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REVISITING THE CASE FOR A FISCAL UNION:
THE FEDERAL-FISCAL CHANNEL OF DOWNSIDE-RISK SHARING
IN THE UNITED STATES

by Luca Rossi*

Abstract

Differentiating between standard risk measures and downside risk has a longstanding tradition in finance. Interestingly, this fundamental distinction has been neglected in the literature on risk sharing. Drawing on a simple definition in Markowitz (1959), we translate downside-risk metrics appropriate for stock returns into ones that can be used in our macro-forecasting setting, and propose a new methodology to estimate channels of downside-risk sharing, with an application to the federal fiscal channel in the United States. Our work reinstates some discarded arguments as to why a fiscal union could be desirable, as our findings suggest that public risk sharing is considerably higher than was previously thought. We also show that the great importance long attributed to the capital market channel estimated with popular income smoothing methodologies is instead entirely driven by the neglect of the effect of capital depreciation. Therefore, our paper argues that the relative importance of the fiscal channel as compared to the capital market one has been substantially underestimated.

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1 Introduction[*]

In 2015, the European Commission published the so-called "Five Presidents' Report" on completing Europe's economic and monetary union. This report sparked once more the debate about risk sharing within the Euro area, an issue whose relevance has grown even more after the Covid-19 recession. Bénassy-Quéré et al. (2018) contributed to revive interest in the topic by proposing a reform of the financial architecture of the euro area, which includes the creation of a European fiscal capacity to address large economic shocks. This paper triggered a series of replies, some of which have been collected in Pisani-Ferry and Zettelmeyer (2019).

It is long believed that the European Monetary Union (EMU) lacks some form of central fiscal capacity like (for example) the one in the US, where a system of centralized taxes and transfers ensures that, whenever a given state falls into recession, its residents start to receive more transfers in relation to the amount of momentarily lower tax payments.[1] This is made possible thanks to both federal taxes paid by individuals residing in states that happen to be less affected by the contraction, and by the ability of the federal government to borrow funds at much better terms, in order to finance transfers to specific households and states.

Based on previous research on the US and a few other federations, some economists have argued that enhancing private risk sharing in the EMU through further capital and credit markets integration would prove much more powerful in cushioning idiosyncratic shocks than what public risk sharing could grant through a potential European federal government.

In this paper, we provide novel evidence based on the US economy that points at a much larger relative role of fiscal risk sharing as compared to risk sharing stemming from inter-state capital market flows. The aim is not to make detailed proposals about an efficient, incentive-compatible federal fiscal structure for the EMU, but to revisit the debate regarding benefits and costs of a fiscal union, which lies at the root of any intent to push for an ever closer fiscal integration.[2]

To the best of our knowledge, we are the first in the risk sharing literature to explicitly focus on left tails and gauge the capability of a given mechanism to share *downside* risks. It has long been recognized in the finance literature (and by real-world investors) that

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[1]Kenen (1969) first argued for the benefits of fiscal integration within a currency union.

[2]Farhi and Werning (2017) provide theoretical support for the usefulness of government intervention within a currency union, whereby the full benefits of risk sharing can be reaped only when such an intervention takes place. In their own words, fiscal integration and financial integration are not perfect substitutes.

upside swings in stocks' valuations do not contribute to increase the riskiness of that given asset. When the distribution of stock returns is perfectly symmetric this distinction is irrelevant, while computing standard deviations in the presence of significant skewness is of little use. In such an environment, an investor that aims at minimizing risk should estimate the volatility of the left tail only. Markowitz (1959) first provides a way to do this by proposing his concept of semi-variance. In a nutshell, he trims off positive returns and computes the variance of the resulting series. Later in the paper, we show how to adapt his definition to our framework in order to obtain estimates of downside risk in aggregate income measures.

We find that the federal fiscal channel of downside-risk sharing cushions notably more than what some of the previous research has suggested. In particular, the fiscal channel is able to hedge on average 30.8% of idiosyncratic fluctuations in labor income over our eight-year horizon, with the share being relatively low (11.6%) in the first-year horizon and then sharply increasing and always exceeding 30% starting from the three-year horizon onwards.

Our new downside-risk methodology proves particularly useful as the estimated risk sharing distribution turns out to be significantly different than the one obtained when calculating risk with standard methods. For instance, we show that (for medium horizons) earlier approaches estimate almost an average five percentage points lower fiscal risk sharing than we do, with this difference peaking at almost seven points after eight years. This result is in line with the recent macroeconometric and forecasting literature which finds downside risks to be particularly high during recessions, as first illustrated in Giglio et al. (2016) and Adrian et al. (2019). The latter paper finds GDP growth distributions to become left-skewed during recessions, while being almost symmetric during expansions. Therefore, instead of implicitly smoothing time-varying downside risks with stable right tails, our approach zoomes into the part of the idiosyncratic income growth distribution that matters the most. Moreover, as opposed to earlier studies which relied on GDP-based estimates, using labor income as we do here unveils clear evidence for the existence of a secular upward trend in the insurance capability of net federal transfers.

Those results are particularly relevant also in light of the burgeoning literature about the first-moment macroeconomic effects of fluctuations in second moments. It is by now well established that uncertainty crucially determines the *level* of economic activity. Therefore, while inter-state transfers certainly have redistributive effects on top of those due to insurance mechanisms alone, the mere reduction in income uncertainty that is obtained thanks to the intervention of the federal government has potentially very beneficial additional effects. This implies that the costs of redistribution for states which are net contributors must be weighed against the benefits of much decreased uncertainty for all the members of the federation, which in turn leads to improved economic outcomes. This consideration is even more relevant if (as is usually the case within a federation) intense trade occurs between member states.[3]

Finally, we re-estimate channels of income smoothing with existing methodologies and account for the capital depreciation channel, which has always been neglected in US applications on the ground of a lack of state-level data. By imposing some reasonable assumptions, we show how to retrieve them, and find that what was previously thought to be income smoothing stemming from capital flows really is fully due to capital depreciation increasing (falling) during booms (busts). This finding is of crucial importance as it questions the long-established result underlying many arguments that have been raised for why capital market integration should be preferred to the constitution of a fiscal union.

2 Literature Review

The literature on risk sharing follows the one on optimum currency areas and dates back to Sala-i-Martin and Sachs (1992). The question asked by these authors was spurred by the process of European unification which raised a long and still ongoing debate on whether the Eurozone needs a fiscal union to accompany the monetary union, or if private risk sharing could be a sufficient substitute for the lack of a federal authority empowered with tax and spending powers. Sala-i-Martin and Sachs (1992) perform regressions of either taxes or transfers on disposable income, measured as personal income net of transfers and taxes. The paper finds that, for the period 1970-1988, between one third and one half of an idiosyncratic shock to the average US region is cushioned by the federal government within the same year.

Von Hagen (1992) contests Sala-i-Martin and Sachs (1992) on the grounds that they use variables expressed in levels, while they argue that if one is to estimate stabilization then *growth rates* should be used instead. Therefore, he estimates either state-specific federal income tax revenues or federal expenditures - both as a percent of state Gross Domestic Product (GDP) - on state's GDP *growth*, finding very low elasticities. The author concludes that the US federal fiscal system does not provide any relevant stabilizing function.

Atkeson and Bayoumi (1993) perform similar regressions over the period 1966-1986, differentiating between variations in income stemming from labor and capital, and obtain

[3] In this paper, we only analyze the fiscal risk sharing properties of the US federal government, while we neglect its redistributive ones. When we refer to risk sharing and redistribution we closely follow the intuitive definitions laid out in Malkin and Wilson (2013), where the authors refer to risk sharing as "stabilization".

overall results whose magnitude is comparable to Von Hagen (1992).

Bayoumi and Masson (1995) estimate both redistribution and stabilization in the US by regressing personal income after federal taxes onto personal income before federal transfers. For the 1965-1986 time span, the authors find that the US federal government indeed provides a high amount of stabilization, in the order of 30 cents per dollar, a much higher estimate than the one found in Von Hagen (1992).

Asdrubali et al. (1996) (ASY henceforth) is a landmark contribution, which shaped much of the subsequent academic literature as well as policy debates. The authors pin down a simple variance decomposition of state GDP growth and are the first to jointly estimate the relevance of each of the three main smoothing mechanisms, namely capital market, credit market, and fiscal channels. They find capital and credit markets to hedge the highest share of income growth, with a corresponding estimated small importance of the fiscal channel.

Sørensen and Yosha (1998) use the method in ASY to estimate risk sharing channels among EMU countries as well as OECD ones, and in both cases find that approximately 20% of the shocks are absorbed by *national* budget deficits after one year, while another 20% is absorbed by corporate savings. The paper also obtains that, contrary to the US, factor income flows do not help smoothing income within the EMU and across OECD countries, suggesting that European markets are less integrated than in the US.

Obstfeld and Peri (1998) follow Bayoumi and Masson (1995) in using personal income (instead of state GDP) as the benchmark income variable, and set up a VAR system which allows to separate redistribution from stabilization, finding that the US federal system stabilizes 10% of idiosyncratic shocks after one year.

Mélitz and Zumer (1999) use ASY's dataset and modify their procedure by (among other things) controlling for state business cycle, size (measured as a region's population relative to its national counterpart), the Campbell-Mankiw index of persistence, and the real interest rate (same for all states).

Sørensen and Yosha (2000) use the same dataset and basic methodology in ASY and ask whether the amount of risk sharing in the United States is uniformly distributed between states or whether there are regions that enjoy more of it, as well as whether geographical proximity matters. They find that western and southern states rely more on the capital markets channel, while central states rely more on the credit market one. Furthermore, while the capital market channel is found to have a nation-wide scope, the credit market one is estimated to be a relatively spatial phenomenon, where states that are closer to each other smooth their respective incomes more than pairs of states that are geographically more distant.

Athanasoulis and Van Wincoop (2001) (AVW henceforth) use ASY's dataset but estimate risk sharing with a very different methodology than previous ones. Given that our paper borrows the basic setting of their approach, we will devote Section 3 to explaining it in detail. One of the advantages of this method is that it does not require to assume a particular process for income, as one needs only estimating forecasting regressions. The authors find the fiscal channel to absorb 10% of idiosyncratic risk after two years, where this estimate increase to 20% and stays approximately constant thereafter, up to 13 years.

Mélitz and Zumer (2002) focus on the fiscal channel and refute previous conjectures whereby estimating models in levels or first differences played a major role. Instead, they find that what drive major differences in previous results are accounting choices, namely whether the model estimates stabilization of personal income or GDP. In the former case, their results for the United States point at a maximum 20% stabilization, whereas in the latter they find only 10%. Those estimates are obtained with a dynamic panel data model that takes into account endogeneity as well as possible lagged effects of the fiscal channel. Asdrubali and Kim (2004) also estimate a dynamic model, obtaining results that are roughly comparable to those in ASY.

Hepp and Von Hagen (2012) estimate the fiscal risk sharing capabilities in Germany during the period 1970-2006. They find that the federal system offsets on average 47% of asymmetric shocks in the 1970-1994 interval, with this number decreasing at 19% for the 1995-2006 time span. Those results highlight the fact that not all federations are born equal, as a given fiscal system at a certain point in time could provide more inter-state insurance than others. Hepp and Von Hagen (2013) follow ASY in estimating the importance of the three channels of risk sharing, and apply their method to German states. For the pre-unification years, they find government-related flows to smooth half of income variation, while for the post-unification ones they estimate the share at 10%.

Malkin and Wilson (2013) separate redistribution from stabilization by getting rid of low frequency movements in transfers, taxes and income, and find that the federal government absorbs 38% of state personal incomes.

Poghosyan et al. (2016) jointly estimate redistribution and risk sharing with a Pooled Mean Group estimator, obtaining estimates that are theoretically similar to those in Bayoumi and Masson (1995), but more efficient. The model is estimated on the 1998-2010 sample, and the paper finds a much smaller degree of risk sharing (point estimate at 11%) than that obtained in Bayoumi and Masson (1995).[4]

[4] When building their dataset however, the authors include corporate income taxes exactly as reported by the Internal Revenue Service (IRS). This class of federal revenues is particularly problematic as it is not obvious how one should interpret available state-level corporate income tax numbers, and taking this data at face value requires the implicit adoption of possibly strong assumptions regarding the actual origin

Duwicquet and Farvaque (2018) rely on a different definition of income, namely, labor income, and using ASY's framework they obtain that the fiscal channel is much more relevant than what previous research found. In this paper, we follow them in using labor income and provide additional reasons for why we also believe it to be a better target variable than GDP. Our results for the fiscal channel are closer - although quite lower - to what they find.

Burriel et al. (2020) discuss the federal structures of Austria, Belgium, Germany, Spain and the United States, and run ASY-like regressions for all of them (except for Belgium whose federal system only consists of three regions). The authors find that federal transfers to lower-level governmental units are less effective in providing risk sharing than direct transfers to households financed by centralized taxes and contributions. Moreover, the paper discusses how higher intergovernmental transfers distort incentives of subnational governments, who tend to deepen their deficits and related vertical imbalances, which in turn feed into higher transfer dependency and bailout expectations.

Finally, two issues are common to many of the above-mentioned papers, where AVW is a notable exception. First and foremost, those contributions yield *ex-post income smoothing* rather than *ex-ante risk sharing* estimates of a given channel. The recent literature on uncertainty has clarified the importance of distinguishing between predictable variations and the uncertainty around the unpredictable component of any series.[5] Only this last component can be regarded as uncertainty, and estimates of risk sharing should therefore focus on it. As exemplified in AVW, if the correlation between income before and after risk sharing is zero with the two series having the same residual standard deviation, some of the existing methods would imply the existence of perfect risk sharing, while the one in AVW (the method we will partly borrow from and that we will explain later) would point to no risk sharing whatsoever.

Second, many of them are static models and also only provide first-year-horizon estimates. It is well known from the macroeconometric literature that current-period macroeconomic variables depend on lagged aggregates too, meaning that only controlling for simultaneous variables could bias results in non trivial ways. Moreover, intermediate-

of corporate taxes. For example, Tax Foundation (1974) warned that "*[...] Each year the Internal Revenue Service publishes statistics showing the amount of federal taxes of each type collected in each state. These figures are a byproduct of the process of collection. Although useful for administrative purposes, they have little validity as an indication of the distribution of the federal tax burden among the states, and are not in fact designed to serve this purpose*". The same warning is provided by the IRS in Table 5 of the IRS Databooks (the source of state-level federal tax data): "*[...] while taxes of corporations might be paid from the principal office, the operations of these corporations may be located in one or more other state(s)*". ASY addressed this issue using suggestions from Tax Foundation (1974) and retrieving state-level data using a weight equal to the average of the share of each state in US personal income and its share in property income.

[5] See Jurado et al. (2015) for an in-depth discussion on the correct measurement of uncertainty.

horizon frequencies of the business cycle are often those where the bulk of the action takes place. Our estimates are no exception, as we indeed find that one-year risk sharing is indeed similar to that reported by older studies, although we then find it to rapidly increase over horizons to reach much higher figures, meaning that the federal fiscal channel takes time to fully reach households' incomes. Therefore, simply showing impact responses could provide a very partial picture of the underlying phenomenon.

3 Methodology

The starting point of our modeling approach is the one laid out in Athanasoulis and Van Wincoop (2001). In this section, we show how we push their methodology forward by gauging the extent to which the channel under consideration is capable of reducing semi-deviations (namely, downside risk) as defined in Markowitz (1959) rather than standard deviations as in the above-mentioned paper.

3.1 AVW - A Review

Let $i = 1, \dots, N$ denote the i-th state of the United States, w_t^i a generic per-capita income measure, and let $g_{t,t+h}^i = \log w_{t+h}^i - \log w_t^i$ be the growth rate of income from period t to $t+h$. While states can insure idiosyncratic risk, they can do little to diversify away aggregate risk. Therefore, AVW write the difference between state and aggregate growth as the sum of a predictable and an unpredictable component, where the residual corresponds to the growth component which is diversifiable. Specifically,

$$g_{t,t+h}^i - g_{t,t+h}^{US} = \boldsymbol{\beta}_h'(\mathbf{x}_{t,h}^i - \mathbf{x}_{t,h}^{US}) + \epsilon_{t,t+h}^i, \tag{3.1}$$

where the superscript US refers to the aggregate variable. Also, $\mathbf{x}_{t,h}^i$ is a $(K+1) \times 1$ vector of control variables which includes a constant term, and we assume that $\epsilon_{t,t+h}^i \overset{iid}{\sim} (0, \sigma_h)$. This system is estimated using non-overlapping intervals of length h, which is necessary in order to obtain state-specific independent innovations.[6]

In this setting, σ_h has to be interpreted as a measure of diversifiable risk. AVW define the amount of risk sharing accomplished by a given channel as the relative reduction in

[6]The reliance on non-overlapping intervals is the reason why we need a subscript h in the control variables. Moreover, AVW assume Gaussianity in the error terms and obtain confidence bands with analytic approximations. Here, we instead drop this assumption and perform inference with bootstrapping procedures. Indeed, when we performed standard Gaussianity tests on our forecast errors, we only found scant evidence of normality. This of course needs not always be the case.

the residual standard deviation of income growth after risk sharing as compared to the one before it. Therefore, their estimates of risk sharing at horizon h are given by

$$RS_h^0 = \frac{\hat{\sigma}_h^b - \hat{\sigma}_h^a}{\hat{\sigma}_h^b}, \tag{3.2}$$

where the superscripts a and b refer to income after and before risk sharing respectively.

Crucially, this modeling approach does not require to recover structural parameters, since all we need is ensuring we predict our growth variables as best as we can. Thus, one can use Ordinary Least Squares (OLS) or - as in our case where we want to down-weight smaller states - Weighted Least Squares (WLS) to estimate equation (3.1).[7]

In a sense, this is no different than the framework employed in Jurado et al. (2015), where uncertainty is defined as the residual standard deviation of each series, where each equation is estimated within a purely forecasting setting. Indeed, this is one of the reasons why we draw from AVW: their methodology computes risk from the unpredictable component of income growth alone rather than gauging covariances between unconditional realizations of income measures. In other words, most of past research in fact attempts to measure the amount of ex-post income smoothing rather than ex-ante risk sharing.

3.2 Adjusting for the Share of Residual Variation

In this section, we acknowledge that the way risk sharing is computed in AVW can be improved, and we therefore first go through an intermediate step we believe we have to perform. In particular, equation (3.2) disregards the actual risk-sharing-reducing role of the share of total variation that is explained by the model; a numerical example can help clarify this. Let's first assume that estimating the model in equation (3.1) leads to point estimates $\hat{\sigma}_h^b = 1.25\%$ and $\hat{\sigma}_h^a = 0.25\%$ for some h. In this case, the channel under consideration is able to hedge 80% of idiosyncratic risk in income growth. In economic terms, this result points to this channel being particularly useful, as the risk reduction is sizeable not only in percentage terms (80%), but also in absolute ones (a one *percentage point* reduction in income growth risk). Now, suppose instead that fitting the same model on the same variables yields estimates $\hat{\sigma}_h^b = 0.25\%$ and $\hat{\sigma}_h^a = 0.05\%$. Also in this case, equation (3.2) would imply the same 80% risk sharing value. *However*, it is clear that risk reduction in absolute terms is now much lower, equal to a mere fifth of a percentage

[7]In the following exposition, we aim at being as intuitive as possible and therefore outline how we would calculate risk sharing if we were *not* to weight observations by population. Our baseline weighted regressions need slightly different computations, and we describe them in detail in Appendix A.

point as compared to one in the previous scenario. In other words, this last 80% is of little economic relevance as idiosyncratic risk was already low *before* risk sharing kicked in. Generally speaking, the same value of RS_h in equation (3.2) is consistent with a whole range of potentially very different values of the amount of risk that agents would like to insure against.

We therefore deem that risk reduction should be computed not as a percentage of the before-risk-sharing *residual* standard deviation as is done in AVW, but as a share of *total* standard deviation. Thus, we first modify equation (3.2) as follows:

$$RS_h = RS_h^0 \frac{\hat{\sigma}_h^b}{\hat{\sigma}_h^{b,tot}} = \frac{\hat{\sigma}_h^b - \hat{\sigma}_h^a}{\hat{\sigma}_h^{b,tot}}, \tag{3.3}$$

where $\hat{\sigma}_h^{b,tot}$ is the sample standard deviation of our before-risk-sharing dependent variable at every horizon.

Note that this adjustment leads to risk sharing estimates that are mechanically *lower* than those obtained in equation (3.2). Continuing with the example above, assume that $\hat{\sigma}_h^{b,tot} = 1.5\%$. In the first case, we would now obtain risk sharing estimates equal to $80\% \cdot \frac{1.25\%}{1.5\%} \approx 66.7\%$, while in the second case they would drop to $80\% \cdot \frac{0.25\%}{1.5\%} \approx 13.3\%$, reflecting the lower absolute risk reduction. In the extreme case where $\hat{\sigma}_h^b = \hat{\sigma}_h^{b,tot}$, we would obtain "adjusted" risk sharing values equal to those in equation (3.2). On the other hand, in the opposite scenario where $\hat{\sigma}_h^b \to 0$, our formula would suggest zero risk sharing, while equation (3.2) would always yield (with the example above) an 80% hedging capability.

3.3 Downside-Risk Sharing

As we mentioned, this paper aims at providing estimates of *downside*-risk sharing, and in the following we therefore modify the framework above to account for this. Markowitz (1959) first acknowledges the limitations of standard deviations as a way to compute the underlying risk of stock prices: large positive returns should not contribute to increase risk estimates of a certain asset. Nevertheless, the very mathematical definition of variance inherently neglects signs and treats positive and negative returns in the same way. Therefore, Markowitz (1959) introduced the concept of semi-variance, which is computed on the series of conditional returns, whereby positive returns are simply disregarded. In other words, for a given series r_t of stock returns, one defines $r_t^- = \min(r_t, 0)$ and computes the sample variance of r_t^- as a measure of the downside risk of that asset.

Here, we apply the very same definition, but we do that on the series of *residuals* we obtain from estimating the system in equation (3.1). The underlying reasoning is the same as the one in Markowitz, simply converted to fit in our macro-forecasting setting: we are interested in gauging how much the risk sharing channel we are considering is able to hedge against unexpected left-tail events. However, computing risk sharing as in AVW would bias the risk measure we are interested in towards the volatility of unexpected *positive* idiosyncratic income growth events.

Operationally, we then define

$$\begin{aligned} \hat{\epsilon}_s^{i,-} &= \min(\hat{\epsilon}_s^{i}, 0), \\ \hat{\sigma}_h^{\cdot,-} &= \sqrt{\frac{1}{S_h \cdot N - K - 1} \sum_{s=1}^{S_h} \sum_{i=1}^{N} \left(\hat{\epsilon}_s^{i,-}\right)^2}, \end{aligned} \tag{3.4}$$

where the index s refers to each non-overlapping interval for a given horizon h, and S_h is the total number of intervals for that given horizon.

We therefore define our baseline downside-risk sharing measure as:

$$DRS_h = \frac{\hat{\sigma}_h^{b,-} - \hat{\sigma}_h^{a,-}}{\hat{\sigma}_h^{b,-,tot}}, \tag{3.5}$$

where $\hat{\sigma}_h^{b,-,tot}$ is the sample semi-deviation of our before-risk-sharing dependent variable at every horizon. Indeed, the same residual-variation-adjustment reasoning we developed in the previous section also applies to downside-risk sharing.[8] In order to perform inference on equation (3.5), we recur to the nonparametric bootstrap in Kapetanios (2008).

Finally, AVW consider the effects that are estimated over very long horizons (up to 26-years-ahead) to also be due to risk sharing. We believe growth rates at lower-than-business-cycle frequencies to be much more determined by structural factors; for example, the fact that federal intervention makes income growth more predictable at very low frequencies might be more related to some redistributive property of the fiscal system rather than to risk sharing as such. Thus, following Stock and Watson (1999) who consider business cycle frequencies to be those that play out after at least six quarters and within eight years (and given that we only have annual data) we restrict the analysis to horizons comprised between one and eight years.[9]

[8] In this case, it could happen that models where the control variables explain little variation could lead to residual *semi*-deviation being slightly *higher* than its total counterpart, thereby leading adjusted risk sharing values to be higher than non-adjusted ones.

[9] To be sure, when we fit the model setting $H = 20$ years (we cannot set $H = 26$ as our sample is only twenty-one-years long) we obtain very similar average estimates for horizons longer than eight years. Those figures are available to the reader upon request.

4 Data

As we said, we apply the model developed in Section 3 to the fiscal channel of downside-risk sharing in the US. One of the choices that has to be made when quantifying the amount of risk sharing is the exact income definition that is to be taken as a benchmark. Many past studies relied on GDP, and virtually all papers that adopted this metric concluded that the amount of fiscal risk sharing is small, around 10-15%. Others have used personal income and generally found higher estimates. In the following, we take issue with both measures and follow Duwicquet and Farvaque (2018) in using labor income, giving further reasons for why we think this is a sensible choice. For greater clarity of the following exposition, and in order to let the reader ascertain the links between various income definitions, Table 1 reports a succinct (and modified) version of a few tables from the National Income and Product Accounts, which disaggregate major income measures at the national level.

Our argument for using labor income starts from the observation that ideally, one would want to work with household-level data, as that would ensure no aggregation bias. If we take capital income as an example indeed, its high concentration would imply that, in an hypothetical household-level dataset, capital income flows would have a combined low weight due to the fact that they are concentrated in the hands of a few households. In state-level statistics however, capital income get aggregated onto fifty state-specific "representative agents". To the extent that (as it surely happens) capital income concentration at the state level is not as high as compared to the one at the household level, state-level statistics will severely bias results that one would have obtained with granular data. While a theoretically similar argument applies to labor income as well, this source of income is far less concentrated than capital income, meaning that this issue is much less relevant in this case.

Since only state-level (and some county-level) data exist, we deem that solely focusing on labor income greatly alleviates this bias: while wages and salaries make up 43.2% (as of 2018) of GDP, they represent by far the most important source of income for 99% of US households, as can be seen in Table 2. The table also confirms that any benefit stemming from the capital market channel of risk sharing will disproportionately be reaped by a very tiny fraction of US households, who incidentally also happen to be those that already have large wealth buffers to cope with idiosyncratic capital income losses. Thus, it would make sense for the federal government to strengthen social cohesion by insuring labor income, as that is the one that backs the vast majority of American households' balance sheets. In practice, Table 2 shows that (not surprisingly) this is indeed what happens,

Table 1: Disaggregation of main income measures

Item	2018 data	% of GDP
Gross Domestic Product (GDP)	20,611.9	100
Plus: Income receipts from the rest of the world	1,142.9	5.5
Less: Income payments to the rest of the world	858.2	4.2
Equals: Gross National Product (GNP)	20,896.6	101.4
Less: Consumption of fixed capital	3,265.0	15.8
Equals: Net National Product (NNP)	17,631.6	85.5
Less: Statistical discrepancy	-58.0	-0.3
Equals: National income	17,689.6	85.8
Less:		
Corporate profits with IVA and CCAdj	2,243.0	10.9
Taxes on corporate income	282.9	1.4
Net dividends	1,390.1	6.7
Undistributed profits with IVA and CCAdj	570.0	2.8
Net interest and miscellaneous payments on assets	619.1	3.0
Business current transfer payments (net)	156.6	0.8
Plus: Personal interest income	1,641.6	8.0
Plus: Personal dividend income	1,305.1	6.3
Equals: Personal income before government	17,617.6	85.5
Less:		
Current surplus of government enterprises	-5.8	-0.0
Taxes on production and imports less subsidies	1,381.5	6.7
Contributions for government social insurance, domestic	1,360.4	6.6
Plus: Personal current transfer receipts	2,970.3	14.4
Equals: Personal income	17,851.8	86.6
Compensation of employees	10,950.1	53.1
Wages and salaries	8,894.2	43.2
Supplements to wages and salaries	2,055.9	10.0
Proprietors' income with IVA and CCAdj	1,585.9	7.7
Rental income of persons with CCAdj	759.3	3.7
Personal income receipts on assets	2,946.7	14.3
Personal current transfer receipts	2,970.3	14.4
Less: Contributions for government social insurance, domestic	1,360.4	6.6

The table largely draws from Table 1.7.5, 1.12 and 2.1 from the BEA, and reports 2018 estimates for various aggregate income definitions, plus some disaggregations. Personal income before government is not an official BEA statistic. Data are in billions of current dollars and as a percent of GDP.

Table 2: Market income shares, by type

Percent	Labor income	Capital income	Social insurance benefits
Lowest quintile	81.9	18.1	33.9
Middle three quintiles	81.3	18.7	19.8
81^{st} to 99^{th} percentiles	73.6	26.4	5.2
99^{th} to 99.9^{th} percentiles	44.8	55.2	1.0
99.9^{th} to 99.99^{th} percentiles	28.5	71.5	0.0
Top 0.01 percent	13.3	86.7	0.0

The table shows own computations from Congressional Budget Office (2017) estimates. Data are in percent of market income, which is defined by the CBO as the sum of labor income, business income, capital income, and income from other nongovernmental sources. We broadly define capital income as market income minus labor income.

and that the government mainly supports individuals who lie on the low spectrum of the income distribution, which again means those that rely on labor income more than anyone else.

The Bureau of Economic Analysis (BEA) defines the non-labor share of Gross Domestic Income (GDI) to be the sum of Net Operating Surplus, Consumption of Fixed Capital, and taxes on production and imports less subsidies, which therefore together make up the difference between wages and GDP.[10] When assessing which is the capability of the fiscal channel to absorb uncertainty in income growth, one should only consider the income aggregates that indeed are targeted by the federal government, and the only of the above non-labor-related items that the government might want to insure is Net Operating Surplus. However, as we showed above federal payments to individuals are empirically almost unrelated to *personal* capital income exactly because those that earn it tend to be high-net-worth individuals. Moreover, corporations traditionally receive very little subsidies, thereby also questioning the usefulness of undistributed corporate profits (but also corporate profits in general) to be included in the analysis.

On the other hand, the opposite logic applies to the capital market channel, as corporations and wealthy individuals are those that benefit the most from cross-border ownership of physical, intangible, and financial assets. To sum up, it could be argued that in order to study public risk sharing one should focus on "representative" households (i.e. those that mostly finance themselves with labor income) whereas when interest lies in private risk sharing it would then probably be more beneficial to benchmark capital

[10]From here on, for ease of exposition we will refer to the BEA category "wages and salaries" simply as "wages".

income alone.

Our labor income measure before federal taxes and transfers is simply equal to wages. On the other hand, we define labor income after government intervention as wages plus federal personal transfers, minus the sum of employee and self-employed contributions, and personal current taxes to the federal government.[11]

Importantly, we are consistent with what suggested in Mélitz and Zumer (2002), namely, we use a narrow measure of government transfers as a consequence of using a narrow measure of income. Indeed, our fiscal flows series do not include federal grants to states that are not bound to be received by the personal sector through lower governmental levels.

5 Novel Evidence on the Fiscal Channel in the United States

We estimate equation (3.1) on US data and compute downside-risk sharing for the 1997-2018 period. The reason why we focus on this time span is twofold. First, as Figure 5.1 shows, federal government intervention in the form of direct or indirect transfers to individuals has gone substantially increasing over time. If we look at a sample starting in 1963 (the starting date for many past studies) one can see that those transfers weighted 5% of US GDP at the beginning of the sample, rapidly increased during the '70s, fluctuated around 11% during the '80s and '90s, and then increased again roughly during the last twenty years, always exceeding 14% of GDP after the Great Recession. Therefore, and as we will show in the results, the parameters underlying the model likely changed due to this secular increase, and extraordinary relief due to the Great Lockdown exacerbated this trend.[12] This makes our "local" approach that focuses on the more recent observations alone desirable. The second reason why we set 1997 to be the first year of our sample is that in this year the BEA replaced SIC codes with NAICS ones, so that we ensure accounting consistency in our baseline estimates.

We follow AVW in the choice of control variables. In particular, we use the log of per capita income at the beginning of each of the non-overlapping intervals, the five-year lagged population growth rate, the ratio of state government expenditure to (state) GDP, and the one-year lagged growth rate of per capita income. We omit investment in the manufacturing sector, the fertility rate, migration rate, education-related variables,

[11]Federal taxes and contributions are from the BEA. As for federal transfers data, Appendix B explains how we build them.

[12]OMB data show that payments and grants aimed at individuals reached 20.1% of US GDP in 2020, and forecasts show they will still sit at 17.1% of GDP by 2026.

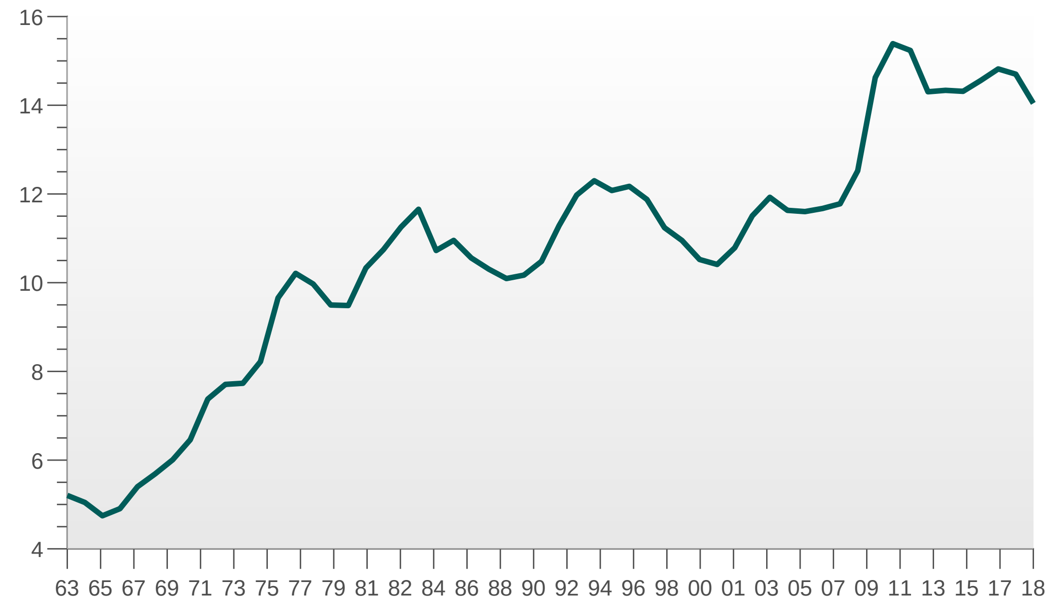

Figure 5.1: Total payments for individuals. The figure shows the evolution of the sum of direct payments for individuals and grants to state and local governments aimed at the personal sector, in percent of GDP. Data are taken from the Historical Tables of the Office of Management and Budget (OMB).

since AVW find that their inclusion does not change the results. In their analysis, in fact, government spending, the initial level of income, and its lagged growth rate are the variables with the most predictive power, so we believe we are not neglecting any crucial information.[13] Finally, our estimates weigh each observation by the corresponding average state's population within each nonoverlapping interval.

Our dataset ends in 2018 as both our baseline model and the income smoothing estimates we show in Section 6 rely on data from the Census Bureau Annual Survey of State and Local Government Finances, thoroughly reviewed by the Census only up to 2018 at the time of writing.[14]

Before presenting our main results, we highlight we first estimated the capital market channel and the fiscal channel with the same methodology as the one in AVW, with a dataset analogous to the one built in ASY (which is the one used in AVW), and with

[13]While AVW use GDP as their preferred income measure in their control variables set, we opt for using the same income variables we plug in the left-hand side, as we deem they are likely to have more explanatory power. Therefore, when we estimate the equation for income before federal government intervention, we use its corresponding initial level and growth rates (although not in deviation from the national level), and similarly for the equation for income after government intervention.

[14]Preliminary 2019 estimates are available, but the Census Bureau urges caution in their use and interpretation, so we prefer not to include them in our dataset at this point. The variables that we draw from the survey are state government expenditures, state and local direct general expenditure, total state and local tax revenue, interests on state and local trust and miscellaneous funds.

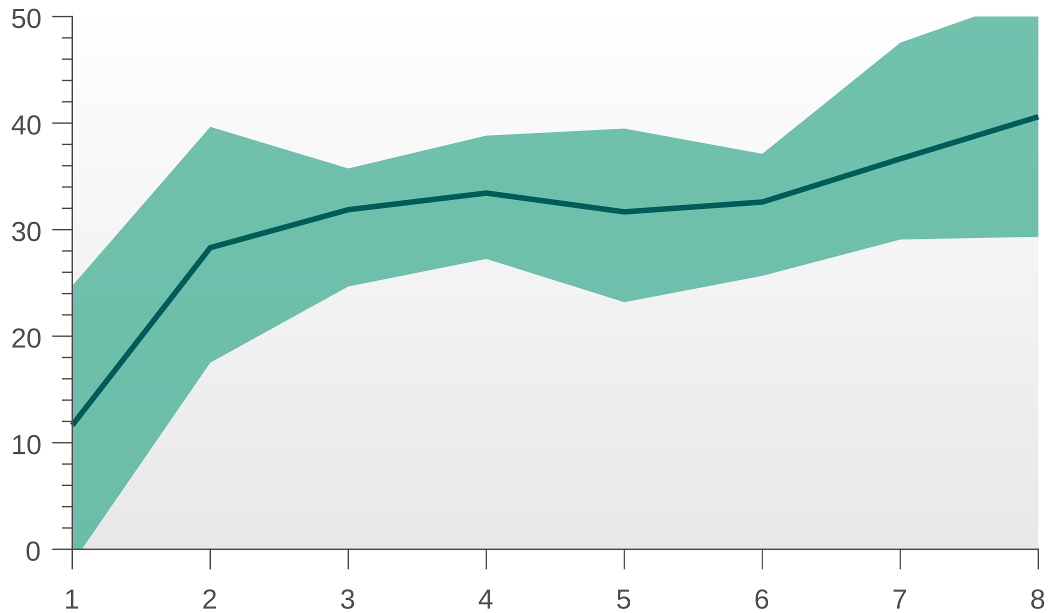

Figure 5.2: Downside-risk sharing through the fiscal channel. The figure plots our baseline estimates of downside-risk sharing. 95% confidence bands are computed with the nonparametric bootstrap as in Kapetanios (2008).

an almost identical time span as theirs (1967-1990 instead of 1963-1990), obtaining very similar estimates.

5.1 Baseline Results

Figure 5.2 shows the main result of this paper: we find that, contrary to many past contributions, the federal fiscal channel of downside-risk sharing does matter a lot in cushioning idiosyncratic income fluctuations. In particular (and consistently with some past research) it starts out at 11.6% during the first year, but then immediately increases, reaching 28.3% in the second year and a maximum 40.6% in the eighth. These values are higher than those found in many past research, questioning the conclusion that the fiscal channel plays a limited role in risk sharing.

Figure 5.3 dissects our findings by showing which is the contribution of the dataset we use as well as the one stemming from each of the methodological differences with AVW. In the top-left panel, we see how our results are to a great extent driven by the choice of using wage-based as opposed to GDP-based data as done in AVW. The latter dataset points at an average 12.4% fiscal risk sharing capability, whereas by limiting the analysis on wages we obtain 28.9%. While we already extensively argued why we believe labor income to be a better benchmark than GDP, in light of those results and of the very large difference between the two estimates we now want to provide some additional thought about the *statistical* reason why the two datasets yield such diverging estimates.

Section 4 showed how most of the difference between GDP (and, for our purposes, also National Income) and wages consists of income items that are very much disconnected with those that the federal government traditionally sustains through its programs. One would then expect this additional non-government-insured income to simply proportionally reduce the amount of risk sharing, the simple reason being that net federal transfers make up a smaller fraction of National Income (NI henceforth) as compared to wages. Therefore, idiosyncratic NI growth rates after government intervention will inevitably be much closer to those before intervention, whereas idiosyncratic wage growth rates will show more marked differences, and we confirm this intuition for the US as a whole in Figure 5.4. As far as control variables explain similar amounts of variation in income before and after risk sharing, this will necessarily lead to NI-based risk sharing estimates being lower than those based on wages.[15]

In the top-right panel of Figure 5.3, one can see that bootstrapping confidence intervals as opposed to assuming Gaussian errors and computing bands analytically as in AVW is likely to provide a more reliable picture of the risk-sharing estimates that one retrieves within our application, as bands are notably much larger than those obtained by assuming normality. To corroborate this, standard tests reject the null of Gaussianity in the distribution of the forecast errors in the majority of the regressions we run.

The bottom-left panel plots what we obtain when we deflate risk sharing formulas in AVW by the share of residual variation, namely, when we compute the "adjusted" version of risk sharing as in equation (3.3). In our case, we obtain R^2 values that are relatively low and broadly in line with those in AVW, and indeed the adjustment lowers our estimates by a small amount.

In the bottom-right panel, one can see the benefits of using our downside-risk sharing methodology, as estimating the volatility of the left tail yields quite higher risk sharing estimates than otherwise. While during the first two-year horizons estimates are virtually identical, starting from the third-year onwards the two methodologies yield an average 4.2% difference, with our approach suggesting the federal government hedges a maximum 40.6% of wage income growth after eight years.[16] Coupled with the fact that the

[15]We also ran a back-of-the-envelope calculation, deflating wage-based fiscal risk sharing estimates in the top-left panel of Figure 5.3 by the average wages-NI ratio during 1997-2018. Estimates are then very similar to those based on broader income aggregates, thereby providing further evidence that using the latters leads to misleading evidence on what is actually accomplished by the federal government.

[16]In this last case, we also ran Kolmogorov-Smirnov tests to assess the null hypothesis that the data come from the same distribution at every horizon. The test always rejects the hypothesis at any reasonable significance level.

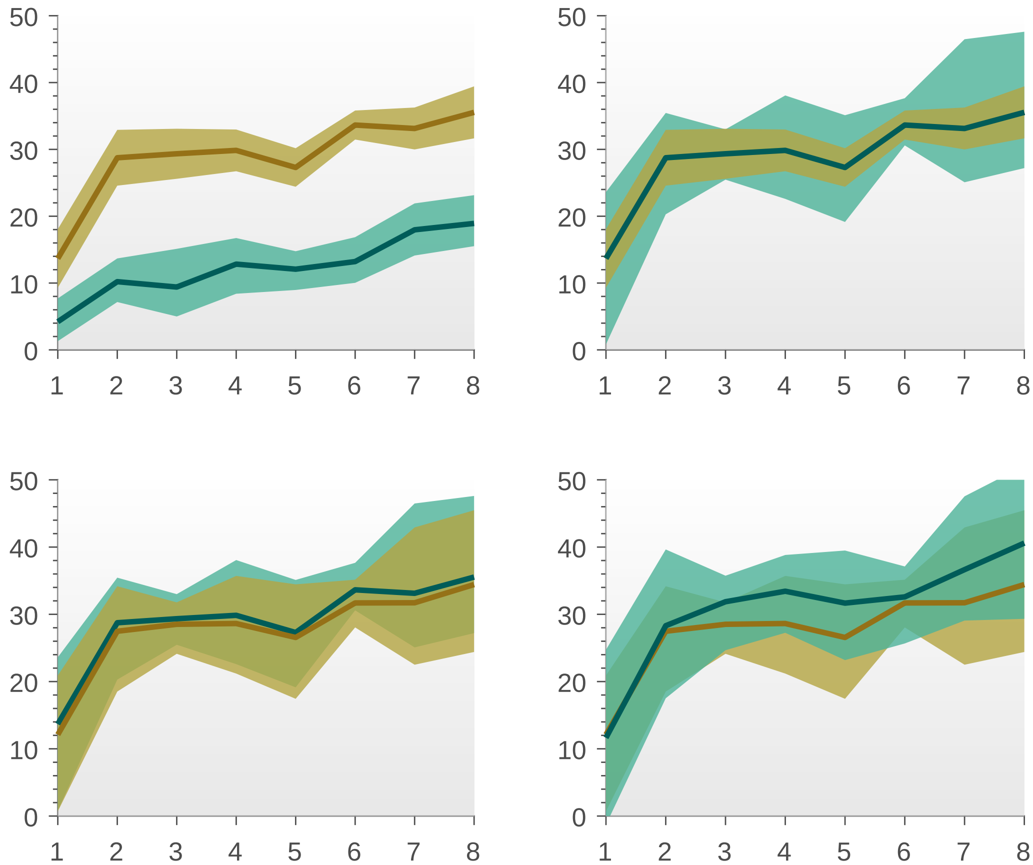

Figure 5.3: **From AVW to our baseline.** Top-left panel: the blue distribution shows results obtained by estimating the model *exactly* as in AVW, namely, using a GDP-based dataset built in a similar fashion as in ASY, using equation (3.2) to compute risk sharing, and also obtaining 95% confidence bands with the analytical methods described in AVW. The brown distribution plots results obtained with the same method, but using our preferred wage-based dataset. Top-right panel: the brown distribution is the same as the one in the top-left panel, while the blue one has been obtained by computing bands with the non-parametric bootstrap in Kapetanios (2008). Bottom-left panel: the blue distribution is the same as the one in the top-right panel, while the brown one computes the "adjusted" version of risk sharing as in equation (3.3). Bottom-right panel: the brown distribution is the same as the one in the bottom-left panel, whereas the blue one is our baseline downside-risk sharing estimate as in equation (3.5).

Figure 5.4: US per capita income growth rates, before and after government intervention. The left panel shows wage growth rates per capita as compared to those obtained by adding net fiscal transfers as we define them in this paper. In the right panel, we plot similar figures for aggregate state income and disposable state income as defined in ASY. Percent data computed from current dollars figures.

federal government especially intervenes to reduce the damage caused by recessions, our results are consistent with what found in e.g. Adrian et al. (2019), namely that the conditional income growth distribution is strongly left-skewed during crises. Finally, it goes without saying that what we obtain in our application needs not be replicated in other frameworks. Therefore, other regressions might well yield much larger as well as much muted differences in each of the above-mentioned steps.

One might also wonder how much our estimates varied in general over our available time spans: Figure 5.5 shows what we obtain when we estimate our model over expanding windows. Interestingly, and contrary with past research which did not find economically significant changes in the insurance role of the US federal fiscal system over time, we do observe a clear upward trend in risk sharing estimates at all horizons, with the sole exception of the first year, where from 2016 onwards estimates fall back to those prevailing during the nineties. This general upward trend is consistent with what we showed in Figure 5.1, namely that federal transfers to individuals have steadily increased over a similar span of time. Again, GDP-based estimates conceal this pattern.

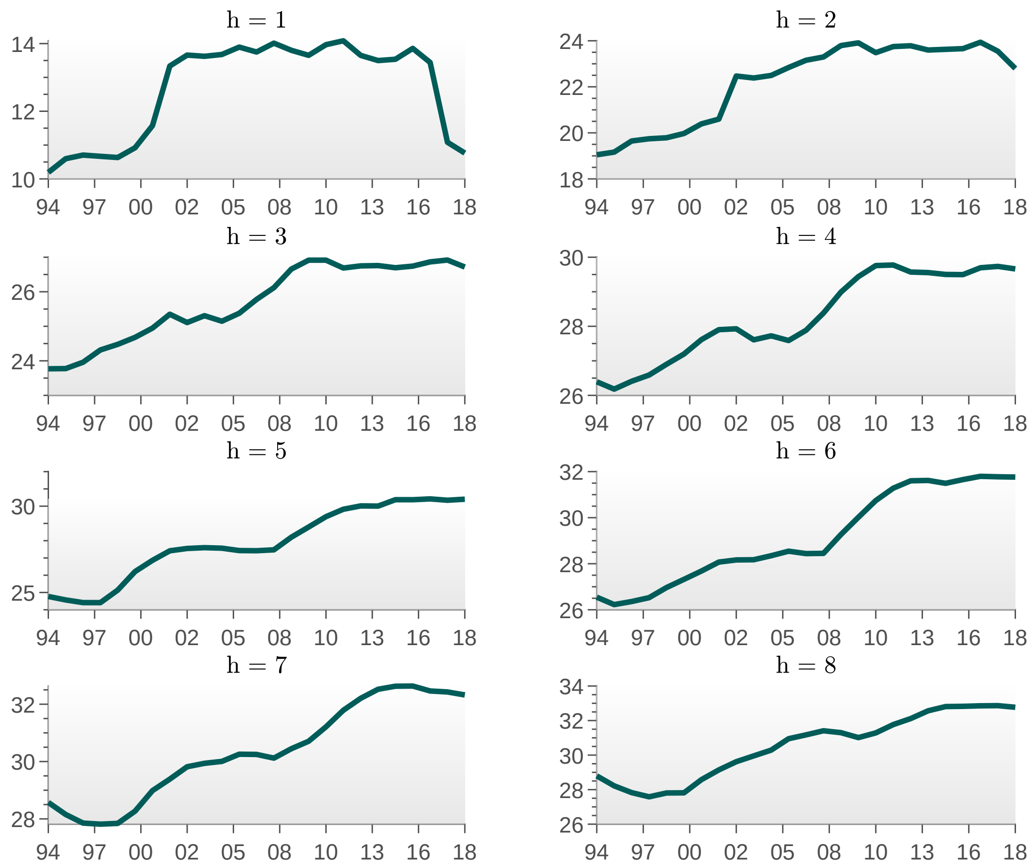

Figure 5.5: Risk sharing over expanding windows. The figure shows horizon- and year-specific risk sharing estimated over expanding windows starting in 1967. Every data point represents the $h - years$ moving average of risk sharing estimates. We resort to moving averages to get rid of the uninteresting horizon-specific seasonality due to new non-overlapping intervals flowing into the regression as the window expands.

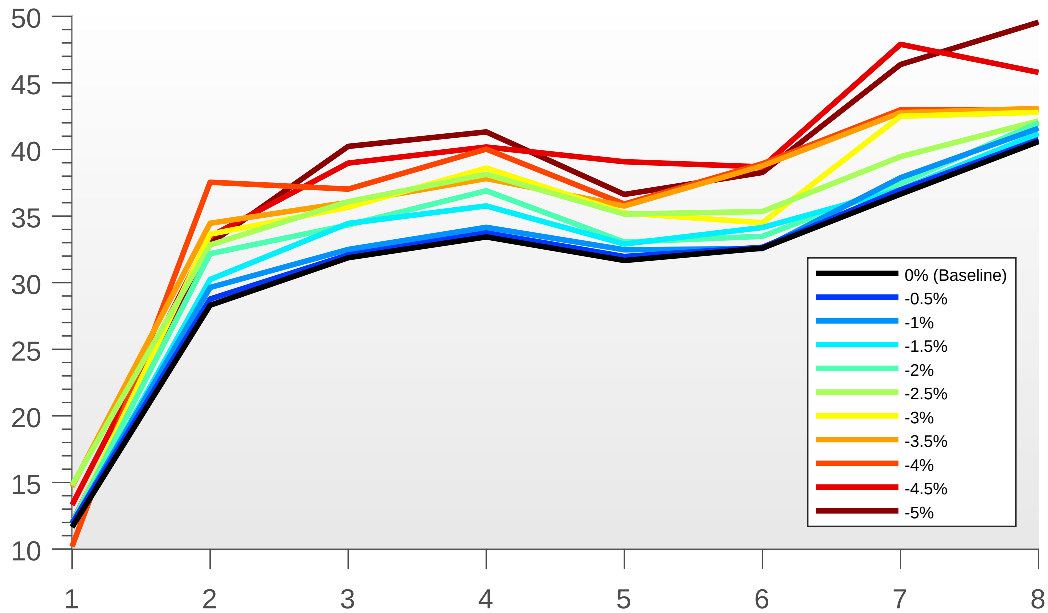

Figure 5.6: Downside-risk sharing with different thresholds. The figure plots downside-risk sharing estimates obtained by setting negative and progressively lower values for c in equation (5.1).

5.2 Hedging Against Larger Shocks

The simplicity and flexibility of our framework allow us to push the downside-risk reasoning even further. One could indeed argue that states might probably be more interested in knowing how much the federal government is able to accomplish when *large* negative shocks alone hit, rather than including small negative idiosyncratic forecast errors in the analysis. Therefore, we perform a further exercise and define downside-risk by setting ever more negative thresholds in the conditional forecast errors distribution. In particular, we generalize equation (3.4) to

$$\hat{\epsilon}_s^{i,-} = \min(\hat{\epsilon}_s^i, c), \tag{5.1}$$

and provide estimates for various values of c, a parameter that has to be interpreted as unexpected state income growth (expressed in percentage points) over and above the national one. Figure 5.6 plots the results. It is interesting to see that, as the threshold gets lowered, downside-risk sharing almost always increases, corroborating the intuition that the federal government especially intervenes to curb large (and less frequent) shocks.

5.3 Sensitivity Analysis

We first want to gauge how much our risk sharing estimates survive if we force a downward bias into equation (3.5), and the way we do this is by not controlling for any available information in the equation for post-intervention income (while we still do in the equation for pre-intervention income). In this way, the after-risk-sharing residual standard deviation will coincide with its sample standard deviation, which is higher. This in turn leads the resulting risk sharing estimate to be lower than our baseline. The top-left panel of Figure 5.7 shows that by doing this we still obtain that the fiscal channel absorbs an average 26.7% of shocks to pre-intervention income, fluctuating around 29.1% after the first year.

Second, recall that our model weighs each state-specific observation by population during the corresponding period. Many past studies do not apply those weights. Nevertheless, we deem this to be necessary since our goal is to estimate the amount of risk sharing the average individual enjoys, rather than the corresponding value for the average state, and US states have widely different population sizes. For example, as of 2018, the 21 smallest states have a combined population that is smaller than that of California, the largest state. Still, even if we were to follow past contributions and perform non-weighted regressions, those results are very close to our baseline (top-right panel of Figure 5.7). We also find similar results if we add employer contributions for government social insurance (bottom-left panel) and if we exclude Alaska and Hawaii, two states that have been shown to create some problems in some applications (bottom-right panel).

Finally, we run a last robustness check by estimating our model for all possible combinations of sample lengths, for a given minimum subsample length of twelve years. More specifically, we first extract all the subsamples obtained from the rolling windows with length twelve years, estimate the model for each window, and store the results. Then, we do the same for subsamples of length thirteen, and so on and so forth, for a total of 55 combinations. Figure 5.8 shows the results. We see that our whole-sample estimates largely agree with the averages taken over all the combinations in the 1997-2018 period, which rarely tend to fall below 20% from the second year onwards, while also often suggesting even higher risk sharing capabilities of the federal system. Having said this, our main estimates should in general be regarded as more reliable per se, for they draw from a larger (although still recent) sample size.

Figure 5.7: **Alternative specifications.** The panel shows results that are obtained when we depart from our baseline specification, which is plotted with a black line. Results hold even in the extreme case where we force a downward bias in the estimates.

6 On the Capital Market Channel of Risk Sharing: the Neglected Role of Capital Depreciation

While we have shown that the fiscal channel of risk sharing has been largely underestimated, in this section we show that because of inherent US data limitations (which we overcome by imposing some reasonable assumption) the opposite argument applies to the capital market channel. We deem both results to be important as they jointly tilt the strength of the fiscal channel as compared to the capital market channel towards the former.

Many researchers have attempted to estimate some version of the capital market channel of risk sharing, which is the one that stems from inter-state income flows due to domestic (foreign) ownership of foreign (domestic) assets. In an international risk sharing model, one would compare GDPs with GNPs, as their difference exactly represents net factor income flowing from the rest of the world[17]. In a US intra-national model however, no state-level GNP data exists, and earlier research implicitly added Consumption of Fixed Capital (CFC henceforth) and corporate savings into net factor income flows.[18]

[17]Sørensen and Yosha (1998) is one such example.

[18]For example, footnote 2 in ASY states that State Income (i.e. the state-level equivalent of National

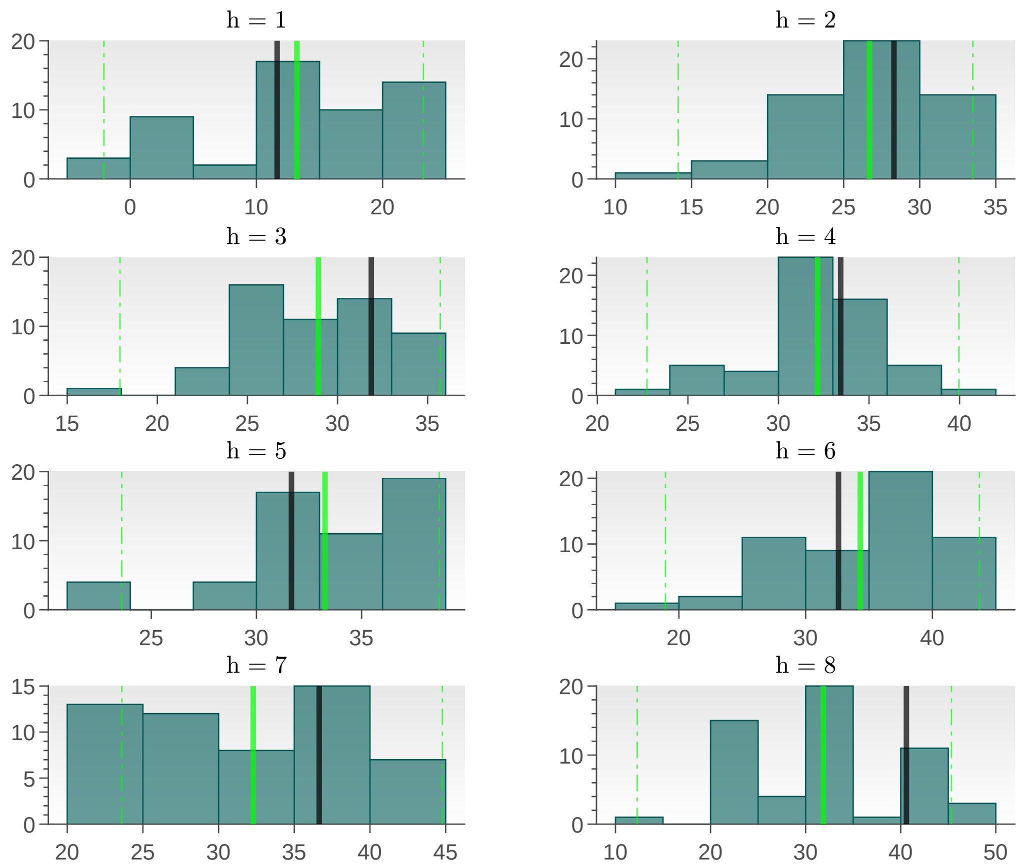

Figure 5.8: All sample combinations. The histograms report the absolute frequency of estimates obtained by running our model over all combinations of time periods during the 1997-2018 sample, using a minimum sample length of twelve years. The black line is our baseline estimate, the solid green line is the horizon-specific average of the estimates for all the combinations, while the shaded green ones mark the minimum and maximum subsample estimates.

This is a serious limitation that has not received much attention in the literature.[19]

In their application on Spanish provinces, Alberola and Asdrubali (1997) recognize that only net production is available for consumption, and therefore subtract capital depreciation from gross income, performing their exercise using NDP rather than GDP as in ASY. Sørensen and Yosha (1998) pointed out that, since the capital-output ratio is countercyclical, the depreciation channel will result in dis-smoothing. While they find this to be true for European Community countries as well as OECD ones, they could not perform this exercise for the US. Figure 6.1 shows that, while the CFC-GDP ratio is indeed - up to low-frequency fluctuations - clearly countercyclical, the annual growth rates of the two series are positively correlated (44.6% over the 1963-2018 period). The countercyclicality of the CFC-GDP ratio therefore comes from the fact that CFC growth tends to fall less in recessions than GDP growth does. Given that CFC growth is pro-cyclical, and since CFC is a cost of production that only affects fluctuations in NDP (not GDP) one would expect to find that a higher CFC does indeed provide some income smoothing.[20]

To the best of our knowledge, no estimates exist that compute the depreciation channel of risk sharing in the United States. The reason is simple, as as we said no state-level CFC data exist. By imposing some reasonable assumption however, we retrieve those data and estimate this channel for the US. Importantly, we find that much of the capital share found in ASY and later studies is driven by CFC alone.

6.1 Consumption of Fixed Capital: State-level Estimates

In order to retrieve state-level estimates of CFC, all we need are state-level estimates of Net Operating Surplus (NOS henceforth). Indeed, the BEA defines NOS as Gross Operating Surplus (GOS henceforth) minus CFC, and state-level data for GOS do exist. Table 3 shows subcomponents of NOS, while Figure 6.2 plots each of them over time. Our goal

Income) is equal to *GDP* plus Net Factor Income. However, National Income as defined by the BEA is equal to *Net Domestic Product* (NDP) plus Net Factor Income (minus the statistical discrepancy). In our setting (and using the notation in ASY) we approximately have that NDP = GDP - CFC; SI = NDP + Net Factor Income; DSI = SI + federal transfers - federal taxes; C = DSI - savings. The approximation mainly stems from the fact that the effect of corporate savings will still be implicitly included in the capital market channel.

[19]It has to be pointed out that, even if state-level GNP figures existed, comparing state GDP with state GNP would not yield inter-state risk sharing estimates coming from the capital markets channel, but rather true international risk sharing ones. The reason is that the difference between state GDP and state GNP would equal net factor income from the rest of the federation *plus* net factor income from the rest of the world outside the federation.

[20]While we expect the bulk of the capital depreciation channel to work within states, flexible multi-plant firms that operate throughout the country might well decide to shift production away from states that are temporarily suffering a recession towards those that are thriving, thereby benefiting from this channel not only along the temporal dimension but also across the spatial one.

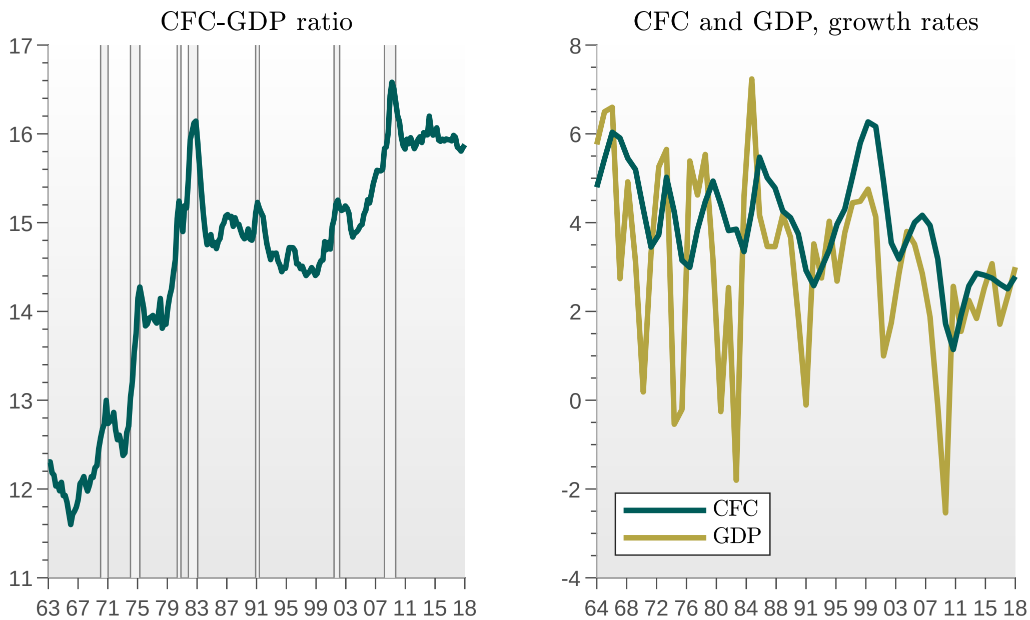

Figure 6.1: **Consumption of Fixed Capital.** The left panel shows CFC in percent of GDP over the 1963-2018 period (shaded areas represent NBER recession dates). The right panel plots annual percent growth rates of quantity indexes of CFC and GDP over the same time span.

is to find sensible ways to allocate each subcomponent to every US state, so as to end up with state-level NOS data.

First, one can see that net business current transfer payments and current surplus of government enterprises are marginal components, and this is true for every year in the 1997-2018 sample, where they jointly count an average 3.1% of NOS. We choose to estimate their state-level counterparts by using GDP weights, although we are confident that, given the almost negligible role of those two series, other weights choices would not have changed our final outcome in any appreciable way.

Second, we allocate rental income of persons with CCAdj (RI henceforth) with rental income data, for which state-level data exist. Over our sample, the maximum absolute difference between the two US aggregates is to all practical purposes equal to zero, making us very confident that our approximation is likely to be very good. A similar argument applies for proprietors' income with IVA and CCAdj (PRI henceforth), where we allocate it to every state using proprietors' income shares. Here, the maximum absolute difference between the two series is equal to 0.3% of NOS.

Third, the BEA defines net interest and miscellaneous payments as net interest plus rents and royalties, where the latter refers to payments made to all levels of government (federal, state and local). In turn, net interest is defined as interest paid by private en-

Table 3: Disaggregation of Net Operating Surplus

Item	2018 data	% of NOS
Net Operating Surplus (NOS)	5,062.8	100
Net interest and miscellaneous payments, domestic industries	836.4	16.5
Business current transfer payments (net)	156.6	3.1
Proprietors' income with IVA and CCAdj	1,585.9	31.3
Rental income of persons with CCAdj	759.3	15.0
Corporate profits with IVA and CCAdj, domestic industries	1,730.4	34.2
Current surplus of government enterprises	-5.8	-0.1

The table draws from Table 1.10 from the BEA, and reports 2018 estimates for disaggregations of Net Operating Surplus. Data are in billions of current dollars and as a percent of NOS.

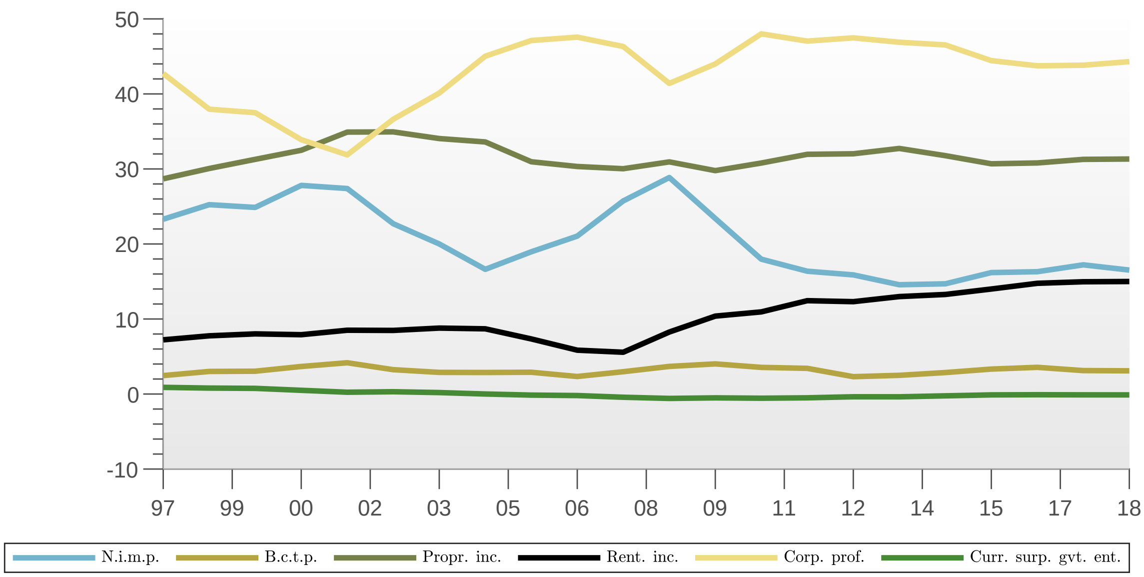

Figure 6.2: Net Operating Surplus. The plot shows subcomponents of Net Operating Surplus (NOS) as percent of NOS. "N.i.m.p." is net interest and miscellaneous payments, domestic industries. "B.c.t.p." is business current transfer payments (net). "Propr. inc." is proprietors' income with IVA and CCAdj. "Rent. inc." is rental income of persons with CCAdj. "Corp. prof." is corporate profits with IVA and CCAdj, domestic industries. "Curr. surp. gvt. ent." is current surplus of government enterprises.

terprises less interest received by private enterprises, plus interest paid by the rest of the world less interest received by the rest of the world. Having said this, the exact subcomponent in the NOS series is net interest *in domestic industries* (NIDI henceforth). Crucially, while no state-level data exists for NIDI, there does exist a series that understandably correlates very much with it and for which state-level data exist, namely monetary interest receipts (MIR henceforth), which are part of personal interest income. One reason why those series should comove stems from the fact that part of the debt issued by private enterprises will be directly held by US households in the form of e.g. bondholdings that pay monetary interest. Within our sample, the two series correlate 92.8% in levels and 93.0% in growth rates, and their size is of the same order of magnitude, whereby MIR amounts equal an average 68.9% of NIDI during our time span. Finally, rents and royalties only weight an average 2.6% of NIDI, and we are therefore confident that approximating state-level NIDI with MIR weights leads to precise estimates.

We are then left with corporate profits with IVA and CCAdj. In principle, we could follow what ASY do with corporate income taxes, namely distributing profits (which are a multiple of federal corporate income taxes) with the average of the share in US personal income and the share of property income. However, we prefer to use the share of personal consumption expenditures which, to be sure, lead to very similar weights than those in ASY.

Before computing state estimates of CFC, we have two main adjustments we have to make. First, available state-level estimates of GOS do not sum to national ones due to overseas activity, which nevertheless only counted an average 1.3% of national GOS. We then assign GOS stemming from overseas activity using state GOS figures. Second, the BEA computes GOS subtracting compensation of employees and taxes on production and imports less subsidies from GDP. The fact that GOS is calculated as a residual of GDP instead of Gross Domestic Income (GDI) implies that the sum of NOS and CFC is equal to GOS only up to the statistical discrepancy (SD) between GDP and GDI. SD represents a small fraction of total income, averaging (in absolute terms) 0.7% of GDP. Again, thise series is only available at the national level, so we assign it to states based on GDP weights.

We then have all the ingredients to extract state-level data for CFC, meaning, we compute it as the difference between GOS and NOS estimated as above, minus the statistical discrepancy.

6.2 CFC-corrected Estimates

In this section, we estimate the three channels of income smoothing as in ASY, plus the one due to fluctuations in CFC. We essentially use the approach in ASY but make some changes to their dataset.

First and foremost, starting from 1997 the BEA publishes state-level data for personal consumption expenditures. In their paper, ASY use retail sales as a proxy, as it was the most sensible thing to do at the time. We instead believe that (at the cost of obtaining a shorter dataset) now-available figures for PCE should be used instead. We also argue that concentrating on this time span makes sense in light of the fact that SIC codes were replaced by NAICS ones by the BEA exactly in 1997, with visible effects on the aggregates. For instance, for the US as a whole, 1997 NAICS-based nominal GDP was almost $300 billions (or 3.5%) higher than 1997 SIC-based GDP. Furthermore, starting from 1997 allows comparability with the estimates presented in Section 5.

Second, and since we concentrate on the post-1997 period where PCE data is available, we believe that allocating corporate income taxes and excise taxes with the share of PCE is to be preferred, as state shares of corporate income taxes and excise taxes are likely to be more correlated with consumption rather than with a mix of personal and property income. Nevertheless, as we already said, the weights we obtain turn out not to be dramatically different from those in ASY.

Third, we include further items on the excise taxes series, some of which were not in place before 1990. Those are taxes on ozone depleting chemicals/products, transportation fuels, health insurance providers, indoor tanning services, medical devices, inland waterway, post-closure liability, oil spill liability, acquatic resources, leaking underground storage tank, tobacco assessments, vaccine injury compensation, supplementary medical insurance, patient-centered outcomes research.

Finally, state-level data for direct payments to individuals and grants to state and local governments have been published by the Census Bureau until 2010.[21] The sudden lack of those extremely valuable data led some organization to estimate it from other sources. The Pew Charitable Trusts use data from the BEA, the `USAspending.gov` website, the Office of Personnel Management, and the Department of Defense to retrieve Census-like state-level data categories from 2004 to 2014.[22] For 2015 only, the Council of State Governments used Pew's methodology and technical assistance to publish the same data.

[21] The Federal Financial Statistics program (which managed the publication of this data) has been terminated in fiscal year 2012, with 2010 being the last year of available data.

[22] The website is maintained by the OMB and is available online since the end of 2007. See The Pew Charitable Trusts (2014) for a summary of the approach used to build their dataset.

Starting from 2016, to the best of our knowledge no other organization took over in providing those data, meaning one has to rely on BEA data from 2016 onwards. Given those data limitations, we prefer to approximate federal payments to individuals with the series we built in Section 4, which also include some federal grant to states aimed at the personal sector (where Medicaid is the most important item in this category).

The system of equation in ASY is the following, where differently from them we separate the capital depreciation channel from the capital market one:

$$\begin{aligned}
\Delta \log GDP_t^i - \Delta \log NDP_t^i &= \mu_{D,t} + \beta_D \Delta \log GDP_t^i + u_{D,t}^i, \\
\Delta \log NDP_t^i - \Delta \log SI_t^i &= \mu_{K,t} + \beta_K \Delta \log GDP_t^i + u_{K,t}^i, \\
\Delta \log SI_t^i - \Delta \log DSI_t^i &= \mu_{F,t} + \beta_F \Delta \log GDP_t^i + u_{F,t}^i, \\
\Delta \log DSI_t^i - \Delta \log C_t^i &= \mu_{C,t} + \beta_C \Delta \log GDP_t^i + u_{C,t}^i, \\
\Delta \log C_t^i &= \mu_{U,t} + \beta_U \Delta \log GDP_t^i + u_{U,t}^i,
\end{aligned} \tag{6.1}$$

where GDP_t^i is Gross Domestic Product of state i at time t; NDP is Net Domestic Product; SI is state income; DSI is disposable state income; C is state consumption; $\mu_{.,t}$ are time fixed effects; β_D, β_K, β_F and β_C are the amount of income smoothed by the capital depreciation channel, the capital market channel, the fiscal channel, and the credit-savings channel respectively; β_U is the amount not smoothed.

Table 4 shows results obtained by estimating various model specifications. In the first column, we disregard the capital depreciation channel and try to get as close as we can to what ASY do. In particular, we allocate corporate income taxes and excise taxes as in ASY, thereby not using our preferred PCE weights. Moreover, we do not weigh observations by population and we do not add state fixed effects. Since we focus on the 1997-2018 period, our results are best compared with those in Alcidi et al. (2017), who show results for 1998-2013 and use PCE data instead of retail sales. Their findings are very similar, and differences are likely to be ascribed to the slightly different samples analyzed: for the capital markets share, we (they) obtain 40.4% (47%) smoothing; for the fiscal channel, 7.2% (8%); for the credit-savings channel, 35.4% (27%); the unexplained share is in both cases estimated at 17.0%. Column (2) then shows that if we are to distribute national figures of corporate income taxes and excise taxes with state PCE shares, no material difference is observed in estimates of β_K and β_F (the only coefficients that are affected by this choice).

Column (3) is the main finding of this exercise: when we separate consumption of fixed capital flows from genuine net factor income ones, we find that virtually all of the smoothing effect that ever since ASY has been thought to be due to the latter is actually

Table 4: Income Smoothing Estimates

Model	(1)	(2)	(3)	(4)	(5)	(6)
$\hat{\beta}_D$ (Capital depreciation)			41.4 (1.6)	38.3 (1.5)	42.3 (1.7)	42.9 (1.8)
$\hat{\beta}_K$ (Capital flows)	40.4 (2.5)	41.2 (2.5)	-0.3 (2.0)	2.9 (1.7)	-0.1 (2.1)	4.8 (2.5)
$\hat{\beta}_F$ (Fiscal flows)	7.2 (0.6)	6.4 (0.6)	6.4 (0.6)	6.4 (0.6)	6.0 (0.6)	9.8 (0.7)
$\hat{\beta}_C$ (Credit and savings)	35.4 (2.6)	35.4 (2.6)	35.4 (2.6)	35.4 (2.6)	36.1 (2.7)	24.8 (3.1)
$\hat{\beta}_U$ (Unexplained)	17.0 (1.2)	17.0 (1.2)	17.0 (1.2)	17.0 (1.2)	15.8 (1.2)	17.6 (1.3)
PCE weights	No	Yes	Yes	Yes	Yes	Yes
Population weights	No	No	No	No	No	Yes
FE	No	No	No	No	Yes	No

The table shows regression results using our version of ASY dataset, and different model specifications estimated over the 1997-2018 period. Column (3) onwards separate the capital depreciation channel from the capital market one. Standard errors in parenthesis. Estimates refer to first horizon only.

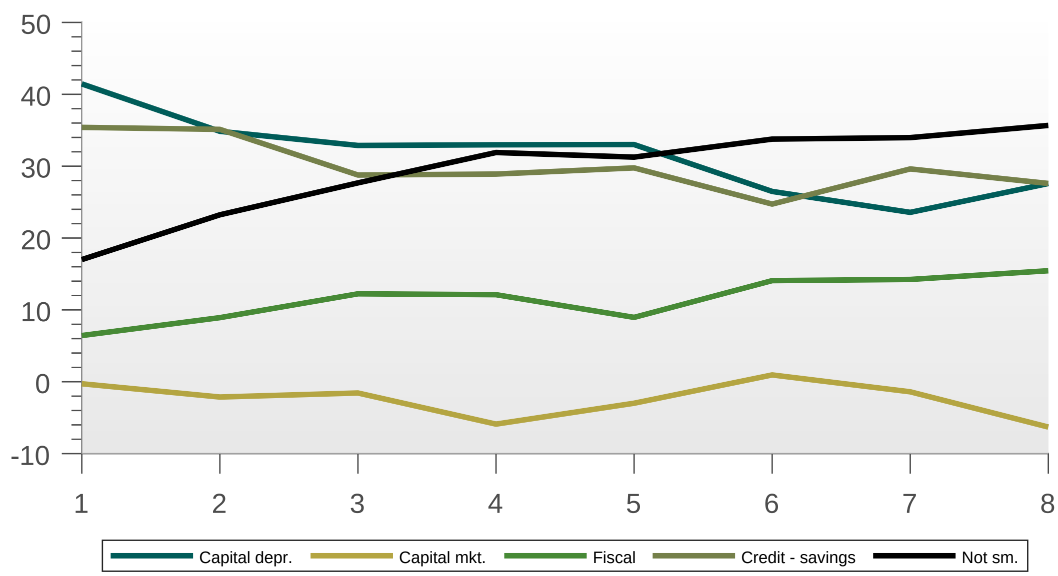

Figure 6.3: ASY estimates, augmented with capital depreciation channel. The figure shows estimates of channels of income smoothing obtained using our version of the dataset in ASY, and adding the capital depreciation channel as explained in the text.

driven by the former. Indeed, the capital depreciation share appears to smooth as much as 41.4% of GDP fluctuations, whereas the capital market one drops to -0.3%. As we said, this has an intuitive explanation: during busts, capital is relatively more idle, and firms consume less of it, which helps sustain NDP, while the opposite happens during booms. We also add that CFC is an important component in national accounting, counting an average 15.5% of GDP over our estimation sample. Therefore, even relatively small fluctuations in CFC can provide significant smoothing of *gross* income. In comparison, the *sum* of interest receipts from the rest of the world and interest payments to the rest of the world only weighs an average 7.9% of US GDP.

Columns (4) to (6) provide robustness analyses to support our result. Column (4) estimates equation (6.1) by substituting NDP with Gross State Income, defined as State Income plus CFC. In this case, the first equation measures the capital markets channel, whereas the second the capital depreciation one. Column (5) estimates the same specification as the one in (3) but also adds state fixed effects; no appreciable difference is observed. Finally, column (6) weights observations by population. Here, we observe a drop in the credit-savings channel of income smoothing to 24.8%, with the difference distributed over the remaining parameters. Still, the capital depreciation channel proves to be very robust, being estimated between 38.3% and 42.9% between the four specifications where we account for it.

Figure 6.3 estimates column (3) of Table 4 over our preferred time horizon length. If we compare our results with Figure 8 in Alcidi et al. (2017) - who do not disentangle the effect of capital depreciation - we observe very similar dynamics. In particular, in both cases $\hat{\beta}_D + \hat{\beta}_K$ starts at a high value and then decreases by more than 10 percentage points by the fifth-year horizon. The fiscal channel and the unexplained share also show very similar estimates, while for the credit-savings channel results are still comparable, though with some more differences.

Crucially, our analysis shows that the capital market channel coefficient remains close to zero over all horizons, and that therefore to all practical purposes all of the effect that ASY and Alcidi et al. (2017) assign to smoothing coming from inter-state capital flows is instead due to capital depreciation alone. Moreover, it has to be said that we are not the first to find a negligible role played by capital income flows in the stabilization of fluctuations in GDP growth. Sørensen and Yosha (1998) already found this to be true both for European Community as well as OECD countries. Our estimates align the evidence from the US with the one available from these sets of countries, with a major difference due to the fact that Sørensen and Yosha (1998) actually find the capital depreciation channel to have weak *dis-smoothing* effects.

Finally, the same unpleasant results we obtain for the capital market channel using the framework in ASY are found when using our preferred modeling strategy, as when we estimate our downside-risk sharing model on both non CFC-adjusted data and adjusted ones over the 1997-2018 sample, we find (on average) negative risk sharing.

6.3 Sensitivity Analysis

One might wonder how much the particular choice of weights $w_{it,c}$ to apply to each NOS subcomponent $c = 1, \ldots, 6$ is driving our results regarding the relevance of the capital depreciation channel. In this section, we run some robustness check on the estimated share of GDP growth that is smoothed by the capital market channel.

First, we re-run the model in equation (6.1) thousands of times, applying a stochastic jitter to every weight at every iteration. In particular, we obtain modified weights as

$$w^*_{it,c} = \kappa_{it} w_{it,c} \quad \kappa_{it} \overset{iid}{\sim} \mathcal{U}(0.8, 1.2), \tag{6.2}$$

where $\mathcal{U}(a, b)$ is a uniform distribution with support in $[a, b]$. Therefore, we estimate the model by increasing (decreasing) each weight by a stochastic amount that can be as high (low) as 20% (-20%) of the original weight, which entails a significant shift from our preferred specification.[23] This approach could be deemed as somehow far-fetched, the reason being that weights are allowed to vary by potentially considerable amounts every year, for all NOS subcomponents. Therefore, we also run a less extreme robustness where we apply the same stochastic draw to the whole series. In other words, we also define

$$w^{**}_{it,c} = \kappa_i w_{it,c} \quad \kappa_i \overset{iid}{\sim} \mathcal{U}(0.8, 1.2). \tag{6.3}$$

Figure 6.4 plots the results we obtain with those two procedures, only focusing on the capital market channel.[24] As expected, the first one yields more dispersed estimates. Nevertheless, the distribution tends to be symmetric around the baseline, but most importantly even the highest estimates fail to get close to those in ASY. As for the second and less extreme procedure we use to re-weight NOS subcomponents, the distribution is very tightly concentrated around the baseline at every horizon.[25]

[23] Once we obtain the w^*s, we rescale them so they sum up to 1 over the cross-section.

[24] Since the ultimate model-relevant object we are modifying is simply state-level NDP, $\hat{\beta}_D + \hat{\beta}_K$ will not be affected by this analysis, and we can therefore only concentrate on one of $\hat{\beta}_D$ or $\hat{\beta}_K$. We choose the second one as is the most interesting for policy purposes.

[25] We also tried computing weights $w^{***}_{it,c} = \max(w_{it,c} + z_i, 0)$, with $z_i \overset{iid}{\sim} \mathcal{U}(-0.03, 0.03)$, namely, we stochastically increased or decreased our weights by as much as 3 percentage points, subject to those

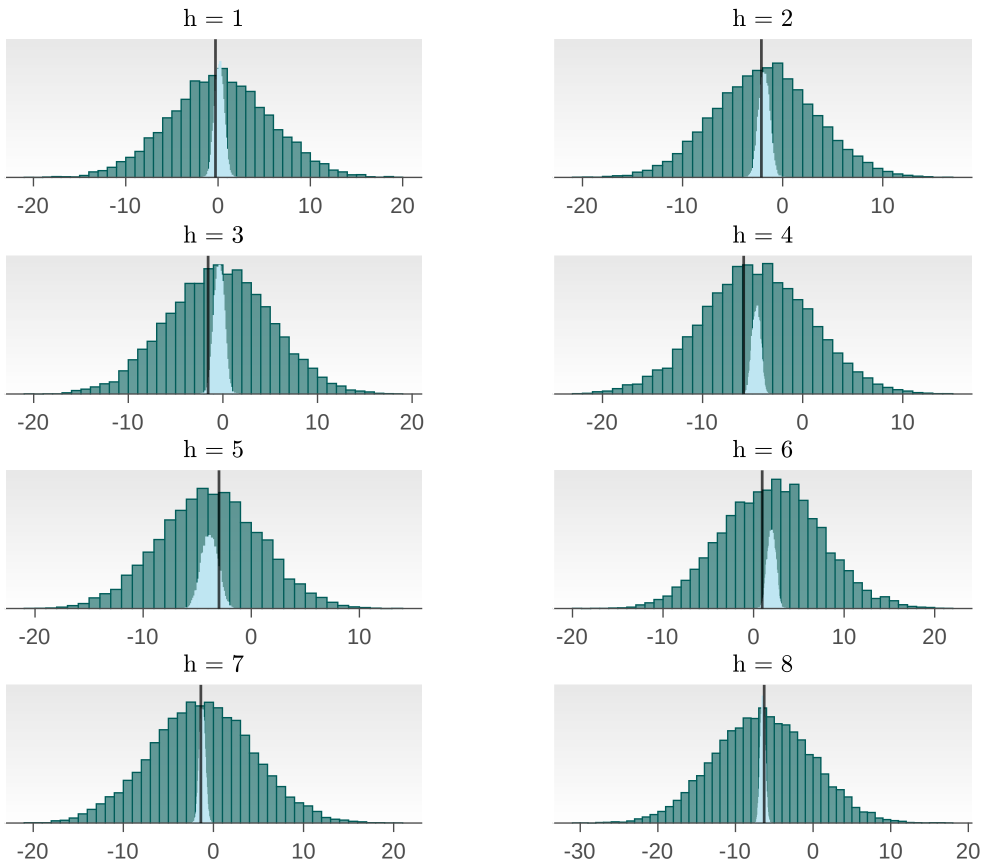

Figure 6.4: Different weights for every NOS subcomponent. The dark-blue histogram reports the set of $\hat{\beta}_K$s obtained by running the model in equation (6.1) 10,000 times, having computed state-level NOS subcomponents with stochastic weights as in equation (6.2). The light-blue histogram refers to estimates obtained with weights computed as in equation (6.3). The black line is the baseline estimate for the capital market channel.

Finally, we force CFC to be artificially low and deflate it by pre-specified amounts. In particular, one can set $CFC_{it}^{*} = \phi CFC_{it}$, with $\phi \in [0, 1]$. When $\phi = 0$, the estimated β_K will be the same as that obtained within the framework in ASY. On the other hand, when $\phi = 1$ we are back to our baseline estimates. Estimating the model over the (approximate) continuum of values that ϕ can assume, we find a close-to-linear decay in $\hat{\beta}_K$ as ϕ increases. For instance, if we discount CFC figures by a significant amount of 20% (i.e. if we set $\phi = 0.8$) we still obtain low estimated capital market channel capabilities, specifically equal to 10.2%.

7 Concluding remarks

In this paper, we develop a new methodology that provides the first estimates of downside-risk sharing. Starting from the framework in Athanasoulis and Van Wincoop (2001), and based on a simple definition of stocks' downside risk in Markowitz (1959), we adapt the latter to our setting in order to compute downside risk in state income growth. We apply our methodology to gauge the extent to which the federal government of the United States is able to insure against idiosyncratic risks, and we revisit the case for a fiscal union by showing that its beneficial effects are significantly higher than previously calculated. As soon as 2020 and even later data will become available, our evidence suggests that estimates will only get larger.

Based on past research, many contributors in the policy debate have taken for granted that the role of the fiscal channel of risk sharing is much lower than the one stemming from inter-state capital flows. Building on that same research, we instead show that once one explicitly disentangles the capital depreciation channel from the capital market one, the importance of the latter disappears, as it is completely substituted by a large smoothing effect from the former.

In light of our results, we conclude that political efforts in the direction of establishing a well-designed fiscal union within the Euro area would definitely be worth the candle. We also still believe that further steps towards more integrated capital markets as well as the completion of the banking union remain key objectives to be reached by the EMU going forward. Yet, it is possible that different empirical approaches might be needed to correctly evaluate the strength of the capital market channel of risk sharing. This is something we leave for future research.

weights being non-negative. However, the overall estimates we obtained tended to yield even stronger dis-smoothing effects of the capital market channel than our baseline suggests.

A Appendix - Weighted Estimates

Here, we show how estimating our model with WLS requires a slight adjustment of our non-weighted formulas, and we therefore first recall some basic facts about WLS that are relevant for our purposes.

For ease of notation, define $y^i_{t,h} = g^i_{t,t+h} - g^{US}_{t,t+h}$, $\mathbf{z}^i_{t,h} = \mathbf{x}^i_{t,h} - \mathbf{x}^{US}_{t,h}$, $u^i_{t,h} = \epsilon^i_{t,t+h}$. We can therefore rewrite equation (3.1) as:

$$\mathbf{y}_h = \mathbf{X}_h \boldsymbol{\beta}_h + \mathbf{u}_h, \tag{A.1}$$

where we have stacked all $j = 1, \ldots, S_h \cdot N$ observations and used matrix notation. As we said, our preferred specification is one where we weight observations by population. We then define $\mathbf{W}_h$ to be our (diagonal) weighting matrix, with diagonal elements $w_{jj,h}$ being equal to state-specific populations at given points in time, normalized so as their sum equals the total number of observations. We also define $\mathbf{P}_h = \text{chol}(\mathbf{W}_h)$ the matrix obtained by applying the Cholesky decomposition on $\mathbf{W}_h$, which in our case simply yields a diagonal matrix with each element in $\mathbf{P}_h$ being equal to the square root of the corresponding ones in $\mathbf{W}_h$. WLS is then performed by running OLS on the following transformed regression:

$$\mathbf{y}^*_h = \mathbf{X}^*_h \boldsymbol{\beta}_h + \mathbf{u}^*_h, \tag{A.2}$$

where $\mathbf{y}^*_h = P_h \mathbf{y}_h$, $\mathbf{X}^*_h = P_h \mathbf{X}_h$, and $\mathbf{u}^*_h = P_h \mathbf{u}_h$. Morever, define $\hat{\mathbf{u}}_h = \mathbf{y}_h - \mathbf{X}_h \hat{\boldsymbol{\beta}}^*_h$, with $\hat{\boldsymbol{\beta}}^*_h$ being the WLS estimator.

Now, because of the fact that also the intercept gets weighted in the transformed regression, only *weighted* residuals $\mathbf{W}_h \hat{\mathbf{u}}_h = \mathbf{P}_h \hat{\mathbf{u}}^*_h$ happen to be zero-mean. This implies that computing conditional residuals as in equation (3.4) or even with the general threshold in equation (5.1) could prove to be misleading.

Therefore, when running weighted regressions we modify the above-mentioned equations and define conditional forecast errors in the following way:

$$\hat{u}^{*,-}_{j,h} = \begin{cases} \hat{u}^*_{j,h} & \text{if} \quad w_{jj,h} \cdot \hat{u}_{j,h} < c, \\ 0 & \text{otherwise}, \end{cases} \tag{A.3}$$

where c is again a general threshold, which in our baseline specification is equal to zero. Finally, we compute residual semi-deviations as

$$\hat{\sigma}^{*,\cdot,-}_h = \sqrt{\frac{(\hat{\mathbf{u}}^{*,-}_h)' \hat{\mathbf{u}}^{*,-}_h}{S_h \cdot N - K - 1}}. \tag{A.4}$$

B Appendix - Federal Transfers

The main source we use to obtain federal transfers data is the BEA. More specifically, we sum up retirement and disability insurance benefits, Medicare benefits, military medical insurance benefits, income maintenance benefits, veterans' benefits (excluding the category "other assistance to veterans"), education and training assistance, other transfer receipts of individuals from governments, current transfer receipts of nonprofit institutions from the federal government.

Public assistance medical care benefits are a large component and almost exclusively consist of Medicaid and the Children's Health Insurance Program (CHIP), which are administered by states and jointly funded by the federal government and the states. The amount of federal funding for Medicaid is determined by the Federal Medical Assistance Percentage (FMAP), which is based on a formula that provides higher reimbursement to states with lower per capita incomes relative to the national average (and viceversa). FMAPs have been defined in the Social Security Act Amendments of 1965, which created Medicaid by adding Title XIX to the Social Security Act. They grant a statutory minimum of 50 percent and a maximum of 83 percent. The amount of federal funding for CHIP is determined by the enhanced FMAPs (E-FMAP), which are higher than standard FMAPs, although in this case the federal funding share cannot exceed 85 percent. Therefore, we adopt a conservative approach and include only 50% of public assistance medical care benefits.

Unemployment insurance compensation also is jointly funded by federal and state governments, but the BEA only provides aggregate benefits figures. For this reason, many studies simply include them in their entirety, thereby inducing an upward bias in the actual amount of *federal* unemployment insurance. As pointed out in Alcidi and Thirion (2017), federal funding for unemployment compensation is very low during normal times. Nevertheless, it increases both during high state-specific unemployment spells through the permanent Extended Benefits program, and through discretionary federal Emergency Unemployment Compensation schemes that have historically been approved when large symmetric shocks hit the US economy.

In general, it is therefore clear that using BEA's all-government unemployment benefits is unsatisfactory, and we thus depart from all previous contributions by using US Department of Labor state-level data for the federal share of unemployment insurance benefits paid at all levels, namely regular, extended, and discretionary ones.[26]

[26] Past discretionary programmes have been funded by the federal government only.

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