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Risk and potential insurance in Europe

by

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ABSTRACT

This paper argues that risk is related to long-run volatility of income and therefore stabilization policies should target permanent fluctuations. We show that such fluctuations can in principle be insured away by a multinational fiscal federation which smooths income cross-sectionally and has no ex-ante permanent redistribution effects. We propose a measure of risk and a measure of potential insurable risk. We estimate these measures for the European countries and compare results with the US. Results show that potential insurable income risk in Europe is about 45%. Most countries will benefit from an average income tax of 10%, but gains differ widely across countries.

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1. Introduction[1]

European countries will soon belong to a club since they will be part of a monetary union (EMU). The literature on EMU and optimal currency areas has discussed advantages and disadvantages of such union. Whatever the empirical evaluation of the latters, there are unambiguous advantages from belonging to a larger club since, with a larger pool of income, there are more opportunities to insure income risk. Possible risk-sharing mechanisms, all potentially important instruments of cross-country income smoothing, are fiscal federations and cross-country ownership in the capital market. Based on this observation, recent literature has discussed the desiderability of a European fiscal federation as an instrument of output smoothing to compensate the potential increase in volatility caused by a Europe-wide monetary policy (e.g., Sala-i-Martin and Sachs, 1992, von Hagen, 1992, Bayoumi and Masson, 1995, Asdrubali, Sørensen and Yosha, 1996 and Fatas, 1998). Others have explored the extent of risk sharing through capital markets and EC structural funds and found that, in Europe, there is very little of it if comparison is made with the US, which is a succesful example of monetary union (e.g., Sørensen and Yosha, 1998).

This paper asks a different but related question, namely what is the size of potentially insurable income risk in Europe beyond what is already insured via either capital markets or structural funds. We will remain agnostic on whether the potential income smoothing should be achieved through a fiscal federation or simply by further integration of capital markets, but the numbers we produce are an important preliminary information to establish the gains that European countries would obtain from belonging to a larger club.

In order to produce these numbers, we clarify some conceptual problems linked to the notions of risk and insurance. We procede in two steps. First, we propose a notion of risk which is related to long-run volatility of income and not just to income variance. This is done by establishing a precise link between expected utility of consumption and low-frequency income variance. The consequence of this result is that stabilization policies should aim at long-run fluctuations. This point is new in the consumption literature and should not be confused with what argued in the debate on whether welfare is related to consumption variance or consumption levels (Lucas 1987, Obstfeld 1994). The literature on international risksharing generally disregards it and focuses on current flows. Recently, Del Negro (1997) and Crucini (1998) have related risk to the variance of the present value of future income changes; our notion of risk,

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while being close in spirit to theirs, has the advantage that it does not rely on arbitrary assumptions on the information set.

Having established a notion of risk, we then procede to the second step and ask what component of total risk can potentially be insured. Note that since risk is the long-run variance, it cannot be smoothed via intertemporal transfers. However, if countries are sufficiently heterogenous, they may insure themselves by participating in risksharing mechanisms which allow for cross-sectional variance smoothing. We construct a simple model of insurance, which can be interpreted as a model of fiscal federation. The scheme has neither ex-ante redistribution nor intertemporal smoothing effects. It is not proposed as a policy recommendation, but as a conceptual experiment to show the cross-sectional smoothing effects of a "pure" insurance device. On the basis of this experiment, we clarify the relation between long-run insurance, ex-ante and ex-post redistribution effects and show that, in principle, a fiscal federation which is neutral with respect to anticipated redistribution, can be implementable. We also show how to construct a simple measure of the insurable component of total risk and provide estimates for the fifteen EC countries.

2. Risk and long run volatility

A natural point of departure for discussing risk is consumption theory. To provide the basic intuition of the notion of risk proposed in this paper, we briefly recall the main features of the simplest version of the permanent income hypothesis of consumption. We assume intertemporally separable quadratic utility, $u(C_t) = C_t - dC_t^2$, absence of liquidity constraints, fixed interest rate r and intertemporal substitution rate equal to the discount factor $\beta = 1/(1+r)$. An infinitely lived representative consumer maximizes the expected utility

$$\mathrm{E}_t \sum_{k=0}^{\infty} \beta^k u(C_{t+k}) = \sum_{k=0}^{\infty} \beta^k \mathrm{E}_t C_{t+k} - d \sum_{k=0}^{\infty} \beta^k \mathrm{E}_t C_{t+k}^2. \tag{1}$$

subject to the sequence of budget constraints

$$A_{t+1} = (1+r)A_t + X_t - C_t, \tag{2}$$

where A_t is assets, X_t is labor income, taken as exogenous and E_t is expectation, conditional on information available at time t.

This model has three implications. First, consumption is a martingale since the first-order conditions for the above maximization problem are

$$\mathrm{E}_{t-1} C_t = C_{t-1}. \tag{3}$$

Second, optimal consumption is equal to permanent income. Solving forward the budget constraint (2) gives $A_t = [\beta/(1-\beta F)]C_t - [\beta/(1-\beta F)]X_t$, where

$F = L^{-1}$ is the forward operator. Taking expectations and using $\mathrm{E}_t C_{t+k} = C_t$, $k \geq 0$, we get the permanent income equation

$$C_t = r\left[A_t + \mathrm{E}_t \frac{\beta}{1-\beta F} X_t\right].$$

The expression in square brackets on the RHS is total wealth, which includes both assets and human wealth, defined as the present value of the expected labor income stream. Consumption equals permanent income, defined as the flow of rental income from total wealth.

Third, consumption and total income are cointegrated. Let us define total income Y_t as the sum of capital income and labor income, i.e. $Y_t = rA_t + X_t$, and savings S_t as the difference between income and consumption, i.e. $S_t = Y_t - C_t = \Delta A_{t+1}$. Then it can be shown that

$$S_t = -\mathrm{E}_t \frac{\beta F}{1-\beta F} \Delta X_t.$$

This is Campbell's 'saving for a rainy day' equation: savings anticipate future labor income falls. If the change in labor income is stationary, then saving is the conditional expectation of a stationary variable and therefore is stationary. Since both consumption and income are I(1) (as can be derived from the stationarity of ΔX_t), then C_t and Y_t are cointegrated, with cointegrating vector $(1 \quad -1)$ (see Campbell, 1987).

We can now use these three properties to derive an expression which links expected utility to the variance of income. Write C_{t+k} as the sum of C_t and $\sum_{i=1}^{k} \Delta C_{t+i}$. By the martingale property, the latter term is zero mean and independent of C_t and of the whole information set at time t so that

$$\mathrm{E}_t(C_{t+k}^2) = \mathrm{E}_t(C_t^2) + \mathrm{E}_t(\sum_{i=1}^{k} \Delta C_{t+i})^2 = C_t^2 + k\mathrm{var}(\Delta C_t).$$

Substituting in equation (1) and using $\mathrm{E}_t(C_{t+k}) = C_t$ we get

$$\mathrm{E}_t \sum_{k=0}^{\infty} \beta^k u(C_{t+k}) = \frac{u(C_t)}{1-\beta} - \frac{d\beta}{(1-\beta)^2}\mathrm{var}(\Delta C_t). \tag{4}$$

Hence, provided that the parameter d is positive —i.e. the consumer is risk averse— the maximum of the expected utility is negatively related to the variance of consumption changes, or, in other words, the variance of permanent income changes.

Intuition suggests that there should be a relation between the variance of permanent income changes and the long-run variance of income changes. To make this point more precise, it is convenient to define the spectral density of

ΔY_t and of ΔC_t; we denote them as $S^y(\lambda)$ and $S^c(\lambda)$, $\lambda \in [-\pi, \pi]$, respectively. We use both the martingale property (3) and the cointegration property with stationarity of savings. The latter implies that total income and consumption must have the same spectral density at frequency zero (same long-run volatility), i.e., that $S^y(0) = S^c(0)$. The former implies that the spectrum of ΔC_t is flat and equals $\text{var}(\Delta C_t)/2\pi$ (ΔC_t is a white noise process). Hence[2]

$$\text{var}(\Delta C_t) = 2\pi S^y(0),$$

so that (4) becomes

$$\text{E}_t \sum_{k=0}^{\infty} \beta^k u(C_{t+k}) = \frac{u(C_t)}{1-\beta} - \frac{2d\beta\pi}{(1-\beta)^2} S^y(0). \tag{5}$$

The intuition for the result is simple: risk aversion implies a desire to smooth consumption. In a world where people can borrow and lend without constraints, consumers can use private capital markets to smooth away transitory shocks. By contrast, shocks having a persistent effect on income cannot be smoothed intertemporally. When a permanent shock arrives, consumption has to fall or raise in order to adapt to the new income path, so that long-run volatility cannot be smoothed away.

Note that this point is not the same put forward by Lucas (1987). Lucas compared the welfare effect of a reduction in consumption variance with that of an increase in consumption level and concluded that, in the case of a trend-stationary consumption, only level effects matter. More recently, Obsfeld (1994) showed that in the unit root case, volatility of consumption may affect welfare, although empirically this effect is not found to be large. Here we do not discuss level effects. Rather, we argue that, as long as consumption variance matters, income variance matters as well, but only if it is at frequency zero.

Several assumptions of the simple consumption model above are far from being realistic: the interest rate is not constant, the quadratic utility function might be a poor description of consumers' preferences and, of course, consumers do not have infinite horizon. More important, capital markets are imperfect, so that consumers may fail to smooth consumption even if they are able to predict perfectly their future income.[3] For these reasons, we motivate our focus on long-run volatility with an additional argument, which does not rely on consumption theory and utility functions.

The idea that stability of income growth is an important policy objective is quite common in the macroeconomic literature (e.g., Shiller, 1993). Let us take this for granted and ask what is a sensible measure of income stability, or income

[2] The implications of this equation for the 'excess smoothness' issue are discussed in Forni (1996) and Forni and Lippi (1997), Ch. 13.4.

[3] The presence of liquidity constraints is also the motivation for not using consumption variance as a measure of risk.

risk. A widely used measure is the variance of the growth rate $\Delta \log Y_t = \Delta y_t$, which is assumed stationary. However, the choice of the time interval over which taking differences is not uncontroversial. In general we may consider

$$\text{var}(y_{t+k} - y_t),$$

where k should depend on the horizon over which the policy maker wants to stabilize y. There is no reason why we should be so myopic to take one quarter or even one year as the relevant time interval. Clearly, in the case in which Δy_t is a white noise, the result is the same for every time interval, but, in general, the variance of income changes may differ a lot for different k, depending on the autocovariance structure of income changes.

The following example provides a clear illustration of this point. Let us consider the MA(2) processes

$$(1 - L)y_{1t} = (1 - .6L - .3L^2)u_t$$

and

$$(1 - L)y_{2t} = (1 + .6L + .3L^2)u_t,$$

where u_t is a normal zero-mean white noise process with unit variance. The variances of Δy_{1t} and Δy_{2t} are equal, but shocks associated to the latter process are much more persistent than those associated to the former. Figure 1 plots the variances of $y_{1t+k} - y_{1t}$ and $y_{2t+k} - y_{2t}$ for $k = 1, \ldots, 40$: the variance of $y_{1t+k} - y_{1t}$ is much larger at all k except for $k = 1$.

The fact that the risk associated to the two processes is very different despite the variances of the first differences being the same can be apreciated also by looking at the simulated realizations plotted in Figure 2 (y_{1t} is in the top part). In both cases the realizations have the same starting level. The more persistent process shows a dramatically higher dispersion across realizations at all dates.

3. A measure of income risk

How can we measure long-run volatility? A quite natural measure is obtained by computing the variance of Δy_t in the frequency band $0 \leq \lambda \leq \frac{2\pi}{k}$, for values of $k/2\pi$ corresponding to long-run waves. Formally,

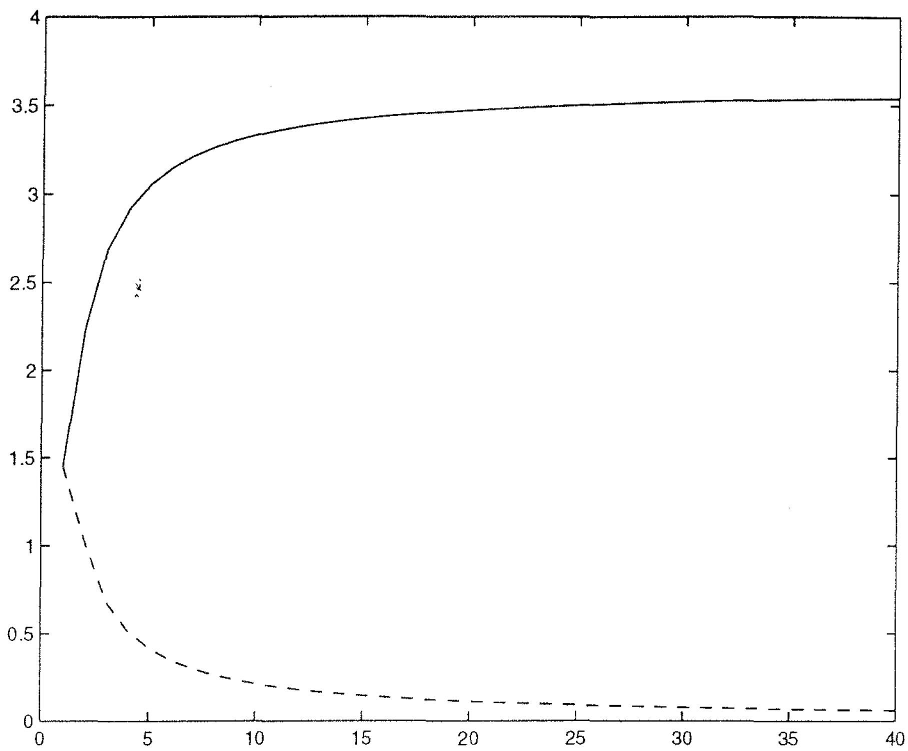
$$R(k) = k \int_0^{2\pi/k} S^y(\lambda) d\lambda \qquad (6),$$

where $S^y(\lambda)$ is the spectral density function of Δy_t. This gives us the average variance of cycles of period k or higher.

$R(k)$ is closely related to $\text{var}(y_{t+k} - y_t)$. To show this, let us consider the spectral density of

$$\frac{y_{t+k} - y_t}{k} = \frac{1}{k}(1 + L + \cdots + L^{k-1})\Delta y_{t+k}.$$

Figure 1. The variance of $y_{1t+k} - y_{1t}$ and $y_{2t+k} - y_{2t}$ for $k = 1, \ldots, 40$



We have:

$$S_k^y(\lambda) = \frac{1}{k^2} \mid 1 + e^{-i\lambda} + \cdots + e^{-i\lambda(k-1)} \mid^2 S^y(\lambda).$$

The function $\mid 1+e^{-i\lambda}+\cdots+e^{-i\lambda(k-1)} \mid^2 /k^2$ for $k = 5, 10, 15, 20$ is plotted in Figure 3. The filter $1+L+\cdots+L^{k-1}$ preserves long-run variance while cutting off short-run variance. The smallest λ for which the function vanishes is $2\pi/k$, as is easily seen by noticing that the filter $1 + L + \cdots + L^{k-1} = (1 - L^k)/(1 - L)$ vanishes for $L = e^{-i2\pi h/k}$, $h = 1, \ldots, k - 1$ (the roots of unity except 1).

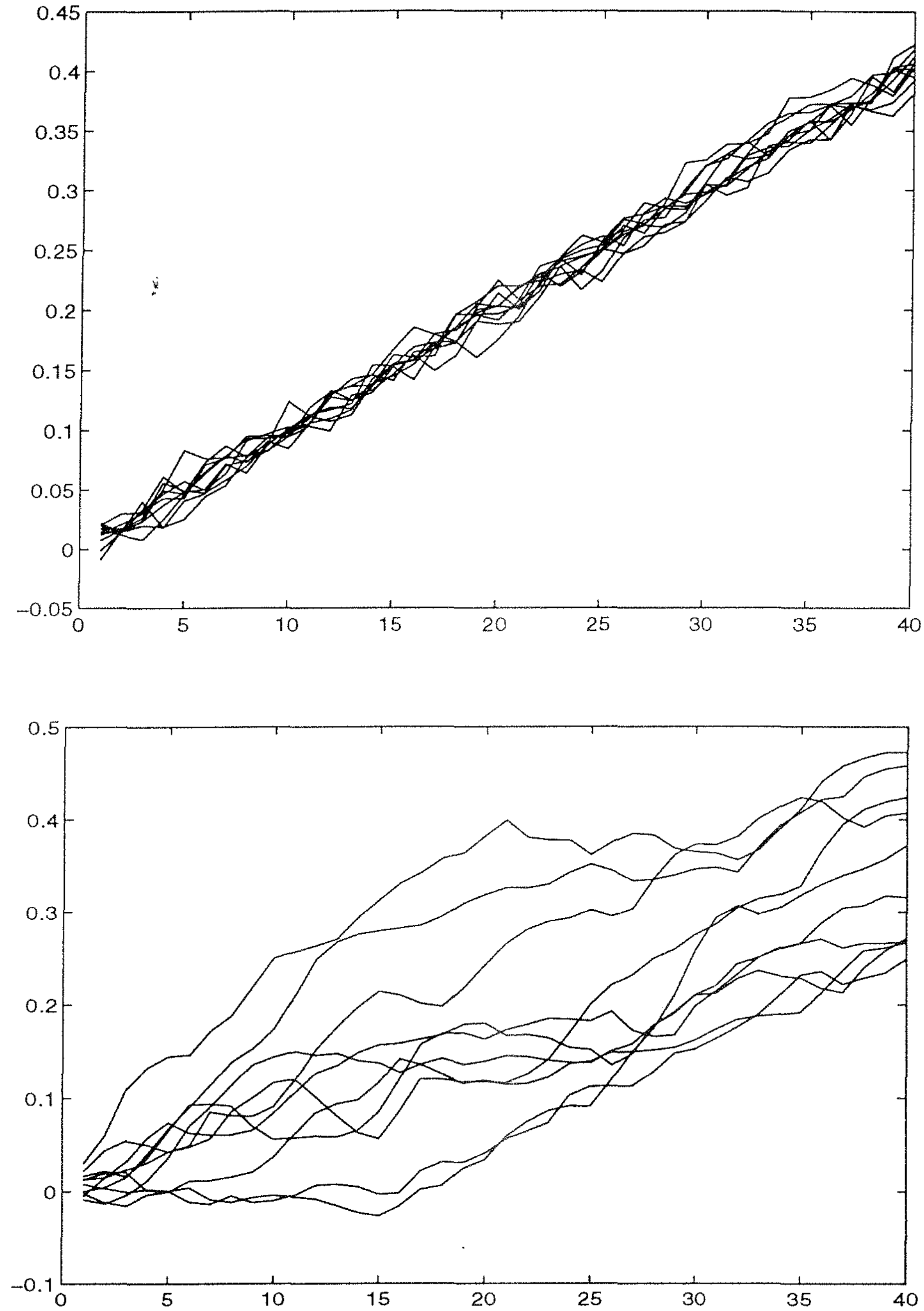
Notice also that [4]

$$\lim_{k\to\infty} R(k) = 2\pi S^y(0) = \lim_{k\to\infty} \frac{\text{var}(y_{t+k} - y_t)}{k}.$$

As an illustration of our proposed measure, let us go back to the MA(2) examples of Section 2. Figure 4 plots the spectral density function of the two

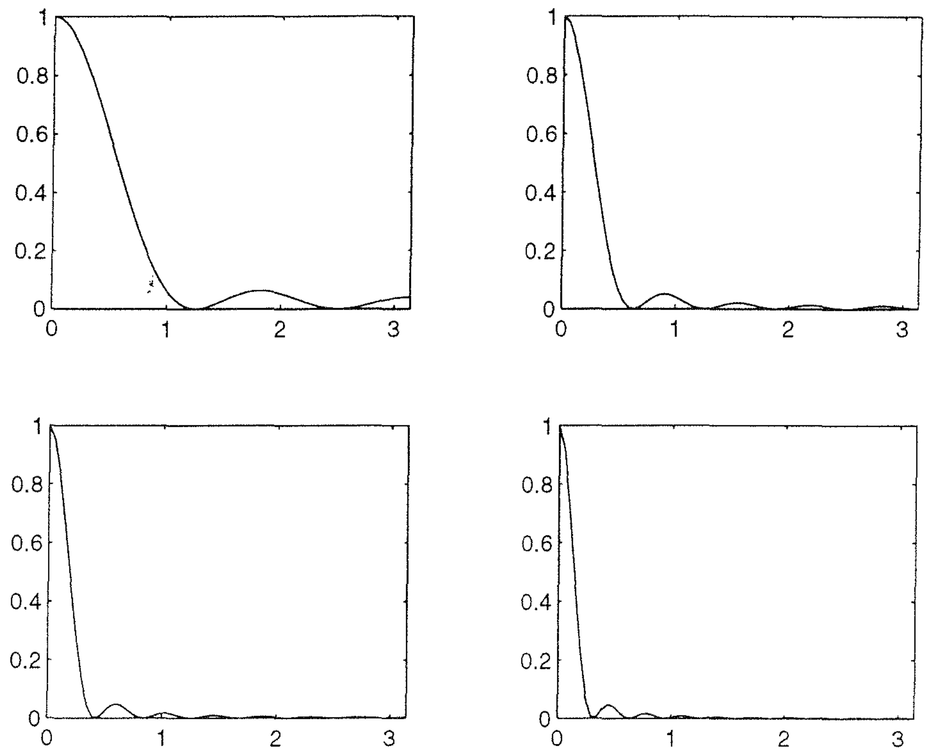
[4] From (7) we see that if we divide $R(\infty)$ by the variance of the first differences of income we obtain Cochrane's (1988) measure of persistence.

Figure 2. 10 simulated realization of y_{1t} and y_{2t}



Top: y_{1t}; bottom: y_{2t}.

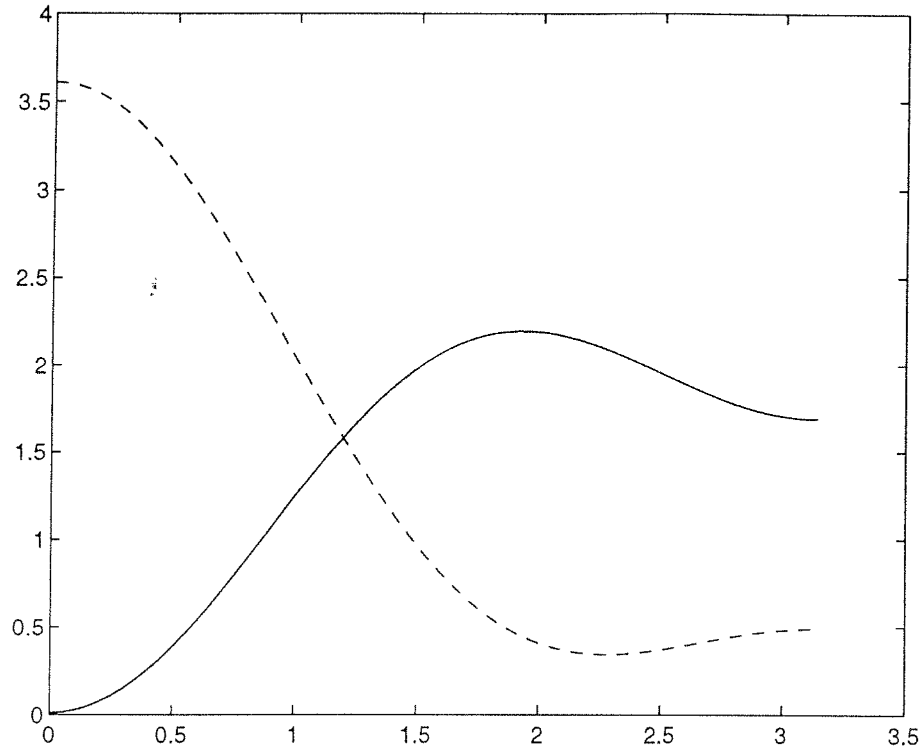
Figure 3. The filter $1 + L + \cdots + L^{k-1}$ for $k = 5, 10, 15, 20$



Vertical axis: spectral density; horizontal axis: frequency.

processes. Since they have the same variance, the areas under the two lines are the same. However, the more persistent process (dashed line) has a larger low-frequency integral and it therefore implies higher risk.

Figure 4. Spectral densities of Δy_{1t} and Δy_{2t}



Vertical axis: spectral density; horizontal axis: frequency. Solid line: Δy_{1t}; Dashed line: Δy_{2t}.

4. Cross-country insurance and potential insurable risk

An immediate implication of the discussion in Section 2 is that policy should aim at long-run stability. Although with imperfect capital markets and liquidity constraints temporary fluctuations may affect welfare, the core of the problem is long-run variance. Decreasing long-run variance is not an objective that can be reached by traditional macroeconomic stabilization policies. Such policies, aimed at intertemporal smoothing, can at best reduce the variance induced by temporary shocks. In a world with heterogenous nations, however, it is well known that a fiscal federation can smooth variance through cross-sectional transfers by acting as an insurance mechanism.

Now the problem is: can a fiscal federation reduce long-run variance? In this section we show that this is the case and propose a measure of the fraction of total risk which is potentially insurable. To this end we should obviously depart from the representative consumer model and consider the case of n heterogenous countries.

Clearly a fiscal federation may affect income levels in addition to income variances and for the clarity of the policy debate, it is useful to distinguish redistribution from insurance. The distinction is also important to understand the political sustainability of an European tax-transfer system. While the volatility effects may be Pareto improving in the sense that all countries can in principle reduce risk, the level effects can be positive for a country only at the expenses of other countries. Hence a fiscal federation could meet political opposition from countries expecting negative redistribution effects. This issue has been discussed by several authors, among wich von Hagen (1992), Goodhart and Smith (1993), Bayoumi and Masson (1995) and, more recently, by Fatas (1998) and Obstfeld and Peri (1998). However, the relation between long-run insurance and redistribution has never been clearly addressed. The question is whether it is possible to implement mechanisms for long-run insurance without affecting income levels.

Here we introduce a stylized model with n countries participating in a fiscal federation which operates as a pure insurance mechanism. The particular scheme we consider should be interpreted as a conceptual exercise, constructed to clarify the mechanism of cross-sectional smoothing and risksharing, rather than a policy recommendation.

Consider n countries with equal population, participating in a fiscal federation with a proportional tax rate τ, $0 \leq \tau \leq 1$, and per capita gross transfers D_{it}. We make the following assumption on D_{it}. Let Y_{it}, $i = 1, \ldots, n$ be per capita income of country i and Y_t be the average per-capita income. Then

$$D_{it} = \tau \frac{\mathrm{E}_0 \sum_{t=1}^{\infty} \beta^t Y_{it}}{\mathrm{E}_0 \sum_{t=1}^{\infty} \beta^t Y_t} Y_t = \tau \frac{W_i}{W} Y_t.$$

In words, the transfer is a fraction of average income, proportional to the ratio of W_i, which is the expected present value at time 0 of future incomes of country i, to W, which is the expected present value of future average incomes.

This assumption has two nice consequences. First, indicating with $T_{it} = D_{it} - \tau y_{it}$ the net transfer at time t, the reader can easily verify that the mechanism satisfies the period-by-period budget constraint $\sum_{i=1}^{n} T_{it} = 0$, so that intertemporal smoothing effects are ruled out. Second, there is no ex-ante cross-country redistribution. To clarify this point, let us define the ex-post redistribution effect for country i as the discounted present value of future net transfers:

$$Z_{it} = \sum_{k=1}^{\infty} T_{i,t+k} \beta^k.$$

Clearly Z_{it} is non-zero —and not even stationary— unless we make very particular assumptions on the Y_{it}'s. However, it is easily seen that $\mathrm{E}_0 Z_{i0} = 0$, i.e., the expected redistribution at time $t = 0$ is zero, so that, ex-ante, there are no losers.[5] These two features allow us to analyze insurance effects in isolation from other aspects of fiscal policy.

[5] Note that the expected redistribution effect is non-zero for $t \neq 0$. However, gross transfers could be renegotiated at fixed dates.

Now let us come to the volatility effects of this tax-tranfer system. Per capita disposable income of country i is

$$X_{it} = (1-\tau)Y_{it} + \tau \frac{W_i}{W} Y_t. \tag{8}$$

Denoting logs with lowercase letters, we have

$$x_{it} = \log[(1-\tau)e^{y_{it}} + \tau \frac{W_i}{W} e^{y_t}].$$

Linearizing x_{it} around $y_{it} = \log(Y_t W_i / W)$ and taking first differences we get approximately

$$\Delta x_{it} = (1-\tau)\Delta y_{it} + \tau \Delta y_t. \tag{9}$$

Hence the growth rate of per capita disposable income of country i is a weighted average of the growth rates of per capita income of country i and average per capita income, implying that there is a smoothing effect on disposable income whenever the variance of Δy_t is less than the variance of Δy_{it}.

Let us analyze this effect in more detail. We assume stationary growth rates and denote with $S_i^y(\lambda)$, $-\pi < \lambda \leq \pi$, the spectral density of Δy_{it}, $S_i^x(\lambda)$ the spectral density of Δx_{it}, $S^y(\lambda)$ the spectral density of Δy_t and $C_i^y(\lambda)$ the cospectrum of Δy_{it} and Δy_t. From (9) we obtain

$$S_i^x(\lambda) = (1-\tau)^2 S_i^y(\lambda) + \tau^2 S^y(\lambda) + 2\tau(1-\tau)C_i^y(\lambda).$$

The benefit for country i in terms of percentage variance reduction is:

$$B_i(\lambda) = \frac{S_i^y(\lambda) - S_i^x(\lambda)}{S_i^y(\lambda)} = (2-\tau)\tau - \tau^2 \frac{S^y(\lambda)}{S_i^y(\lambda)} - 2\tau(1-\tau)\frac{C_i^y(\lambda)}{S_i^y(\lambda)}. \tag{10}$$

A measure of the benefit which does not depend on frequency can be obtained by averaging the spectra over the relevant frequency bands. According to the analysis in Section 3, we are interested in the frequencies between 0 and $2\pi/k$, i.e. in the quantities

$$\hat{B}_i(k) = (2-\tau)\tau - \tau^2 \frac{R(k)}{R_i(k)} - 2\tau(1-\tau)\frac{\hat{C}_i(k)}{R_i(k)}, \tag{11}$$

where

$$\begin{aligned} R_i(k) &= k \int_0^{2\pi/k} S_i^y(\lambda) d\lambda \\ R(k) &= k \int_0^{2\pi/k} S^y(\lambda) d\lambda \\ \hat{C}_i(k) &= k \int_0^{2\pi/k} C_i^y(\lambda) d\lambda. \end{aligned}$$

From (11) we see that the insurance benefit $\hat{B}_i(k)$ may be both positive or negative. Moreover, it is positively related to the variance of income growth rate in country i, negatively related to the variance of average income and negatively related to the covariance of income and average income.

While $\hat{B}_i(k)$ measures the benefit specific to country i, we can get a synthetic measure of the aggregate benefit as the weighted average

$$B(\lambda) = \frac{\sum_{i=1}^{n} B_i(\lambda) S_i^y(\lambda)}{\sum_{i=1}^{n} S_i^y(\lambda)}.$$

We have approximately[6]

$$B(\lambda) = \tau(2-\tau)\left(1 - \frac{S^y(\lambda)}{\sum_{i=1}^{n} S_i^y(\lambda)/n}\right) = \tau(2-\tau)P(\lambda). \tag{12}$$

Equation (12) says that the overall benefit is positively related to the quantity $P(\lambda)$: a 1% increase in τ produces a percentage reduction of the average variance approximately equal to 2% times $P(\lambda)$. Note that in general not all the risk is insurable. $P(\lambda)$ is the maximal fraction of insurable risk, obtained when $\tau = 1$. It is simply the percentage deviation between the average of the variances and the variance of the average, decomposed by frequency. The corresponding quantity over the interval $[0, 2\pi/k]$ is

$$\hat{P}(k) = \frac{\sum R_i(k)/n - R(k)}{\sum R_i(k)/n}. \tag{13}$$

Both $P(\lambda)$ and $\hat{P}(k)$ vary between zero and 1 and increase when cross-correlations decrease. The maximum is reached when the variance of the aggregate is zero. In this case there is no aggregate risk and all the variance is insurable. The minimum is reached when all countries have equal output changes. Clearly, in this case, there is nothing to insure. Note also that $P(0) = 0$ if and only if all per capita output changes have the same spectral density at zero frequency and are perfectly coherent. In this case, long-run insurance is impossible. This case corresponds to per-capita output levels being pairwise "stochastically cointegrated" with cointegrating vector $(1 \quad -1)$, i.e. $y_{it} - y_{jt}$ is trend stationary for any pair i, j.

5. Empirical results

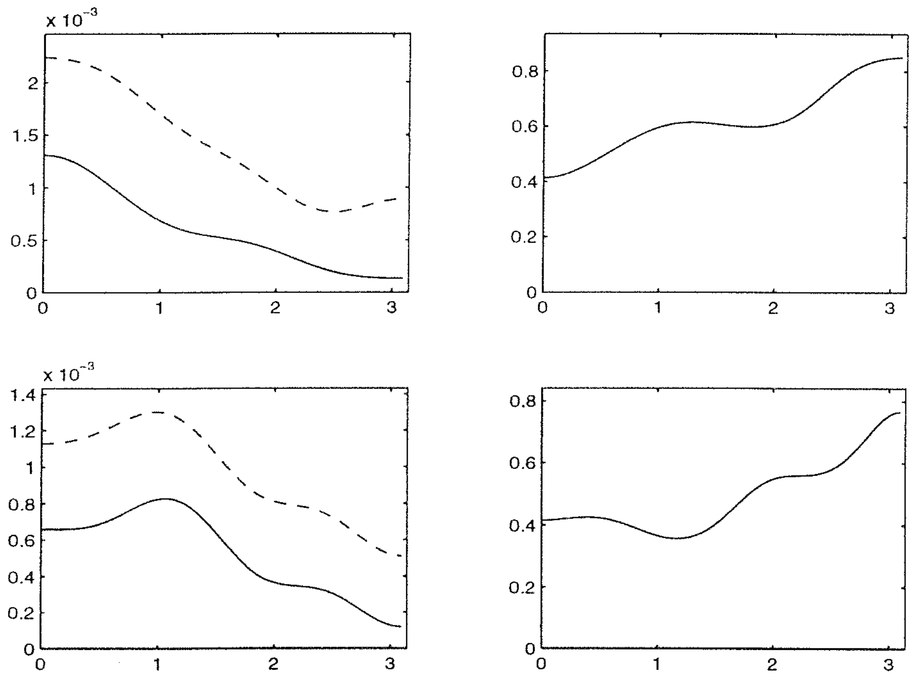
- *Aggregate results*

In Figure 5 (first row) we have the plot of the mean of the spectra (dashed lines) and the spectra of the mean (solid line) on the left quadrant and the measure

[6] We use the approximation $\sum C_i^y(\lambda) \approx S^y(\lambda)/n$, which is motivated by $\sum \Delta y_{it}/n \approx \Delta y_t$.

of potential insurable risk $P(\lambda)$ (second quadrant). In the second row we have the same quantities for the US. The plots of the means of the spectra show that, although Europe and the US have roughly the same variance, the former has larger concentration of variance at low frequencies and no typical cyclical shape. This indicates that income risk is higher in Europe than in the US. The plot of $P(\lambda)$, however, shows that the insurable component of risk is similar in the two cases implying that the bulk of long-run variance is a common characteristics of the European cycle (we found the same empirical result from the estimation of a dynamic factor model for the output of European regions in Forni and Reichlin, 1997). The European 'malaise' is not so much the large long-run variance, but the fact that most of it is common to all countries and therefore not insurable. There are no obvious policy instruments to address this problem. Potential insurable risk, however, remains large: around 45% of long-run variance could in principle be smoothed away.

Figure 5. Average risk and potential risk reduction for Europe and US



Top: Europe; bottom: US. Left: average of the spectral densities (dashed line) and spectral density of average income growth (solid line); right: estimated insurable risk $P(\lambda)$.

Table 1 shows the average risk and potential risk reduction for Europe and US for cycles of different lenght (standard errors are indicated in parenthesis). For the long cycles considered, the point estimates of the maximum insurable potential in Europe is slightly above the US average. Notice, however, that results have to be interpreted with caution since, for Europe, the standard errors for long-cycles are very large.[7]

Table 1. Risk and potential insurable risk at different time horizons (standard errors in brackets)

	$k=5$	$k=10$	$k=15$	$k=20$
European EC countries				
mean of spectra $\times 1000$ ($\sum R_i(k)/n$)	1.97	2.17	2.21	2.22
	(0.49)	(0.81)	(1.02)	(1.21)
spectrum of EC $\times 1000$ ($R(k)$)	0.97	1.20	1.26	1.28
	(0.40)	(0.67)	(0.86)	(1.01)
max insurable risk ($\hat{P}(k)$)	0.51	0.45	0.43	0.42
	(0.18)	(0.31)	(0.40)	(0.47)
US states				
mean of spectra $\times 1000$ ($\sum R_i(k)/n$)	1.22	1.16	1.14	1.13
	(0.34)	(0.43)	(0.51)	(0.59)
spectrum of US $\times 1000$ ($R(k)$)	0.73	0.67	0.66	0.66
	(0.29)	(0.37)	(0.45)	(0.52)
max insurable risk ($\hat{P}(k)$)	0.40	0.42	0.42	0.42
	(0.19)	(0.21)	(0.25)	(0.29)

- *Country risk*

Table 2 shows, for each European country separately, the reduction of output variance that can be achieved with an average tax of 10%. Most countries have positive gains from insurance, but there are large differences across countries on the percentage gain. The big winners are the poorest countries, Greece and Portugal, but also small and volatile countries such as Finland and Luxembourg. For most countries the profile of variance reduction is quite flat for the time horizons considered. Notable exceptions are the UK, Italy and Germany which show a steep decrease for larger k. This is explained by the shape of their spectral densities, shown in Figure 6. The UK shape in particular differs clearly from the average European shape and it has a clear cyclical peak and relatively small low frequency variance.

6. Summary and discussion

In this paper we argue that risk is linked to long-run income variability and we propose a measure of macroeconomic risk based on estimation of the spectral density of income growth. On this basis, we show how to compute potential insurable income and evaluate the benefits that different countries may obtain from

[7] Larger standard errors for the European case are explained by the fact that the aggregation effect is larger in the US since there are 49 cross-sectional units instead of 15.

Table 2. Percentage variance reduction for $\tau = 10\%$

$\hat{B}_i(k) \times 100$	$k = 5$	$k = 10$	$k = 15$	$k = 20$
Austria	1.3	0.2	−0.2	−0.3
Belgium	2.6	2.7	2.7	2.7
Denmark	9.6	7.1	5.6	5.1
Finland	13.2	12.2	11.8	11.6
France	−0.1	0.3	0.4	0.4
Germany	6.2	4.2	2.8	2.3
Greece	11.5	11.2	11.2	11.2
Ireland	9.2	8.5	8.3	8.2
Italy	3.9	2.3	1.4	1.1
Luxemburg	13.6	12.8	12.3	12.1
Netherlands	4.5	4.7	4.9	4.9
Portugal	13.2	12.4	12.0	11.9
Spain	8.5	8.7	8.7	8.7
Sweden	8.8	7.2	6.7	6.6
United Kingdom	6.8	2.5	−0.2	−1.3

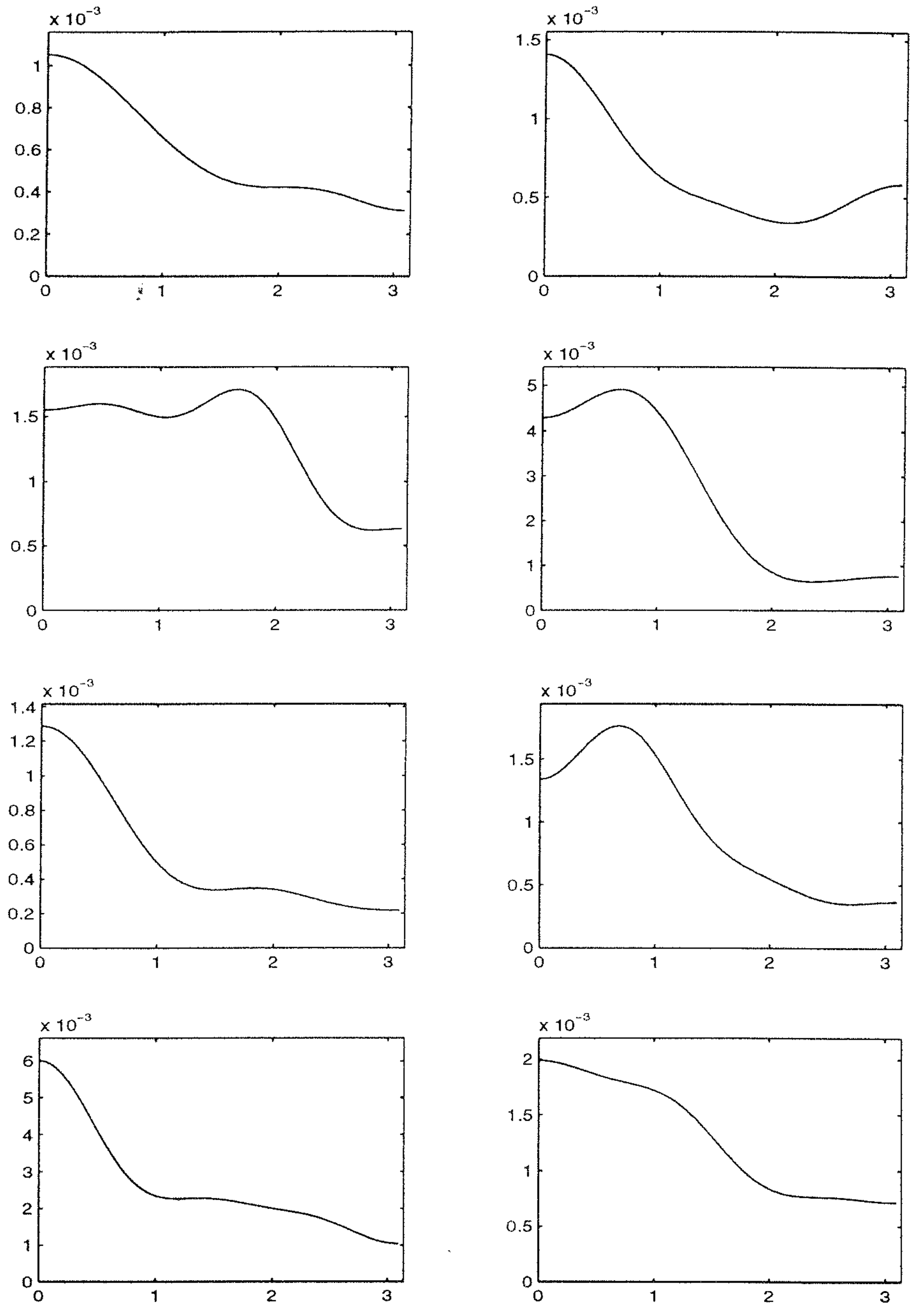
joining a fiscal federation. We also evaluate the effects of a fiscal mechanism with pure insurance effects which is neutral with respect to anticipated redistribution. Our empirical results on the effect on income volatility of a proportional income tax suggest a larger role for insurance than what esiomated by Fatas (1998). According to our estimates, although gains differ widely across countries, every country wins. Are the gains large or small? We cannot answer to this question without computing precise welfare measures. However, since the tax equals the expected future transfer, the fact that our estimates are positive for all countries is a strong argument in favor of the establishment of a fiscal federation in Europe. Moreover, in Europe, where a large part of income volatility is associated to persistent shocks, a fiscal federation which provides cross-country smoothing via insurance is the only potentially effective policy instruments, since intertemporal stabilization policies can only smooth the short-run. We have shown that more than 40% of long-run income volatility is potentially insurable and this number is non-negligible.

Few caveats are in order. First, although the insurance mechanism we have analyzed is neutral with respect to redistribution, it might be difficult to implement since benefits for each country depends on expected income at the time of the negotiation of the contract and, if realizations differ widely from expectation during the life of the contract, some partners will exert pressure to renegotiate.

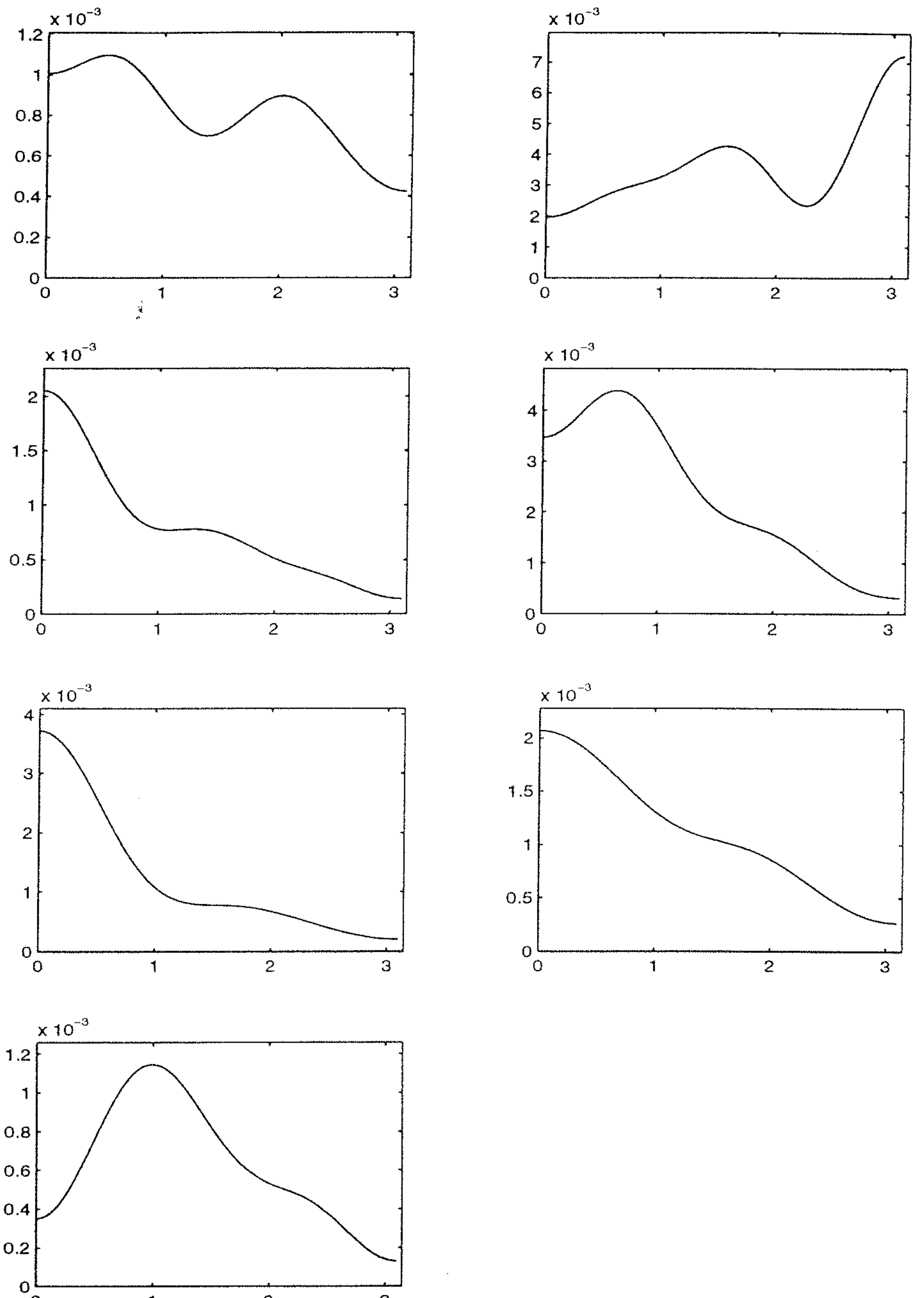
Second, our example is very stylized, since we have considered a proportional rather than a progressive tax and we have assumed regressive transfers. Therefore, we are likely to underestimate the potential role for insurance.

Third, we have taken the nation as the relevant aggregate and considered

Figure 6. Estimated spectral densities for 15 European countries



From the left to the right: AU, BE, DK, FI, FR, GE, GR, IR.



From the left to the right: IT, LU, NE, PO, ES, SW, UK.

a European tax which is additional to national ones. This is not an obvious choice. Redistribution and insurance effects within a country may vary across regions (see, for example, Forni and Reichlin, 1997) and it might be interesting to consider the effects of a European tax which replaces national ones at the regional level.

Finally, our analysis is based on past history and output dynamics in Europe is likely to change as an effect of EMU. However, we think that common monetary policy is unlikely to change long-run income variance which is the quantity on which our measure of insurable risk is based.

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Appendix

- *Data*

We consider annual disposable real per-capita income for the fifteen EC countries for the period 1962-1994. We use the consumer price index as the price deflator. The source is Eurostat. For the US, the data are "Per capita personal income (USD)" for 49 states (Alaska and Hawaii excluded). The source is REIS, database provided by the Bureau of Economic Analysis, Economics and Statistics Administration of the US Department of Commerce. All data are taken in national currencies; comparability is insured by deflating and taking logs.

- *Estimation method*

Spectra and cospectra are estimated by the Bartlett lag-window estimator, with window size equal to 6. We computed the spectra at 64 equally spaced points between 0 and π. The integrals in Tables 1 and 2 are approximated by averaging these point estimates over the interval $[0, 2\pi/k]$.

The standard errors of the estimates of $R(k)$ and $R_i(k)$ in Table 1 are based on

$$\mathrm{cov}(\hat{R}_i(k), \hat{R}_j(k)) = \frac{4\pi^2 k}{T} \int_0^{2\pi/k} |S_{ij}(\lambda)|^2 k/2\pi \; d\lambda,$$

where $\hat{R}_i(k)$ is the estimate of $R_i(k)$ and $S_{ij}(\lambda)$ is the cross-spectrum of countries i and j. This formula can be derived following Priestley (1981), Section 6.2.5. The integral is estimated by the average over the point estimates of the cross-spectrum in the interval $0 \geq \lambda \geq 2\pi/k$. Since $\hat{P}(k)$ is a nonlinear function of the $R_i(k)$'s, the standard errors for the estimates of $\hat{P}(k)$ are computed by the *δ-technique.*

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