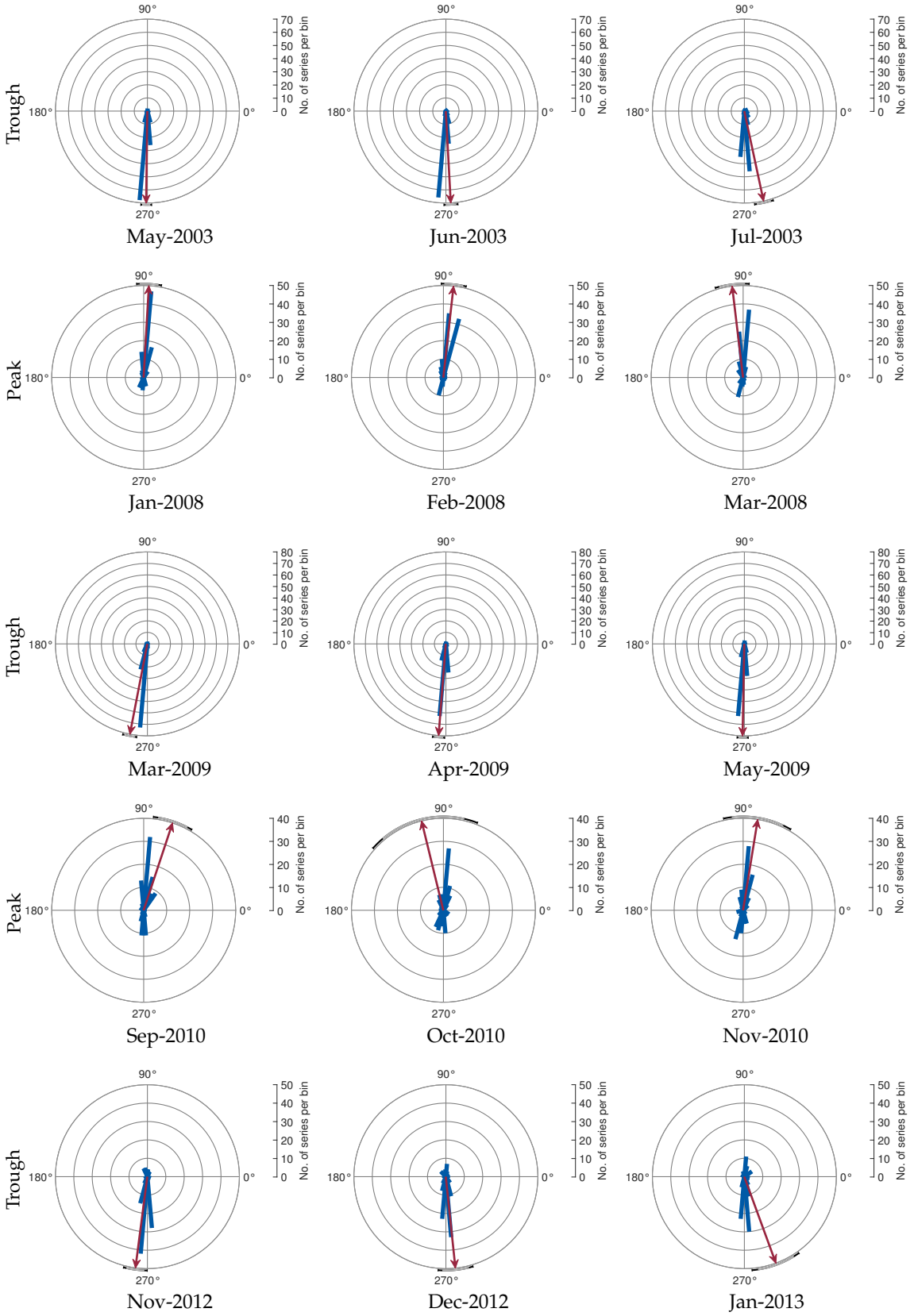

FIGURE A.1: Pseudo real-time business cycle clock.

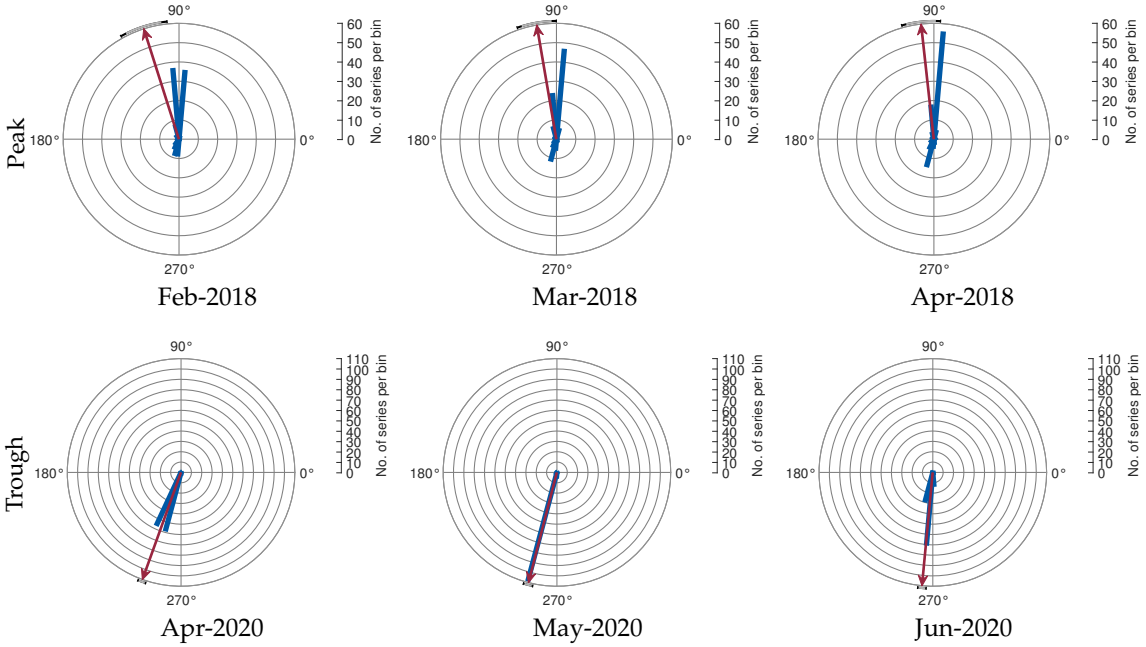

FIGURE A.1: Pseudo real-time business cycle clock (continued).

Appendix B: Pseudo real-time circular clock for the growth rate

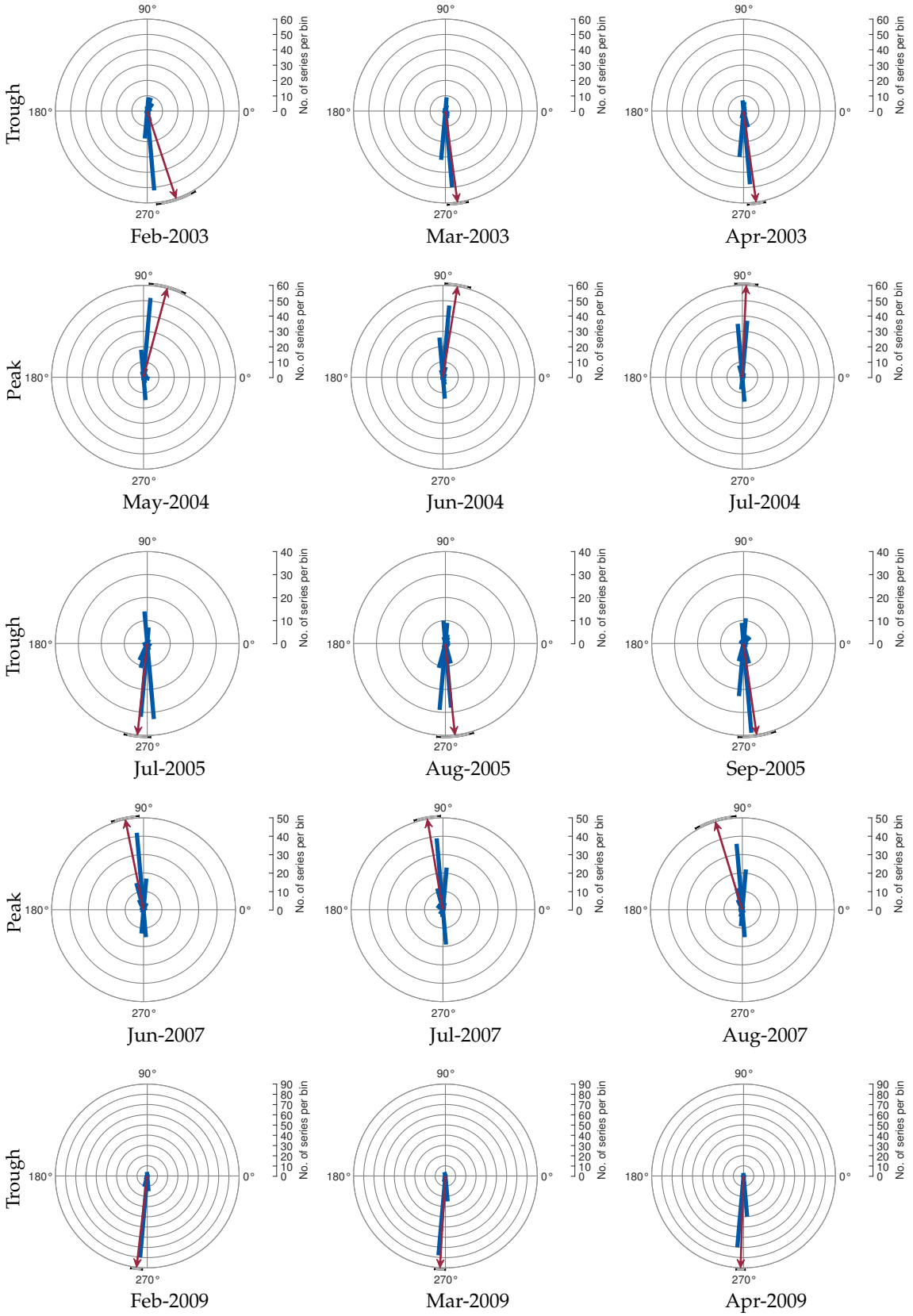

FIGURE B.1: Pseudo real-time circular clock for the growth rate.

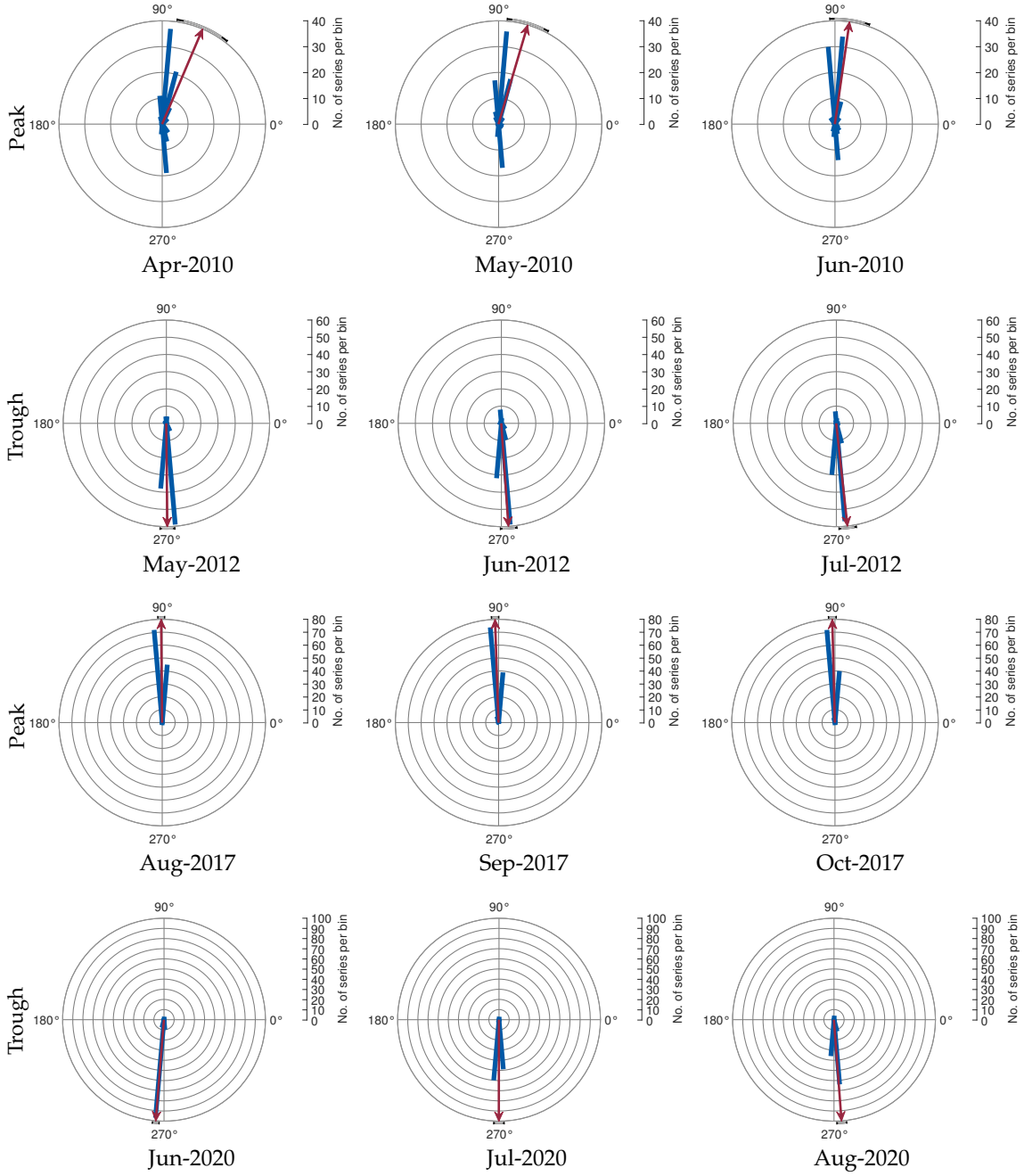

FIGURE B.1: Pseudo real-time circular clock for the growth rate (continued).

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