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The capital share and income inequality: Increasing gaps between micro and macro-data

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Abstract
In this paper, I study how the contrasting coverage of labour and capital incomes affects inequality estimates. I use national accounts as a benchmark to evaluate the scope of household surveys, for a number of countries, and tax data for the United States. Due to both measurement error and conceptual differences, capital income is always more underestimated. In most countries, the gap grows during the last two decades. Based on accounting identities, I show that inequality estimates are likely affected in level, trend and composition. Surveys thus largely exaggerate the impact of changes in the labour income distribution, while they undermine the capital share and its dynamics. As a reference, in a panel of nineteen countries, households collect half of total capital income, as opposed to corporations; but surveys only capture close to twenty percent of that half, versus seventy percent of total labour income. For any quantile group –e.g. the top 10% or bottom 50% share– a unit increase of its labour income share translates into an increase of nine tenths of a unit in the overall share, for capital income, the effect is only one tenth of a unit. Gaps are narrower but still present in tax data.

Keywords Capital Income · Inequality · Top income shares · Measurement error

1 Introduction

During the last 50-60 years most developed countries recorded a substantial growth in their capital share of national income IMF (2007), Arpaia et al. (2009), Piketty and Zucman (2014), and Karabarbounis and Neiman (2014). That is, the part of macroeconomic income remunerating capital, as opposed to labour, has been growing for decades. This phenomenon occurred in parallel to an increasing concentration of personal income (Atkinson et al. 2011; Alvaredo et al. 2018), which has led researchers to explore the relationship between

Replication codes and data are available at: https://github.com/ignacio-flores/income-under-the-carpet, along with an appendix that provides further insight, figures

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factor shares (i.e. capital/labour shares) and the personal income distribution. From a theoretical perspective, accounting identities depict a clear and positive relation between the capital share and overall income inequality (Atkinson and Bourguignon 2000; Milanovic 2017). However, empirical assessments report contradictory findings, which seem to depend largely on underlying data, leaving room for ambiguity (Bengtsson and Waldenström 2018; Francese and Mulas-Granados 2015).

How to explain the divergent findings between the empirical and theoretical parts of this literature? How do different sources measure income composition, and how does it translate into inequality estimates? How do macroeconomic factor shares impact inter-personal income inequality? This article aims to answer these questions by focusing on discrepancies –or data gaps– that emerge when comparing aggregates from different sources. In particular, I study gaps between estimates from the United Nations' System of National Accounts (SNA) and those from distributive data, including both household surveys from the Luxembourg Income Studies (LIS) and tax statistics from the American Internal Revenue Service (IRS). As standard, I consider the SNA to be the benchmark, mostly because its aim is to confront and reconcile a wide variety of data sources, often including household surveys and administrative records too, while preserving accounting consistency (United Nations 2009).

National accounts –which are typically used to estimate factor shares– often report substantially higher aggregate incomes than distributive data sets –from which inequality estimates are computed. This is due to both conceptual differences and measurement error. The most obvious conceptual difference is that the SNA considers all incomes in the economy, including for instance undistributed profits retained in corporations, while distributive data deliberately consider only household incomes (OECD 2013). Yet, even focusing on household income alone, the SNA still uses broader definitions (Zwijnenburg 2016; Zwijnenburg and et al. 2017). Another part of the discrepancy is caused by measurement error in households surveys, which is explained by both sampling and non-sampling issues. The former not only include biases introduced by sampling design, but also the small sample bias, which undermines top incomes (Taleb and Douady 2015). Non-sampling issues include non-random misreporting, which usually results in a negative correlation between income and measurement error (Bound and Krueger 1991; Bollinger 1998; Abowd and Stinson 2013). That is, a tendency to over-reporting at the bottom and under-reporting at the top of the distribution. Moreover, lower response rates are generally observed in both tails of the distribution, which also contributes to the understatement of top incomes (Groves and Couper 1998; Chenevert et al. 2016). On aggregate, Törmälehto (2011) and Endeweld and Alkemade (2014) find that, together, capital and self-employment income, suffer from larger underestimation than labour incomes, which are relatively well represented in surveys. Both studies also point out that countries using register data in the surveying process have narrower gaps in the coverage of aggregate incomes.

The main contribution of the present paper is to establish stylised facts on data gaps and to assess their impact on inequality estimates, which are not only affected in level but also in trend. I use a simple theoretical framework to trace the path of factor incomes from macro- to micro level. Larger gaps result in a higher underestimation of inequality levels, also affecting the sensitivity of estimates to the capital share. Survey estimates largely understate the influence of capital income and thus seem to follow almost exclusively the distribution of labour income. Tax data appear to be moderately more sensitive to the capital share and its distribution, at least in the United States, during the period 1975-2015. Additionally, I find evidence to support the use of register data in the construction of household income surveys as a way to reduce inconsistencies.

I distinguish two types of data gap. First, to account indirectly for income out of the scope of distributive data, I measure the "household share of capital income", which experienced a generalised and strong decrease during the last decades. This implies that an increasing part of national income is retained in corporations and thus is ignored by most distributive data. This trend is found in 43 countries with sufficient detail in the United Nations' official statistics on National Accounts. It also holds when studying a balanced panel of 19 countries during the period 1995-2015. The longest available series show that trends start falling around 1990 in most cases. Second, I measure the relative underestimation of the household sector's incomes. I use the flexibility of surveys to maximise the comparability of income concepts. However, some conceptual inconsistencies remain, which I attempt to disentangle from measurement error for recent years. In a balanced panel of 13 countries for the period 1995-2013, I find that both labour and capital income are undervalued. Capital income is always less covered, with only around 20% recorded in surveys, against 70% of labour income. This relation remains generally stable over the period. In the United States, tax data capture 30% of capital income, versus close to 80% of labour income.

Based on accounting identities, I study marginal contributions to the top 10%, the middle 40% and the bottom 50% shares of the income distribution, at country level. I find that distributive estimates are rather insensitive to the dynamics of capital income, while they are over-sensitive to those of labour income. Even using tax data, in the United States, the rising concentration of labour incomes explains close to 13 out of 14 points of the increase in the top 10% share. Contrasting, the increase in the top decile's share of capital income (from 50% in 1975 to 70% in 2010), only contributed with little more than one point. The big increase in the national capital share –of seven points– contributed with less than one point, while the decreasing coverage of capital incomes even attenuated such increase.

This study is organised as follows. Section 2 discusses both theoretical and empirical literature on the link between capital shares and inequality. Section 3 defines stylised facts on the distribution of capital income across institutional sectors and on the measurement gaps of factor income in surveys. Section 4 presents the theoretical framework that is used to decompose the relation between capital shares and inequality measures. Section 5 displays empirical applications of the model, aiming to understand the composition of variations in inequality estimates. The last section discusses the main findings and concludes.

2 Literature on capital shares and inequality

The theoretical work by Atkinson and Bourguignon (2000), Atkinson (2009), and Milanovic (2017) shows that, although the relation between capital shares and inequality is more complex than it seems, it is reasonable to expect a positive correlation in realistic scenarios. Since individuals receive income from different sources and different incomes can be found throughout the whole distribution, these studies build their models based on both the relative concentration of factor incomes and their joint distribution. Building on Atkinson and Bourguignon (2000), Atkinson (2009) defines the conditions for the capital share to have a positive impact on inequality, which are rather plausible in reality.[1] Milanovic (2017) depicts a similar framework using the Gini coefficient. The author defines three clear requirements to have a positive relation between capital shares and inequality: first, high

[1]The capital share (π) has to satisfy the following inequality: $\pi > (1 - \lambda\rho)/(1 - \lambda^2 - 2\lambda\rho)$, where λ is the ratio of the squared coefficient of variation of capital over that of labor income and ρ is the correlation between capital and labor incomes.

saving out of capital income; second, high concentration of assets; third, high correlation of capital income ranking and total income ranking. In real cases, all of these requirements are also easily fulfilled.

Although the theoretical findings of this literature are based on straightforward accounting identities, its empirical assessment seems more opaque. Bengtsson and Waldenström (2018) use a panel of 21 countries to assess the statistical relation between the variables of interest. They build capital shares using historical national accounts data and then regress them to income-concentration estimates. They use two of them: Top income shares from the World Inequality Database (WID),[2] which are based on administrative records, and Gini coefficients, which they draw from Atkinson and Morelli (2012).[3] Their estimates, including country fixed-effects, are in line with what is expected. They find a strong positive marginal effect of the capital share over both inequality measures. A contribution with somehow contrasting results is Francese and Mulas-Granados (2015). The authors use a different data source: the Luxembourg Income Study Database, which provides harmonised household surveys (http://lisdatacenter.org). They perform a decomposition analysis of the Gini coefficient in 43 countries during the period 1978–2010. They break down the Gini coefficient to its accounting components and then implement a similar regression than Bengtsson and Waldenström (2018), but only using the survey's Gini coefficient as a dependent variable. After analysis they conclude that the capital share plays a negligible role in the evolution of measured inequality, especially relative to the evolution of labour-income inequality, which they judge as the main driver of total inequality.

The issue with existing models is that they only allow for a negative –or null– relation between capital shares and inequality under very restrictive circumstances. Therefore, when negative correlations emerge empirically these models do not seem to provide a convincing description of the mechanisms at play. For instance, in Milanovic (2017), the only channels trough which it can be achieved, is by releasing at least one of the requirements, which results in rather unrealistic scenarios. When Bengtsson and Waldenström (2018) observe a negative correlation for Argentina and Canada, they treat it as an anomaly, for which their model does not provide a meaningful explanation.

3 Stylized facts

This section starts by describing concepts and data sources, before proceeding to the analysis of stylized facts showing how both measurement error and conceptual differences contribute to the underestimation of capital incomes in distributive data.

3.1 Data and concepts

National accounts Estimates in this section are mainly built using the United Nation's 'National Accounts Official Country Data', which is publicly available at: http://data.un.org. This data set distributes the whole national income to different institutional sectors. Ideally these are six: the household sector, non-profit institutions, financial and non-financial

[2]The authors cite the database using its name at the time they were writing: the World Top Incomes Database (WTID).

[3]Atkinson and Morelli (2012) estimate Gini coefficients either directly from popular local household surveys or from well-known international data centers. These estimates are available for a subset of countries and a shorter span in time compared to top shares

corporations, the general government, and the rest of the world. As not all countries build their accounts equally, the level of aggregation among sectors varies. For the sake of clarity and comparability, the main estimates of this paper aggregate both financial and non-financial corporations in what is referred as 'private corporations'. Although the general government, or 'public sector', is partially studied in the present paper, the evolution of its share of capital income is mostly not commented as it has little economic relevance. This happens because its capital income is mainly defined as the profit of publicly held firms less the payment of interests on public debt, which are only a part of public revenue and expenses. Non-profit institutions are mostly ignored in the analysis, as they always receive a negligible share of capital income. Data on the foreign sector is only used to estimate national income, as opposed to domestic income.

The guidelines of the UN's official System of National Accounts (SNA henceforth) have been re-edited five times since its first version in 1953. Every revision included substantial methodological modifications, which often render different series hardly comparable. For that reason, both the aggregate and country-level estimates that are presented here do not mix information from different SNA series. The series that are included in the balanced panel of 19 countries all correspond to the latest existing SNA, which is the 2008 version. However, only for the long-run analysis and for the inclusion of less developed countries in an unbalanced panel, I also use series based on the 1993 SNA guidelines.

Household surveys I use survey micro-data from the Luxembourg Income Study Database (LIS), which contain detailed harmonised surveys from a group of countries, for two empirical applications. First, it is used to assess the measurement gaps of surveys. Second, it provides an empirical application of my model. I take advantage of the flexibility of income definitions in surveys to make them more comparable to both tax data and national factor incomes. The income definition that is used corresponds to the LIS variable named 'factor income' and the population that is considered for comparison are all adults aged twenty or older. In practice, the definition includes gross yearly income (pre-tax), combining monetary and in-kind revenues. However, Table 1 maps survey incomes to national accounts concepts. It displays the main problematic items, some of which are never included in the survey's definition, as imputed rents, imputed incomes to insurance policy holders, reinvested income abroad and investment income on pension funds.

Table 1 Mapping survey-concepts to national accounts

System of National Accounts - 2008			
Survey Concept	SNA-Concept [1] = [2] + [3]	Matching [2]	Problematic [3]
Labour inc.	Comp. of Empl.	Wages & Sal.*	SSC: Employer & Employee
Self-Empl.	Mixed Inc.	Self-empl., Indep.	Rent of non-dwelling build.
	Op. Surplus	Rent of dwellings	Imp. rent for owner occup.
Capital inc.	Property Inc.**	Distrib. profits, Interest	Imp. rent to policyholders, Reinv. inc. on FDI & portfolio, Inv. inc. on pension funds

Major conceptual differences are reported in this table, for other minor differences see Table B.1 in OECD (2013). Notes: (*) The part of wages and salaries paid while an employee is on sick-leave are recorded as a part of social insurance benefits in SNA. (**) SNA does not deduct any expense when deriving property income. Source: Compiled by the author based on definitions in United Nations (2009) and OECD (2013)

Tax data In the case of the United States, I analyse data for a wider time span, that is the period 1975-2015. Piketty and Saez (2003) and relevant updates are used as estimates of total capital and labour income declared to American tax authorities. Furthermore, DINA estimates from Piketty et al. (2018) are also used to make empirical comparisons. These estimates combine both survey and tax statistics to distribute the whole national income to the personal income distribution.

Income concepts The empirical estimates of inequality in this article are limited to the study of pre-tax income. Although this is standard in the top incomes literature, it is not in the broader an more traditional literature on income inequality that generally focuses on disposable income, which is better suited to study households' economic well-being. Both concepts are relevant for different reasons, while pre-tax income is the direct result of market outcomes, which relate to production functions, disposable income depends more on redistribution, which is the result of history and politics. This study does not discuss the role of redistribution.

Sectoral income In national accounts, each institutional sector ($i = 1, \ldots, n$) receives a capital income KI_i, which is defined as the sum of the sector's Operating Surplus (OS_i) and Net Property Income (NPI_i).[4] The only exception is the Household sector, which also receives Mixed Income (MI). A part MI^K of this aggregate is also assumed to remunerate capital. Naturally, the sum of the capital income of every sector KI_i is equal to total national capital income. I thus define the total capital income of the economy KI in two ways:

$$KI = \sum_{i=1}^{n} KI_i = MI^K + \sum_{i=1}^{n} (OS_i + NPI_i) \tag{1}$$

In the following subsection, I study each sector's share of capital income (KI_i/KI). Furthermore, labour income is by definition only affected to natural persons, which are either national or foreign households. Since the share received by foreign households is always negligible, I chose to ignore it when presenting results, but it is subtracted in calculations. Labour income is defined as the Compensation to Employees (CE) plus MI^L, which is the share of Mixed Income remunerating labour.

Capital income The literature defines capital income as the sum of the total Operating Surplus and Net Property Income, plus the share of Mixed Income remunerating capital. While the first two terms are consensual, the latter is often more problematic. Mixed Income broadly corresponds to the income of the self-employed, who usually combine both labour and capital to produce goods and services. However, the partition between factor incomes always relies on a priori assumptions. The literature has developed three ways to deal with this issue. The first –and most data intensive– method relies on surveys to estimate wages of workers with given characteristics, to then assume that independent workers with similar characteristics pay themselves similar wages. The rest is a residual. A second approach relies on the capital share of the private sector to split mixed income. But it largely depends on the quality of national accounts, which are poorly detailed in many countries. The third and simplest approach assumes a fixed share –generally 30%– remunerates capital. ILO (2019) uses the first method, while Bengtsson and Waldenström (2018) and Piketty and Zucman (2014) use both the second and third approaches. The second approach is used

[4] In the definition of Net Property Income, the word 'Net' refers to: income received less income paid.

when data are sufficiently detailed (i.e. recent years), while the third method is used for long run estimates. Since the the present paper does not aim to establish precise levels of capital shares, I only use the third method to maximise eligible countries and to ensure transparency in the estimates.[5] Own estimates are displayed and commented in more depth in Appendix A.

Fixed capital consumption Estimates in this paper are gross of fixed capital consumption. Since capital depreciation increased during the last decades as a share of GDP in most countries, Appendix B shows that the main conclusions of this paper also hold when using net estimates. However, as information on depreciation is rare, the number of countries would be substantially reduced if one only focused on net estimates.

3.2 The declining household share of capital income

This subsection shows that capital incomes have been increasingly held inside private corporations, during the last decades, instead of being directly received by households. This affects standard inequality measures because traditional distributive statistics deliberately ignore incomes retained in corporations.

Balanced panel Figure 1 shows that both the Public Sector and Private Corporations increase their share of gross national capital income between 1995 and 2015. A bigger part of private profits are thus held inside corporations instead of being distributed to shareholders. Chen et al. (2017) report a similar phenomenon, happening since the 1980s. They observe a shifting of household savings towards corporate savings, most of which did not translate into investments, but rather into the accumulation of cash, the payment of debts and the increase of share buybacks. Figure 1a displays a modest increase of the share of private corporations (near 3 percent), yet it makes more sense to focus on the evolution displayed in Figure 2b, which excludes the public sector.[6] Figure 1b describes a clear and relatively constant decrease close to 7 percentage points in the household share of gross capital income. It is only interrupted by an ephemeral increase between 2007 and 2009, which is likely to be driven by corporate losses during the financial crisis. This trend corresponds to the aggregate capital income produced in 19 developed countries which form the balanced panel for the period. Certainly, the weight of each country over this trend is unequally distributed, as the first 5 contributors account for near 70% of total capital income in the panel (Table C.1). However, the same conclusions are achieved when studying individual countries, unweighted averages or net-of-depreciation estimates (Appendices B and C).

Unbalanced panel The dynamics displayed in Fig. 1 are not exclusive to developed countries. In total, 46 countries from several continents report detailed-enough data for this period. They do not cover, however, all years in the period. Figure 2 shows the evolution

[5]This strategy assumes implicitly that independent workers' remuneration has the same composition in both developing and developed countries, which is most probably incorrect. One could expect the produce of independent workers in developing countries to take a bigger share of macroeconomic income and to be more labour intensive than their developed counterparts. However, developing countries are mostly absent from the analysis and only studied as time series.

[6]The Public Sector starts with a negative value near -2.8% and ends the period with a low but positive share of 5%. Yet, this finding does not have high economic relevance in itself as it does not take into account the full income or expenses of the Government. The trend is driven by a reduction of expenses (Figure C.1).

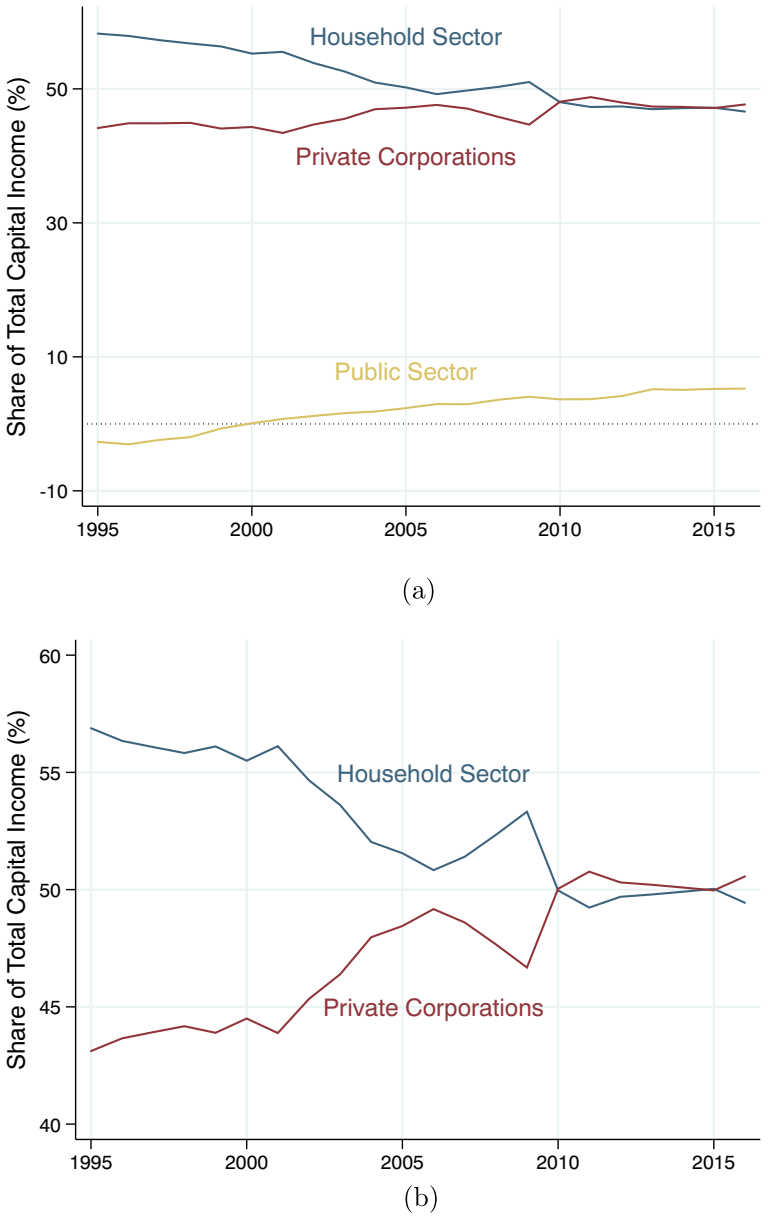

Fig. 1 Decreasing Household Share of Gross Capital Income, Balanced Panel (1995–2016) **a** Including the Public Sector **b** Excluding the Public Sector. Both the Public Sector and Private Corporations increased their share of capital income, while the Household share decreases through the period. In 1995, the household sector received 57% of the capital income produced in a balanced panel of 19 developed countries (excluding the public sector). Two decades later, it receives less than 50%. Countries included: Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Poland, Portugal, Slovakia, Sweden, Switzerland and the United Kingdom. Income from different countries is aggregated based on yearly average Market Exchange Rates. The United States is studied separately

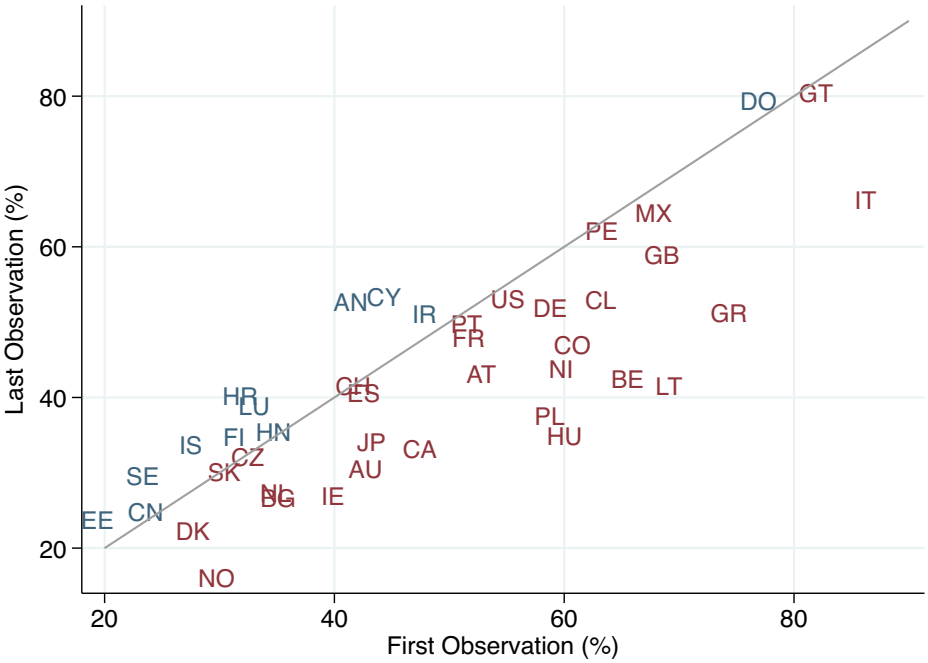

Fig. 2 Decreasing Household Share of Capital Income, Unbalanced Panel (1995–2015). The share of capital income received by households, as opposed to public and private corporations, decreased in 30 out of the 43 cases that have at least 6 observations during the period (excluding the public sector). That is, it decreases in near 70% of cases. The countries that experienced an increase are those which already had relatively low shares to start with

between the first and the last year recorded by each of these countries. The red countries below the bisector line (close to 70% of them) saw a decrease in their household share of capital income. Apart form the countries in the balanced panel, one can find several countries from Latin America (Chile, Colombia, Guatemala, Mexico, Nicaragua and Peru), a few from Eastern and Southern Europe (Poland and Lithuania, Greece, Spain) and one from Eastern Asian (Japan). The blue dots above the bisector, which saw an increase in the household share of capital income, gather mostly at the bottom-left corner. Their position shows they already were at low levels to start with. The biggest increase corresponds to Netherlands Antilles, yet it should be considered a special case, since it is a tax haven (Zucman 2015). When the public sector is excluded, conclusions are unchanged. For estimates from net capital shares, due to increasing capital depreciation, a lower majority of countries follows a decreasing trend (Appendix B).

Long-run series Some countries have enough data to estimate the household share of capital income for several decades with consistent SNA definitions. Figure 3 displays their long-run estimates, to study the starting point of the decreasing trend observed in Figs. 1 and 2. Italy is the first country to start a clear decreasing trend in the early 1980s. Others, as the United States, Canada, Australia and Japan start around 1990. The countries with the latest starting trend are Netherlands, at the end of the 1990s and Norway, which experiences a big drop after its fiscal reform of 2005 that introduced the permanent taxation

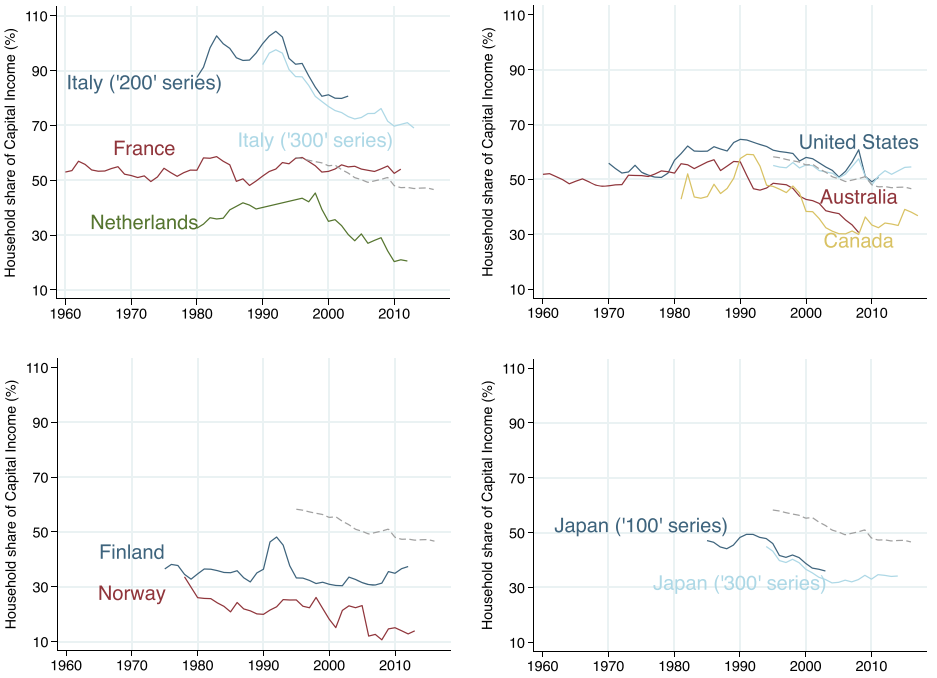

Fig. 3 Decreasing Household Share of Capital Income, Long-run. **a** Selected European countries **b** English Speaking Countries c Scandinavian Countries d Japan. The grey dashed line represents the aggregate tendency in the balanced panel of 19 countries pre- sented in gure 1. Most countries with long-run data exhibit a decreasing trend starting before the beginning of the panel, around 1990. Relatively more stable trends are described in previous decades

of distributed profits (Atkinson and Aaberge 2010). France and Finland are cases without particularly strong or sustained trends, but rather ephemeral dynamics. Finland experienced an ephemeral jump of the estimate at the beginning of the 1980's, which was likely provoked by corporate losses during the Finnish banking crisis of 1991-1993. Excluding the public sector and/or using net estimates does not seem to affect general conclusions (Appendix B).

3.3 Measurement gaps in distributive data

This subsection documents measurement gaps in traditional distributive statistics (i.e. surveys and tax statistics), distinguishing between labour and capital incomes. Due to survey data availability, I study a sub-panel of thirteen countries, including Austria, Canada, Czech Republic, Denmark, Finland, Germany, Great Britain, Greece, Hungary, Italy, Netherlands, Poland and Spain.

Survey data Figure 4a shows that both labour and capital income are underestimated in surveys relative to national accounts. The level of the underestimation, however, is not homogeneous. Labour incomes are relatively well represented, with near to 70% coverage in surveys, capital incomes are only covered at around 20% during the period. Between 1995 and 2013, the evolution of these estimates is rather stable. This finding holds in the

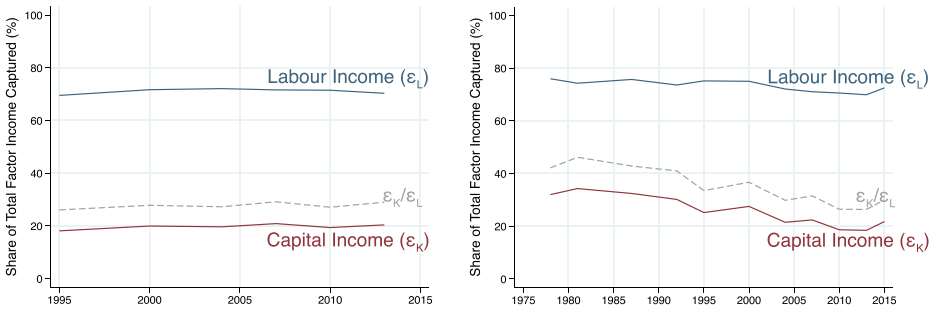

Fig. 4 Unequal Measurement Error in Surveys and Tax Data. **a** Surveys: Balanced Panel (1995–2013) **b** Tax Data: United States (1975–2015). Labour income is better represented in both surveys and tax data, relative to capital income. The dierence in the underestimation of each factor income, however, appears to be wider in surveys. Table D.1 displays the weight of each country in the Panel, in terms of aggregate national income. The ϵ_K/ϵ_K ratio is displayed here yet it is only commented in the following sections. Survey estimates for the United States are provided separately

long term and in both net and gross figures; at the country level, the relative underestimation also holds in every case, yet there is some variation in levels and trends (Appendix D). Table 2 reports countries using administrative records in the construction of surveys, which seem to achieve a better coverage of both factor incomes. The Netherlands is a noteworthy case, since tax records are introduced in the survey-wave of 2004. Unlike the rest of the countries in the table, which use register data for the whole period. That year, the coverage of capital incomes increases substantially, from close to 20% in 2000 to 40% in 2004 and 80% for following observations.[7]

Tax data In the case of tax data, it is more difficult to find estimates for total factor income. Many studies directly use totals from national accounts to estimate top income shares (Atkinson et al. 2011). And those basing their aggregate estimates on fiscal data, usually do not report their composition in terms of factor incomes. In the case of the United States, most of the adult population fills tax declarations as only around 20% of them do not declare income to the Internal Revenue Service. Piketty and Saez (2003) provides estimates on the decomposition of the aggregate income they use. Figure 4b shows that, although capital incomes remain relatively more underestimated than labour incomes, the gap is narrower than in surveys for most countries. Indeed, Fig. D.4 shows that this is also true when comparing tax and survey estimates for the US alone. It is worth noticing that both survey and tax estimates for the United States cover more than three decades. During the 1975-2011 period, survey data get progressively worse at capturing capital incomes, as the share it captures goes from around 30% to 20% during the period.

Decomposing measurement gaps Ideally, one would always distinguish between measurement error and conceptual differences to evaluate data gaps and their evolution, but due

[7] It should be noted that not all countries using register data employ them equally. For instance, in the case of Austria, they are mostly used to complete variables for labour income and not necessarily for capital incomes, which explains its higher coverage for labour income but not for capital incomes.

Table 2 Countries using register data in surveys

Country	Period
AUT	1994 - 2016
BEL	1995 - 2000
CAN	1998 - 2013
DNK	1995 - 2013
FIN	1991 - 2016
NLD	2004 - 2013

Source: Metadata from www.lisdatacenter.org

to lack of detail, it is not possible to do so for all countries and years. To test the main conclusions of this subsection, I use harmonised data from OECD National Accounts (starting in 2008) to match income items with more detail. Appendix E, shows that dividends and interests, which are main components of capital income, are generally more underestimated than wages, the main component of labour income (Fig. E.1). The only exception is Denmark, where wages are covered at almost 100%, while dividends and interests are overestimated close to 20%. Again, countries using register data seem to be relatively better at capturing both capital and labour incomes, yet some heterogeneity remains, likely due to the different uses that each country gives to such data. Figure E.2 compares rents, which are a part of national capital income, but problematic since they can only be partially matched using the SNA's institutional sector approach. It compares surveys' imputed and realised rents to gross operating surplus, which includes both in the same aggregate. In this case, the accuracy of estimates varies greatly across countries, with cases of over- and under-estimation. This not surprising, since imputed rents largely depend on home-ownership rates and usually accrue to substantial amounts relative to total household income, yet methodological issues render it difficult to measure.[8] Figures E.3 to E.12 provide a decomposition of the household sector's income, highlighting conflicted items, which are included in the SNA but systematically excluded from distributional data.[9]

4 Theoretical framework

This section uses accounting identities to evaluate how measurement error and conceptual differences end up affecting inequality estimates from distributive data, such as household surveys and tax data.

4.1 Setup

To describe the theoretical framework behind this study, I will consider the following setting. Let K and L be two real non-negative random variables whose sum is equal to 1. K is the capital share of national income, while L is its counterpart: the labour share. Both

[8] Although imputed rents are considered as a variable in the LIS data set, it is not included in the capital income definition used in the main analysis, since it is only available for a limited set of countries and time-coverage is patchy (see Table 3).

[9] On the capital income side, that is, imputed incomes on foreign investment, on pension funds and those imputed to insurance or policyholders. On the labour income side, the aggregate is basically employers' social security contributions. These figures show that in a large majority of cases, a bigger share of labour incomes is excluded.

Table 3 Availability of imputed rents by wave in balanced panel

Country	I	II	III	IV	V	VI	VII
AUS			x	x	x	x	
AUT			x	x	x	x	x
BEL	x						
CHE				x	x	x	
CHL	x	x	x	x	x	x	x
CZE				x	x	x	
DEU	x	x	x	x	x	x	x
DNK	x	x	x	x	x	x	
ESP			x	x	x	x	x
EST		x		x	x	x	
FIN	x	x	x	x	x	x	x
FRA		x	x		x		
ITA	x	x	x	x	x	x	
LUX		x	x	x	x	x	
NLD			x	x	x	x	
NOR	x	x	x				
SVK				x	x	x	
SVN				x	x	x	
USA	x	x	x	x	x	x	x

Source: Metadata from www.lisdatacenter.org

variables are recorded in National Accounts, which divides income by institutional sector $i = (1, \ldots, n)$. labour income belong integrally to the household sector (h), while capital income is divided in different institutional sectors, which receive a share of total capital income $\Phi_i = (\Phi_1, \ldots, \Phi_h, \ldots, \Phi_n)$, so that $\sum_{i=1}^{n} \Phi_i = 1$. In the following subsections I will focus on the relation between K and common inequality estimates. These estimates are recorded by distributive statistics, which use a narrower definition of income and are subject to mismeasurement. In consequence, ϵ_K and ϵ_L are defined as two real numbers higher than 0; they represent the overlapping share of capital and labour income (respectively), which is recorded by both distributive data and national accounts.[10] The total income of the household sector in distributive data is therefore defined as follows.

$$H = K\Phi_h\epsilon_K + L\epsilon_L \tag{2}$$

4.2 Identities

Income shares The population is ranked by increasing total income and divided into equally sized quantile groups $q = (1, \ldots, m)$. The share of household income received by each group is $S_q = (S_1, \ldots, S_m)$. Each of them also receives a share of capital income

[10] In rare cases, incomes can be overestimated by distributive data, translating into $\epsilon > 1$, which is not a problem for the model.

$S_q^K = (S_1^K, \ldots, S_m^K)$ and a share of labour income $S_q^L = (S_1^L, \ldots, S_m^L)$. Hence, a group's share of household income is defined as follows.

$$S_q = \frac{K\Phi_h \epsilon_K S_q^K + L\epsilon_L S_q^L}{H} \tag{3}$$

In this expression, S_q is equal to the sum of both capital and labour incomes held by the quantile group q divided by total household income (H), which is defined in Eq. 2. In other words, group q receives a percentage S_q^K of the total capital income recorded in distributive data, $K\Phi_h\epsilon_K$, plus a share S_q^L of total labour income recorded in the same data, $L\epsilon_L$. Now, the same expression can be rearranged in a less intuitive yet useful way:

$$S_q = \frac{S_q^K K\gamma + LS_q^L}{K\gamma + L} \qquad \text{s.t.} \qquad \gamma = \Phi_h \times \frac{\epsilon_K}{\epsilon_L} \tag{4}$$

Equation 4 can be translated graphically into Fig. 5, which depicts S_q in the empirically relevant case where group q concentrates a relatively higher share of total capital income ($S_q^K > S_q^L$). The function is defined for all possible values of K, keeping other variables as fixed parameters, in 3 different scenarios.

The black straight line represents the situation were the household sector receives all the capital income and both capital and labour income are estimated with the same error in the distributive data set ($\gamma = 1$). The red convex line illustrates the most realistic case, where public and private corporations have positive income and/or aggregate capital income is relatively more underestimated than labour income ($\gamma < 1$). Conversely, the blue concave line describes the situation where private and public corporations have capital losses instead of income and/or a bigger part of capital capital income is recorded in the distributive data, compared to labour income ($\gamma > 1$).

Figure 5 shows that the γ parameter defines the linearity, concavity or convexity of the function. While the factor income concentration variables (S_q^K and S_q^L) define the sign of the slope and both the upper and lower boundaries for each quantile group's income share. The construction of the γ parameter reveals that Φ_h and ϵ_K/ϵ_L influence income shares in the same way and that they multiply each other. Indeed, both components of the γ parameter

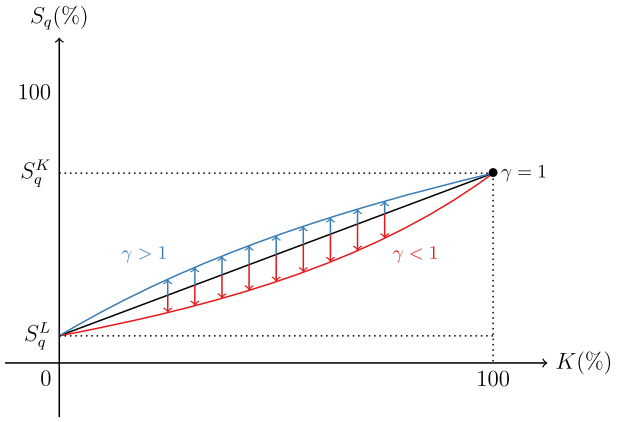

Fig. 5 From the Capital Share to Top Income Shares. The γ parameter defines the linearity, convexity or concavity of the relation between the capital share and top income shares, while the relative concentration of factor incomes determines the slope and both upper and lower boundaries of top shares

operate as filtering-out a part of the capital income from the equation. Furthermore, the γ variable has both a direct and indirect impact on group shares. That is, a lower γ not only results in lower S_q for a given K, but it also has an impact on the marginal effect of K over S_q.[11]

5 Applications

This section provides an empirical application of the theoretical framework introduced in the previous one. It focuses on the dynamics of the top 10% income share, as it is estimated by different data sources. The first subsection provides a sensitivity analysis, based on the marginal effects of estimates that are presented in Appendix F. The second subsection analyses contributions to change. Results for other groups, such as the top 1% share, the middle 40% and the bottom 50% of the distribution are presented in Appendix G.

5.1 Sensitivity analysis

Surveys: Balanced panel (1995-2013) Table 4 presents empirical estimates of the partial derivatives defined in Table F.1. The highest marginal effect is that of the concentration of labour income (column 2) for all the countries in the panel. In the aggregate scenario – i.e. when all countries are taken as one– an isolated increase of 1 percentage point in this variable, is followed by a an increase of 0.91 points in the top 10% share, which is close to perfect correlation. If there was not any conceptual difference or measurement error across distributive data sets and national accounts ($\gamma = 1$), the marginal effect would be equal to the labour share, which is close to 0.62 for most of the period. Instead, here the marginal effect is equal to the labour share estimated by the distributive data set (see Table F.1). However, the marginal effect of factor income concentration is not exclusive to top income shares, it is exactly the same for the middle 40%, the bottom 50% or the top 1% shares (see tables G.1, to G.3). The mismeasurement of the capital share by surveys therefore has an impact in measured inequality as a whole, by exacerbating the role of labour income everywhere in the distribution.

Table 4 shows that the marginal effect of variations in the capital share of national income is weak in all countries (column 1). In the panel, as a whole, it is only 0.04. Whereas, in a scenario where differences across data sets do not exist, this estimate would be equal to the difference in concentration in factor incomes, which is likely underestimated in surveys. The value would be near 0.1 for most years (Fig. F.1b). Moreover, the concentration of capital income and the gamma coefficient appear to have a low impact on the survey's top 10% share as well. An isolated variation of 1 point in the former variable (column 3) is translated into only a 0.09 point increase of the top share in the aggregate scenario, while the the effect is 0.06 for the latter (column 4). The hierarchy of effects is the same for all countries.

In the case of other groups than the top decile, the effect of variables such as the capital share or the components of γ depends on the composition of each group's income. For instance, Table F.1 shows that an increase in the capital share would have a negative impact on the group's total income share in every country. In the case of the bottom 50%, somehow

[11] It is worth noticing that the relations described by Fig. 5 and Eq. 4 are based on an underlying assumption whereby individual income rankings are kept unchanged after variations in the capital share. This can be a rather strong assumption, yet if the analysis is restricted to infinitesimal variations, it should not be a problem.

Table 4 Empirical Estimate of Partial derivatives, Top 10% Share

Country or Area	$S_q(K)'$ [1]	$S_q(S^L_{top10\%})'$ [2]	$S_q(S^K_{top10\%})'$ [3]	$S_q(\Phi_h)'$ [4]	$S_q(\epsilon_K/\epsilon_L)'$ [5]	$S_q(\gamma)'$ [6]
Panel (1995–2013):						
–Austria	0.03	0.92	0.08	0.01	0.03	0.05
–Canada	0.02	0.93	0.07	0.01	0.01	0.03
–Czech Republic	0.04	0.93	0.07	0.03	0.03	0.11
–Denmark	0.06	0.94	0.06	0.06	0.03	0.12
–Finland	0.09	0.90	0.10	0.07	0.04	0.14
–Germany	0.06	0.91	0.09	0.02	0.05	0.08
–Greece	0.03	0.85	0.15	0.01	0.01	0.02
–Italy	0.07	0.87	0.13	0.02	0.07	0.09
–Netherlands	0.04	0.93	0.07	0.04	0.02	0.08
–Poland	0.05	0.93	0.07	0.02	0.04	0.09
–United Kingdom	0.01	0.91	0.09	0.01	0.01	0.02
Total:	0.04	0.91	0.09	0.02	0.04	0.06
U.S. (1974–2011):						
–Survey	0.03	0.92	0.08	0.01	0.02	0.04
–Tax	0.07	0.90	0.10	0.03	0.04	0.07
–DINA	0.38	0.76	0.24			

These are empirical estimates of the marginal effects in Appendix F. In Austria, an isolated 1 unit variation in the capital share [1] only results in a variation of 0.03 units. But the same evolution in the concentration of labour income [2] produces a systematic increase of 0.92 units

surprisingly, Table G.2 shows that variations in the capital share should have a positive impact on the group's share of total income, yet the effect is smaller than for the top decile. It should be noted that most capital income accruing to the bottom of the distribution is the result of private pensions being added to the factor income distribution and a higher prevalence of self-employment.[12]

Comparing data sets: United States (1975-2015) In the case of the United States, I compare estimates from different data sets. The comments made in the previous paragraphs on survey estimates also apply to US surveys. Furthermore, Table 4 shows that the use of tax data somehow alleviates the exacerbation of labour incomes. Its average marginal effect is modestly closer to the actual value of the labour share, which stays between 65% and 70% through the period (see Appendix H). In the same line, the estimate of capital income concentration has a higher marginal effect (0.1) relative to the one from surveys (0.08). However, although the effect of variations in the capital share is more than double in tax data compared to the survey estimate, it remains low, at 0.07. This is not the case for the DINA estimate, which exhibits a marginal effect of 0.38. Of course, this is due to the fact that DINA estimates distribute all the national income to the personal income distribution.

[12] In 2019, the Luxembourg Income Study database revised its guidelines and stopped adding private pensions to capital income, yet estimates presented here were obtained before that modification.

This corresponds to the situation where there is no difference in the income definition used to estimate capital shares and inequality estimates.[13]

5.2 Estimated contributions

The marginal effects studied in the previous subsection can be estimated empirically for every country and every year. This allows to compute each variable's contribution to change, from the perspective of accounting identities, by multiplying each variable's yearly variation to its marginal effect. Table 5 provides estimates for all countries and databases. Column 7 aggregates the total estimated contribution of variables in the model. The difference between the estimated variation of the top share and the real variation (column 8) is due to the fact that databases only report subsequent snapshots at given points in time. Most of the countries in the balanced panel only report data every 2-3 years, whereas tax data are available on a yearly basis. If one had access to the continuous evolution of these variables, there would not be any error in the estimate. Again, this is because the model is based on accounting identities.

Surveys: Balanced panel (1995-2013) In surveys, the capital share is not a relevant driver of trends described by the top 10% income share. In the balanced panel taken as a whole, the top 10% income share increases around 3.4 percentage points during the period. But the increase in the capital share (2 points) only explains 0.08 points of such variation (column 1 in Table 5). In fact, this contribution is completely counterbalanced by the variation of the gamma γ coefficient, which has a negative and modest influence of -0.15 points. It is the concentration of labour income that gets the lion's share of contributions (column 2). These conclusions also apply, in general, to the country-level analysis. In surveys, the capital share and the concentration of capital income does not play a significant role in defining total income concentration in surveys. This is most likely explained by a large underestimation of capital incomes (see Appendices D and F).

Individual countries As an illustration, consider the case of Poland in Table 5. The country experienced the biggest drop of the top 10% income share in the panel –as recorded by the survey– from close to 40% in 1995 to close to 35% in 2013. Despite an increase of 4%-5% of national income for the capital share, it only contributes marginally with 0.14 point to the evolution of the top decile, being completely offset by a considerable shift in the institutional allocation of capital income, which contributed with a negative -0.47 (see Appendix H). Both components of the gamma coefficient explain the low transmission of the capital share to the income distribution. Another noteworthy example is Canada, one of the countries that uses register data to construct household surveys for the whole period. It is also one of the countries that experienced a big increase in both its capital share and top 10% share. Appendix H shows that its ϵ_K/ϵ_L ratio is higher than most other countries, and even increases over the period due to an improvement in the coverage of capital incomes. In this case the increasing concentration of capital income seems to play a bigger role, explaining 0.73 out of 3.75 points in the top decile's variation. However, the impact of motions in the

[13]The capital share used in Piketty et al. (2018) and therefore in the DINA estimates in Table 4, is slightly different from the one displayed in Fig. H.11a because it corresponds to the authors' personal factor income definition of national income.

Table 5 Modeled contribution to variation in top 10% share

Country or Area	Estimated Contribution (%)						Total Variation in period (%)		
	K [1]	S_q^L [2]	S_q^K [3]	Φ_h [4]	ϵ_K/ϵ_L [5]	γ [6] = [4] + [5]	Model Δ [7]=[1] to [5]	Real Δ [8]	Error [8]-[7]
–Panel (1995–2013):									
–Austria	0.11	3.97	0.36	–0.11	0.19	0.08	4.51	4.39	0.12
–Canada	0.06	2.90	0.73	–0.07	0.12	0.05	3.75	3.81	–0.06
–Czech Republic	–0.08	2.26	–0.47	0.05	0.34	0.39	2.10	1.97	0.13
–Denmark	0.35	3.11	0.32	–0.25	–0.26	–0.51	3.26	3.29	–0.03
–Finland	–0.04	1.33	–0.33	0.25	0.00	0.25	1.20	1.86	–0.65
–Germany	0.35	4.68	–0.16	–0.12	–0.17	–0.28	4.59	4.92	–0.33
–Greece	0.15	5.94	0.70	–0.12	–0.19	–0.31	6.48	6.52	–0.04
–Italy	–0.02	1.72	0.91	–0.44	–0.59	-1.03	1.58	1.54	0.04
–Netherlands	–0.03	4.33	–0.01	–0.16	0.27	0.11	4.40	5.13	–0.73
–Poland	0.14	-2.74	-1.38	–0.47	0.10	–0.37	-4.36	-4.22	–0.14
–United Kingdom	–0.13	2.59	–0.30	–0.07	–0.05	–0.11	2.04	2.11	–0.07
Total:	0.06	3.48	0.07	–0.23	0.09	–0.15	3.46	3.54	–0.08
U.S. (1974–2011):									
–Survey	0.38	9.12	–0.10	–0.01	–0.26	–0.27	9.14	9.11	0.03
–Tax	0.64	13.17	1.33	–0.03	–0.71	–0.74	14.39	14.27	0.12
–DINA	1.84	9.50	–0.05				12.37	12.10	–0.27

The concentration of labour income appears to be the dominant factor for variations in surveys' top 1% share estimate. The role of the capital share and its distribution is largely undermined. The difference is weaker in tax data, but still present. DINA estimates are, by definition, not distorted in this sense

national capital share remains limited –contributing with only 0.06 points– likely due to a major drop in the Φ_h coefficient.

Comparing data sets: United States (1975-2015) In US surveys, the conclusions are basically the same than with panel data, but with different levels, due to the larger extent of the period under study. The concentration of labour income also explains the largest part of variations in the local top 10% share, with an influence of near 9 points. The second largest contribution is a positive 0.38 points that is provoked by the increasing trend described by the capital share of national income. Measurement gaps have a marginal influence, contributing with negative -0.27 points, which are mainly due to the evolution of the ϵ_K/ϵ_L ratio. It indeed appears that the low level of γ has a bigger influence than its trend; by distorting the marginal effect of other variables.

When analysing tax data, both the capital share and the concentration of capital income seem to be of higher relevance compared to figures in surveys, since together they contribute with close to 2 points to the increase of income concentration. However, their aggregate contribution remains modest, adding to less than 15% of the total variation estimated by the model. This is probably due to the fact that even though tax data are better at capturing capital income income than surveys, the γ coefficient associated with tax data oscillates between 35% and 18% during the period (Fig. F.3). That is to say, tax data still ignore around two thirds of the capital income produced by the country. It is only with DINA estimates that the capital share starts to play a substantial role in the evolution of the top 10% share. It explains near 1.8 points alone in the total increase of 14.4 points.

6 Discussion and conclusion

The general message of this study is that survey statistics do not capture a growing part of national income that remunerates capital, which is due to both measurement error and conceptual differences. Capital income is typically concentrated at the very top of the distribution. Yet, in surveys, top incomes are downward biased –i.e. small sample bias (Taleb and Douady 2015), incomes are under-reported at the top (Abowd and Stinson 2013) and response rates decrease with income (Chenevert et al. 2016)– which contribute to the underestimation of aggregate capital incomes. Moreover, capital incomes are also subject to bigger conceptual differences than labour incomes. All these factors explain that a sizeable part of macroeconomic capital income is not measured in household surveys.

I use accounting identities to show that both income under-coverage and conceptual differences affect inequality estimates in a very similar way, in that both end up with surveys 'ignoring' a part of aggregate capital income; and that both result not only in a mechanical underestimation of the level of inequality, but also in a distortion of its trend. I also show, that the under-coverage of capital income is such that it renders most survey estimates insensitive to the evolution of capital shares. Empirical applications in this paper assume that the whole national income, including income retained in corporations, can and should be distributed to the household sector –hence, adopting a view similar to that of the Distributional National Accounts project described in Alvaredo et al. (2020). However, the same modelling can be applied to more conservative definitions of income (as for instance the one used by Zwijnenburg and et al. (2017) and the OECD-DNA Experts group, who aim to reconcile estimates exclusively for the household sector, following recommendations by Canberra Group (2001) and Stiglitz et al. (2009).

The fact that household surveys represent capital incomes poorly certainly does not imply that they should be discarded. Surveys are widely available and usually report a variety of covariates that are helpful to study the drivers of economic inequality. They usually capture labour incomes relatively well, which makes them appropriate to describe most individuals in an economy. They are also one of the rare sources to study the income of informal workers. However, despite these strengths, most surveys are badly adapted to study the dynamics of capital income. In that sense, Francese and Mulas-Granados (2015)'s conclusion: *"...changes in income inequality across a wide range of countries have been driven significantly by changes in the inequality of wages, while the distribution of income between labour and capital has not been a major factor"* is speculative, given that household surveys are an inadequate source to hold such argument.

As a way to enforce income coverage rates in surveys, and thus to improve macro-micro consistency, results point to the use of register data in various steps of the surveying process. Although it seems natural that statistical institutes will converge to progressively introducing these methods in the future, it is also necessary to find solutions to adjust earlier versions of surveys, which cannot be re-sampled. Although a part of the literature is already producing and analysing alternatives, more attention and debate is needed to produce sound and homogeneous estimates –see Blanchet et al. (2018) and Lustig (2019). In the same vein, more transparency on the different methodologies used to estimate imputed rents, seems to be a crucial step in achieving statistical consistency. Reconciling micro and macro data sets is a tedious task, but it is useful in that not only it helps improving distributive data, but macroeconomic estimates too.

This paper also documents the general decline of the households' share of macroeconomic capital income (ϕ_h), which is consistent with Chen et al. (2017). In their study, the authors find that global savings have risen during last decades, having shifted from the household to the corporate sector. They also find that such phenomenon happened without significant changes in the structure of investment but rather resulting in the accumulation of cash, repaying debts and increasing share buybacks. The financial literature thoroughly documents the explosive growth of share buybacks (see Bagwell and Shoven (1989), Fama and French (2001), and Skinner (2008) for studies on the United States and Eije and Megginson (2008) for Europe), occurring in parallel with the fall of dividends, which are generally judged to be less tax-efficient from the shareholder perspective. In fact, the corporate finance literature includes both dividends and buybacks as part of payout policy. That is, they are considered as partial substitutes, both serving to remunerate shareholders (Floyd et al. 2015). By ignoring the shifting of shareholder remuneration practices, inequality estimates are progressively more underestimated and become even more insensitive to capital income dynamics (Section 4), which provides an argument for expanding the definition of income in distributional estimates (as it is done in Piketty et al. (2018), Garbinti et al. (2018), and Alvaredo et al. (2020)).

Corporate savings and buybacks increase stock value, which generates capital gains. In theory, they thus enter the Haig-Simons definition of income (consumption plus changes in net wealth). However, surveys and tax data can only measure realised capital gains, which are too irregular since they only occur once shareholders sell stock. In that sense, imputing corporate retained earnings to shareholders should be considered as a proxy of accrued capital gains that is less affected by the latest shifts in shareholder remuneration. Ideally one would also add other items that generally qualify as increases in net wealth, such as changes in home equity, which remain a challenge in most countries due to a lack of information.

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