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ABSTRACT

The Feasible Gains from International Risk Sharing

We argue that since there are several impediments to international risk sharing, the welfare gains from full international risk sharing, which have been the object of analysis in the previous literature, are not suggestive. Instead, we study the gains from *feasible* risk sharing and find that they are considerable (0.5% increase in permanent consumption). Marginal benefits from further risk sharing are low, which indicates that feasible risk sharing can achieve most of the benefits from international risk sharing. Surprisingly, we find that sharing short-term consumption risk lowers welfare. On the basis of the results we make suggestions on how to improve existing international risk sharing systems.

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NON-TECHNICAL SUMMARY

Standard portfolio theory suggests that agents should hold international portfolios in which country-specific risks are eliminated. Empirical studies show, however, that households tend to hold a large part of their portfolio in domestic assets. Moreover, governmental institutions do not make full use of the possibility of sharing risk with other countries. For example, even within the European Union we observe large cross-border fluctuations in welfare-relevant aggregates. It therefore does not come as a surprise that studies examining the extent of international risk sharing regularly reject the hypothesis of full risk sharing. This lack of full risk sharing is of interest for policy-makers because it suggests that risk averse agents forgo the welfare gains from reduction in consumption risk.

If the gains from international risk sharing are small, however, this is not something one should worry about. Consequently, a number of papers have studied the gains from full international risk sharing. Estimates vary widely, from essentially *zero* gains up to gains of 100% (measured as increase in permanent consumption). Moreover, absence of full risk sharing may also not be surprising if impediments to international risk sharing exist, such as the problem of enforceability of international contracts and issues of moral hazard.

In this Paper we take into account that full risk sharing is not possible and estimate the gains from risk sharing that are *feasible* in the presence of such impediments. We argue that any risk sharing that does not lead to redistribution can exist under moral hazard and enforceability problems. Moreover, we follow an approach that does not fully specify preferences and extract information about preferences by applying Euler equations. In contrast to most of the literature, we also do not assume a specific consumption process. Instead, we simply measure the *ex post* gains for some major industrial countries over a roughly 40 year horizon. In that way we sidestep some of the issues which led to the wide variation of estimates of risk sharing gains, namely the assumptions on the preferences of agents and the correct specification of the consumption process.

We find that, using a more conventional approach in which the utility function is specified, the gains from risk sharing are sizeable even if one does not allow for redistribution. In fact, we find average gains for the G7 countries equivalent to a 0.5% increase in permanent consumption. This number is high given the considerable restriction we imposed on risk sharing. Moreover, we find that risk sharing can also result in welfare losses if the horizon of risk sharing is too short. An explanation for that is when countries are at different stages of a business cycle, a country which is at the trough has low consumption but is expected to grow while a country at the peak has high consumption but will contract. Hence, if they share short-run consumption innovations, countries with low marginal utility will have even more consumption and *vice versa*. Surprisingly, measuring welfare gains by using Euler equations results in negligible gains. The reason for that may be that due to market imperfections, market interest rates do not fully reflect intertemporal optimization. On the other hand, the difference may also stem from the fact that standard preferences are not able to take account of such important issues as, for example, habit persistence. Further research aiming at identifying the concrete reasons for the difference in the estimates is appealing because it may be that conventional preferences overstate welfare gains.

Relying on our estimates from standard utility, the results suggest that it is worthwhile for countries to engage in more risk sharing even if full risk sharing cannot be achieved or is not desirable. Since quite substantial benefits can be reaped by risk sharing without redistribution, risk sharing mechanisms should be extended towards this end. We argue in the Paper that this could be done by having explicit contracts between countries that share national income risks. Our results show that sharing short-term risks may increase consumption fluctuations, therefore existing risk sharing systems should be checked to find whether they provide such short-term insurance.

1 Introduction

There is ample evidence that risk sharing across countries is far from optimal. Sørensen and Yosha (1998), for example, find that risk sharing among OECD countries is basically zero. French and Poterba (1991) report that, for some major countries, the percentage of assets invested in domestic markets is between 80% and 90%, while standard portfolio theory suggests that households should hold internationally diversified portfolios. It is therefore hotly debated whether agents forgo sizeable gains from diversification. Several studies have addressed this issue and have estimated the welfare gains from fully eliminating the lack of risk sharing. Most of them find that the gains are in fact considerable, although estimates vary widely. Not surprisingly, it is a common view that the current degree of international risk sharing is unsatisfactory.

We argue in this paper that the welfare gains from *full* risk sharing are not a good basis for evaluating the benefits from further risk sharing. This is because there are several impediments to international risk sharing that prevent full risk sharing (or cause costs that can make risk sharing undesirable). For instance, a high degree of risk sharing leads to large transfers between countries, which are difficult to enforce among sovereign nations. Moral hazard constitutes a further constraint to risk sharing. This is because risk sharing amounts to insurance and can cause incentive problems for governments.

It is therefore appealing to examine whether risk sharing that is *feasible* in the presence of such imperfections is worthwhile. This is the primary aim of this paper. In order to do so, we will compute the welfare gains from international risk sharing that is restricted having transfers that sum up to *zero*. Moral hazard and enforceability issues are then of limited relevance. Moreover, we aim to sidestep some of the crucial assumptions of the previous literature on the gains from international risk sharing by proposing a method to compute *ex-post* welfare gains from historical consumption data. The motivation is that, in spite of the extensive literature,[1] there is no consensus regarding the likely size of the welfare gains. Estimates vary as widely as from 0.1% to 100%. Van Wincoop (1999) has surveyed the literature and finds that this variation is mainly due to different assumptions on the implicit risk-free interest rate, the risk-adjusted growth rate, the endowment uncertainty, and the degree of risk aversion. By measuring ex-post gains, however, all but the last assumption may be sidestepped.[2] Welfare gains are further sensitive to the specification of the preferences as work on habit persistence has shown.[3] We therefore develop a second approach that employs Euler equations and does not hinge on a specific utility function. The idea is that market interest rates reflect intertemporal optimization of households and accordingly allow to value consumption streams over time.[4]

We measure the welfare gains for the G7 countries in the period from 1956 to 1992. For our first approach, which rests on a standard utility function, we find average gains of 0.5% (measured as increase in permanent *total* consumption). In contrast, the welfare gains implied by interest rates are very small. There are several explanations that can account for this difference. Owing to market imperfections, interest rates may not fully reflect intertemporal marginal rates of substitution and may tend to understate the welfare gains. On the other hand, the standard approach may not be flexible enough in that it does not capture relevant issues such as habit persistence, separability of risk aversion and

[1] See surveys in Tesar (1995), Lewis (1996) and Van Wincoop (1999). Furthermore, there is the related literature that measures the costs of business cycle fluctuations, starting with Lucas (1987).

[2] The only similar approach we are aware of is Athanasoulis and Van Wincoop (2000). They estimate the endowment uncertainty from growth regressions.

[3] Campbell and Cochrance (1995) match the equity premium with habit persistence and find much larger gains relative to comparable studies assuming standard preferences.

[4] Alvarez and Jermann (2000) also use asset prices to estimate gains from reducing risk. Their approach differs from ours in the sense that they estimate a process for risk premiums which fits asset data and then use the process to value consumption streams, while we extract information about intertemporal marginal rates of substitution from actual asset prices.

intertemporal substitutability, and the heterogeneity of consumption in terms of durables and non-durables. We think that more research in that area will be interesting since Euler equations can take account of these issues.

Relying on our estimates from standard utility, we conclude that further risk sharing is indeed worthwhile. It is true that the welfare gains are moderate in contrast to some estimates for full international risk sharing. For a comparable sample, Van Wincoop (1999), for example, finds gains in the range of 1.1% to 3.5% increase in permanent *tradeables* consumption.[5] Feasible risk sharing, however, is easier to implement and does not create moral hazard problems. Our analysis further indicates that extending risk sharing beyond feasible risk sharing does not yield substantial welfare gains. This is because the marginal benefits from risk sharing decline considerably and are small for a household with feasible risk sharing. We also find that sharing yearly consumption risks causes welfare losses (-0.4%). We argue that this is a natural result for countries that differ mainly with respect to their business cycles.

Our results suggest that existing international risk sharing is far from optimal. This is because it commonly leads to redistribution that certainly has its costs because it distorts incentives. Its gains, on the other hand, are questionable because they can also be reaped, at least partly, by relying on risk sharing that does not cause redistribution. In the concluding section of the paper, we make some proposals for improving international risk sharing along these lines.

The remainder of the paper is organized as follows. Section 2 outlines the rationale for feasible international risk sharing and the restriction to risk sharing without redistribution. In section 3, we model the measurement of the welfare gains. Section 4 applies the method to the G7 countries. The final section contains the conclusions.

[5] Tradeables make up for roughly half of the total consumption spending in Van Wincoop's sample.

2 Feasible Risk Sharing

Why is full international risk sharing unlikely to arise? If countries were fully insured against consumption risk, this would lead to considerable transfers between countries in case the countries develop differently. Since countries are sovereign, these payments will be difficult to enforce. Moreover, because one is not able (at least not completely) to contract on the risks faced by countries (and has to condition on observeables instead such as national income), full risk sharing amounts to insurance. A country which is insured against fluctuations in its income or consumption, however, has less incentives to use its resources for production and moral hazard arises. Further, full risk sharing requires sharing risk in perpetuity, it is difficult to imagine such agreements in practice.[6]

Consequently, if one wants to study gains from risk sharing which is achievable and this without causing additional costs (such as through distortions caused by moral hazard), one has to restrict risk sharing such that it results in low cross-border transfers (enforceability), yields a low degree of insurance (moral hazard), and has a restricted horizon. In this paper we consider risk sharing which is restricted by the condition that the (sum of) ex-post transfers are zero.[7] Enforceability issues can then not arise. Moreover, since countries are not able to influence the amount of payments, moral hazard is limited to shifting payments between periods. Such a contract can be seen as sharing business cycle risk (although it is broader in that it includes also shocks beyond business cycles), therefore the gains will not be sensitive to the horizon of risk sharing agreements. We simply take the duration to be the sample period of our data (roughly 36 years).

[6] There are additional complications arising from the fact that the gains of risk sharing in perpetuity may not be defined, see Van Wincoop (1994).

[7] This is, in a way, an arbitrary choice. Our decision was determined by the motivation to study whether relatively restricted risk sharing can already reap substantial benefits.

3 Measuring Welfare Gains

Under international risk sharing, the representative consumer in the home country exchanges a stream of claims to home (aggregate) consumption $\{C_t\}_{t\geq 0}$ against claims to world consumption $\{C_t^*\}_{t\geq 0}$. We consider two types of risk sharing 'contracts': one in which yearly consumption risk is shared and one which has as horizon the whole sample period. In general, if the horizon of the risk sharing contract is n-periods, the welfare gains under time separable expected utility are:

$$E_0[\sum_{t=1}^{n} \delta^t u(C_t^*) - \sum_{t=1}^{n} \delta^t u(C_t)] \tag{1}$$

where δ is an appropriate discount-factor. Following the convention in the literature to measure the gains as increases in permanent consumption, we define the gains implicitly:

$$0 = E_0[\sum_{t=1}^{n} \delta^t u(C_t^*) - \sum_{t=1}^{n} \delta^t u(C_t(1 + gain))] \tag{2}$$

Sharing Yearly Risk Consider risk sharing in which countries fully share their yearly consumption innovations. Contracts pay a share of $\frac{C_0(1+g)}{C_0^*(1+g^*)}$ units of world consumption C_1^* for domestic consumption C_1, with g and g^* being the home and world (ex-post) growth rates.[8] The gains from the contract can then be written as:

$$0 = E_0[u(C_1^* \cdot \frac{C_0(1+g)}{C_0^*(1+g^*)}) - u(C_1(1 + gain))] \tag{3}$$

Sharing Business Cycle Risk In contrast to above, the duration of a contract is now $T > 1$ with payments taking place in each period. To define contracts without redistribution, we detrend $\{C_t\}_{t\geq 0}$ and $\{C_t^*\}_{t\geq 0}$ by the ex-post growth rates g and g^* to obtain: $C_t^D := C_t/(1+g)^t$ and $C_t^{*D} := C_t^*/(1+g^*)^t$ and define the exchange ratio between

[8] By using ex-post growth rates, we ensure that the payments from the contract sum up to zero over the whole sample period.

C_t^D and C_t^{*D} such that average transfers are zero. The expression for the welfare gains is then:

$$0 = E_0[\sum_{t=1}^{T} \delta^t u(C_t^{*D} \cdot \overline{C}_t^D / \overline{C}_t^{*D}) - \sum_{t=1}^{T} \delta^t u(C_t^D (1 + gain))] \qquad (4)$$

where $\overline{C}_t^D$ and $\overline{C}_t^{*D}$ are the sample means of C_t^D and C_t^{*D}.[9] The essential difference between (3) and (4) is that in the former the terms of exchange are adjusted every period (for the current levels of C and C^*) but are fixed in the latter. We set later $\delta = 1$ in (4) because a data point at the end of the sample should be treated equal to one at the beginning since we detrended the data . To save notation, we will in the following write C_t and C_t^* for $\overline{C}_t^D$ and $C_t^{*D} \cdot \overline{C}_t^D / \overline{C}_t^{*D}$, respectively, when referring to equation (4), and write C_1^* for $C_1^* \cdot C_0(1+g)/C_0^*(1+g^*)$ when referring to equation (3).

Example: The Welfare Gains with Power Utility For a representative consumer with power utility $u(C) = C^{1-\gamma}/(1-\gamma)$, equation (3) and (4) can be manipulated to:

$$gain = (\frac{E_0[C_1^{*1-\gamma}]}{E_0[C_1^{1-\gamma}]})^{1/(1-\gamma)} - 1 \qquad (5)$$

where γ is the coefficient of relative risk aversion.

3.1 The General Case

Our aim is to transform the expression for the welfare gains (equation 3 or 4) in an equation of observables without fully specifying the utility function nor assuming (or estimating) a process for consumption. To do so, we first approximate $u(C_1 + \triangle x)$ by $u(C_1) + u'(C_1)\triangle x$ in (3). By doing so we measure the gains from international risk sharing at constant *marginal* benefits. Solving for *gain* in (3) yields:

$$gain = \frac{E_0[u'(C_1)C_1^*]}{E_0[u'(C_1)C_1]} - 1 \qquad (6)$$

[9] The definitions of contracts do not ensure that in *every* period the consumption in the countries add up to world consumption. However, the deviations are negligible

Equation (6) shows that the gains from risk sharing are determined by the expected consumption weighted with marginal utilities. Since there are no differences in expected consumption (zero redistribution), gains can only arise from the fact that the 'timing' of world consumption is better, i.e., world consumption is above domestic consumption if marginal utility is high (a bad state) and below domestic consumption if marginal utility is low (a good state).

We again assume the existence of a representative consumer, then a frictionless capital market (unrestricted borrowing and lending at the risk-free rate) ensures that the Euler equation holds:

$$u'(C_1) = \delta(1 + r_1)E_1[u'(C_2)] \tag{7}$$

where r_1 is the one-year spot rate at $t = 1$.[10] Approximating $u'(C_0 + \triangle x)$ by $u'(C_0) + u''(C_0) \triangle x$ to substitute for $u'(C_2)$ in (7) and plugging the result into (6), one obtains:

$$gain = \frac{E_0[\delta(1 + r_1)E_1[u'(C_0) + u''(C_0)(C_2 - C_0)]C_1^*]}{E_0[\delta(1 + r_1)E_1[u'(C_0) + u''(C_0)(C_2 - C_0)]C_1]} - 1 \tag{8}$$

Since $u'(C_0)$ and $u''(C_0)$ are known at time $t = 0, 1$, this simplifies to:

$$gain = \frac{E_0[(1 + r_1)C_1^*[1 - \gamma(C_0)E_1[\frac{C_2 - C_0}{C_0}]]]}{E_0[(1 + r_1)C_1[1 - \gamma(C_0)E_1[\frac{C_2 - C_0}{C_0}]]]} - 1 \tag{9}$$

where $\gamma(C_0) = -u''(C_0) \cdot C_0/u'(C_0)$ is the relative risk aversion parameter at time $t = 0$. Equation (9) is now an equation involving only observables $(C_0, C_1, C_1^*, C_2, r_1)$ and the (at time t known) relative risk aversion $\gamma(C_0)$.

3.2 Deriving Bounds for the Welfare Gains

An estimator for *gain* could be obtained from (9) by replacing the expected value $E_1[C_2]$ with C_2 ($E[\cdot]$ is with rational expectations unbiased). However, such a procedure is imprecise since it requires replacing expectations of expected values by their realizations.

[10] Assuming a representative consumer can be justified for a wide range of utility functions (see Huang and Litzenberger, 1988, chapter 5 and Obstfeld and Rogoff, 1996 , chapter 5).

Instead, we analyze $E_1[C_2]$ for two stylized consumption processes and argue that the estimates obtained for these processes provide lower and upper bounds for the true welfare gains.

Temporary Shocks If innovations to consumption are *temporary* at $t > 0$ (i.e., fully mean reverting in the next period), then $E_t[C_{t+1}] = C_{t-1}$ and (9) simplifies to

$$gain_T = \frac{E_0[(1 + r_1)C_1^*]}{E_0[(1 + r_1)C_1]} - 1 \tag{10}$$

Persistent Shocks If shocks are *persistent*, or more generally, detrended consumption follows a random walk, then $E_t[C_{t+1}] = C_t$ and (9) can be written as

$$gain_P = \frac{E_0[(1 + r_1)C_1^*[1 - \gamma(C_0)(\frac{C_1 - C_0}{C_0})]]}{E_0[(1 + r_1)C_1[1 - \gamma(C_0)(\frac{C_1 - C_0}{C_0})]]} - 1 \tag{11}$$

If the true consumption process follows a more general pattern, i.e., has innovations which are partly temporary and partly persistent, equation (10) tends to understate the welfare gains. The intuitive reason is as follows. If households build their expectations on the basis of a temporary shock, a change in marginal utility is fully reflected in interest rates, while if the shock has also a persistent component, interest rates change less because they are accommodated by changes in expected next period consumption. Measuring the gains by assuming a mean reversion process (temporary shock) will thus dampen the gains since it reduces the variation in marginal utility implied by the interest rates (and therefore reduces the potential for welfare gains from risk sharing). Correspondingly, a random walk overstates the welfare gains because changes in marginal utility fully map into changes in expected future utility (persistent shocks). Interest rate changes will then overstate changes in marginal utility. Consequently, estimates on the basis of assuming this two consumption processes will bound the true welfare gains:

$$gain_T \leq gain \leq gain_P \tag{12}$$

The appendix shows that (12) is fulfilled for a consumption process that has temporary and persistent innovations and derives the general conditions for (12) to hold.

4 The Empirical Evidence

We compute the welfare gains for G7 countries (United States, Germany, Canada, France, United Kingdom, Italy and Japan) between 1956-1992 according to equations (5),(10) and (11). The data come from the Penn World Table (real per capita consumption), OECD Macroeconomic Indicators and Datastream (money market interest rates). World consumption C_t^* is computed from the per capita consumption of the countries (where all countries are weighted equally). Interest rates are, when available, the market rates on one-year treasury bills (otherwise we preferred shorter maturities). Real interest rates are obtained by deflating with ex-post inflation.[11]

The gains are computed by replacing the nominator and denominator in equations (5),(10) and (11) by their respective sample means. For the relative risk aversion γ we assume a value of 3. The results for equation (5) are summarized in Table 1. We find average gains for sharing business cycle risk of about 0.5% increase in permanent consumption. This number is at the lower end of estimates from the risk sharing literature but in line with studies assuming stationary processes[12], i.e., Obstfeld (1994) and Tesar (1995) estimate gains of less than 0.5%. The average gains from sharing yearly risk are negative (-0.4%). The explanation for that is simple: if a country is at the trough of a business cycle (and marginal utility is high) it is expected to growth. Sharing current consumption growth with a country that is at the peak is not beneficiary since this country is expected

[11] Alternatively we tried real interest rates computed from current and lagged inflation and obtained similar results.

[12] Since consumption is detrended, we effectively measure the welfare gains from a stationary process.

to have a lower consumption next period.

We also compute the *marginal benefits* from risk sharing. Setting $u'(C_1) = C_1^{-\gamma}$ in (6) one obtains the marginal benefits evaluated at *home consumption*:

$$gain = \frac{E_0[C_1^{-\gamma} C_1^*]}{E_0[C_1^{1-\gamma}]} - 1 \qquad (13)$$

We find average marginal gains of 0.9% for business-cycle risk sharing and losses of 0.2% for one-year contracts (not reported in Table 1). The numbers for the business cycle are higher than those of Alvarez and Jermann (2000) (they find gains of about 0.3%). The marginal benefits evaluated at *world consumption* can be computed from:

$$gain = \frac{E_0[(C_1^*)^{1-\gamma}]}{E_0[(C_1^*)^{-\gamma} C_1]} - 1 \qquad (14)$$

Equation (14) has been derived from (6) by replacing $u'(C_1)$ with $u'(C_1^*) = (C_1^*)^{-\gamma}$. As reported in Table 1, the marginal gains from sharing further business cycle risk are small on average (0.1%) and again negative for the yearly risk (−0.4%). As one would expect, the marginal gains from reducing consumption variability fall with a reduction in consumption variability, i.e., the marginal gains from full risk sharing of business cycle risk is smaller than the initial marginal gains from sharing business cycle risk ($0.1\% < 0.9\%$). Analogous, since sharing one-year risk seems to increase consumption variability, marginal costs will raise with the degree of risk sharing ($-0.2\% > -0.4\%$). The low marginal gains for the for the business cycle contract suggests that the potential gains from sharing consumption risk beyond the business cycle risk are small.

The welfare gains implied by Euler equations (equations 10 and 11) are negligible (contained in Table 2). They are for both, the business cycle and the one-year contract, lower than 0.1%. The interval for the true gains given by the boundaries ($|gain_P - gain_T|$) is surprisingly narrow. It is then quite appealing that out of 14 cases, only in one case the boundary condition (12) is violated.[13]

[13] For Canada, the mean reversion estimate for the business cycle contract (−0.10%) is larger than for

What makes up for the apparent difference between the welfare gains measured with power utility (Table 1) and the ones implied by interest rates (Table 2)? On the one hand, due to imperfections in capital markets, market interest rates may not fully reflect the optimization behavior of consumers. If this is true, marginal utilities implied by interest rates will be less sensitive to changes in consumption than the true marginal utilities. Consequently, the welfare gains will be understated. In fact, since the seminal work of Hall (1978), the use of the Euler equation for empirical work has been criticized on this grounds.[14] This view is supported by the fact that in our sample, the average correlation between yearly consumption growth and interest rates is negative (-0.35%), which is contrary to what one should obtain from an Euler equation. On the other hand, the assumptions underlying the Euler equation may be fulfilled but the use of power utility may not be appropriate. For example, Obstfeld (1994) argues that the failure of power utility to separate between risk aversion and intertemporal substitutability distorts the welfare gains. Moreover, market interest rates can capture variations in marginal utilities not caused by consumption, such as habit persistence.[15]

A deeper investigation into this issues is beyond the scope of this paper. Our interpretation of the results is that capital market imperfections certainly account for differences in estimates. However, they are unlikely to be the complete story. This is because, if interest rates do not reflect changes in marginal utility at all, we would expect the welfare estimates to fluctuate more across countries and the boundary condition to be more often violated (the latter is only valid under the assumption that the Euler equation holds). The restrictions imposed by power utility, which has been employed in most of the studies due to its analytical convenience, is probably a further reason as the work on habit per-

the random walk (-0.13%).

[14] See for example Campbell and Mankiw (1989).

[15] Campbell and Cochrane(1995) use habit formation to match the equity premium and find large gains from risk sharing.

sistence and intertemporal substitutability suggests. Using an Euler equation approach is then a promising method to overcome this shortcoming since its flexibility does not require a detailed modelling of the deviations from conventional preference specifications. More research in that direction seems appealing. For the forthcoming conclusions, however, we will rely on the more traditional estimates from power utility.

5 Summary and Conclusions

In this paper we have studied the welfare gains from risk sharing that can emerge in the presence of imperfections, such as moral hazard and sovereign risk. The gains were computed without fully specifying the consumption process and preferences, first, by using an ex-post approach to measure the gains, and, second, by deriving information about intertemporal marginal rates of substitution from market interest rates. We found that the welfare gains implied by interest rates are negligible (less than 0.1%), which is in contrast to estimates obtained from a power utility function (0.5%). The latter estimate suggests that expanding international risk sharing, despite the restrictions we have imposed, is worthwhile.

This can be done in accordance with our analysis as follows. Countries could share *national income* risks by making transfers when the income of a country deviates from some *moving average* of the country's income. Such an arrangement would be similar to the consumption risk sharing studied in the paper. It allows only for limited redistribution because any permanent divergence in the development of countries will not be insured since the moving average will eventully adjust to the new income level. In contrast to fully sharing national income risks, incentive problems for governments are limited. This is because a reduction in national income will also lower average income and reduce payments in the periods to come. Since transfers are quite restricted and cannot persist over periods (this would require an accelerating growth rate), there is limited scope for default in the presence of substantial gains from such risk sharing.

Our results have implications for existing risk sharing systems. Since the marginal gains from risk sharing beyond feasible risk sharing are small, risk sharing that causes redistribution may be undesirable because the benefits can be largely reaped without incurring costs by exploiting the gains from feasible risk sharing. Moreover, since the evidence shows that sharing short term risk can in fact reduce welfare, existing risk sharing systems should be checked on whether they provide such short term insurance.

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6 Appendix: Bounds for the Welfare Gains

Let the foreign consumption process be constant and normalized to zero: $\{C_t^*\}_{t\geq 0} = 0$. Home consumption is hit every year by a shock ε_t which is either permanent or temporary (vanishes in the next period). Home consumption is then:

$$C_t = C_{t-1} + \varepsilon_t - (1 - D_{t-1})\varepsilon_{t-1} \tag{A1}$$

where the stochastic dummy variable D_t assumes the value 0 if the shock ε_t is temporary and 1 if the shock is permanent. Shock ε_t is normally distributed with zero mean. The dummy D_t is independently distributed with $0 < P(D_t = 0) < 1$ and $P(D_t = 0) + P(D_t = 1) = 1$. Home consumption and shock at time 0 are assumed to be zero ($C_0 = 0$, $\varepsilon_0 = 0$), thus expected home consumption equals foreign consumption.

We show that for the given consumption process equation (12) is fulfilled if the gains are expressed in absolute instead of relative terms. The absolute versions of equations (9), (10) and (11) are:

$$\begin{aligned} gain^A &= E_0[(1 + r_1)(C_1^* - C_1)[1 - \gamma(C_0)E_1[\frac{C_2 - C_0}{C_0}]]] && \text{(A2)} \\ gain_T^A &= E_0[(1 + r_1)(C_1^* - C_1)] && \text{(A3)} \\ gain_P^A &= E_0[(1 + r_1)(C_1^* - C_1)[1 - \gamma(C_0)(\frac{C_1 - C_0}{C_0})]] && \text{(A4)} \end{aligned}$$

Then, for (12) in absolute terms to be true, (A5) and (A6) have to hold:

$$\begin{aligned} gain^A - gain_T^A &= E_0[(1 + r_1)(C_1^* - C_1)[-\gamma(C_0)E_1[\frac{C_2 - C_0}{C_0}]]] \geq 0 && \text{(A5)} \\ gain^A - gain_P^A &= E_0[(1 + r_1)(C_1^* - C_1)[-\gamma(C_0)E_1[\frac{C_2 - C_1}{C_0}]]] \leq 0 && \text{(A6)} \end{aligned}$$

Simplifying (A5) and (A6) yields the following *general conditions* for equation (12) to hold:

$$\begin{aligned} E_0[(1 + r_1)(C_1^* - C_1)(E_1[C_2] - C_0)] &\leq 0 \quad (gain^A - gain_T^A \geq 0) && \text{(A7)} \\ E_0[(1 + r_1)(C_1^* - C_1)(E_1[C_2] - C_1)] &\geq 0 \quad (gain^A - gain_P^A \leq 0) && \text{(A8)} \end{aligned}$$

For the given consumption process, $(1+r_1)(C_1^* - C_1)(E_1[C_2] - C_0)$ can be simplified to $-(1+r_1)\varepsilon_1^2 \leq 0$ if $D_1 = 1$. For $D_1 = 0$, the expression vanishes. Hence, condition (A5) is fulfilled. Analogous, $(1+r_1)(C_1^* - C_1)(E_1[C_2] - C_1)$ is $(1+r_1)\varepsilon_1^2 \geq 0$ for $D_1 = 0$ and becomes zero for $D_1 = 1$. Thus, also condition (A6) is fulfilled.

Table 1: The Welfare Gains Computed from Power Utility

	Total Gains		Marginal Gains	
	Business Cycle	1-year	Business Cycle	1-year
United States	0.0%	0.2%	-0.1%	0.2%
Germany	0.2%	-0.7%	-0.1%	-0.8%
Canada	0.5%	0.2%	0.1%	0.2%
France	0.3%	-0.3%	0.2%	-0.4%
United Kingdom	-0.1%	0.4%	-0.6%	0.3%
Italy	0.5%	-0.4%	0.3%	-0.5%
Japan	1.8%	-2.1%	0.6%	-2.1%
Average	0.5%	-0.4%	0.1%	-0.4%

Gains are expressed as percentage increase in permanent consumption for the period 1956-1992.

Total gains are estimated from equation (5), while marginal gains are estimated from equation (14)

Table 2: The Welfare Gains as Implied by Interest Rates

	Business Cycle		1-year	
	Lower bound	Upper bound	Lower bound	Upper bound
U.S.	0.01%	0.04%	0.01%	0.04%
Germany	-0.01%	0.08%	0.01%	0.08%
Canada	-0.10%	-0.13%	0.00%	0.15%
France	-0.04%	0.00%	-0.02%	0.00%
U. K.	0.09%	0.15%	0.01%	0.15%
Italy	-0.10%	-0.03%	-0.02%	0.08%
Japan	0.12%	0.35%	-0.03%	0.09%
Average	0.00%	0.07%	-0.01%	0.08%

Gains are expressed as percentage increase in permanent consumption for the period 1956-1992. Lower bounds are estimated from equation (10), while upper bounds are estimated from equation (11)