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Have Consumption Risks in the G7 Countries Become Diversified?

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Abstract

This paper studies the dynamics of international consumption risk sharing among the G7 countries. Based on the dynamic conditional correlation model due to Engle (2002), we construct a time-varying, consumption-based measure of risk sharing. We find that although the exposure to country-specific shocks has declined in the G7 countries, with Japan being an exception, the evolution of risk sharing is rather heterogeneous across countries.

Key words: Dynamic conditional correlation, consumption risk sharing,

JEL codes: E3, F4

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1 Introduction

International financial markets should, in principle, allow to insure against macroeconomic risks by pooling these risks internationally. Empirical evidence shows rather convincingly that risks are shared only so a small extent across countries. Backus et al. (1992) pointed out that cross-country correlations of consumption growth rates are too low to be consistent with a substantial amount of international consumption risk sharing (see also Ambler et al., 2004). In addition, a large literature documents that consumption is too sensitive to country-specific fluctuations in GDP (see e.g. Lewis, 1999; Obstfeld and Rogoff, 2000).

Nevertheless, even though risk sharing appears to be limited, the globalization and integration of financial markets may have resulted in an increase in risk sharing over time. In fact, several authors document that risk sharing has indeed improved (Sørensen et al., 2005; Artis and Hoffmann, 2008, 2007; Kose et al., 2007). While the existing literature that studies the evolution of risk sharing over time uses subsample estimation and rolling estimation techniques, we propose a time-varying measure for risk sharing based on the dynamic conditional correlation (DCC) model due to Engle (2002). The DCC models allows us to obtain time-varying estimates of conditional second moments. Using these time-varying second moments, we construct a measure of risk sharing in the spirit of Asdrubali et al. (1996).

We focus on risk sharing among the G7 countries. Thus, we confine ourselves to the analysis of a small and relatively homogeneous group of industrialized countries. In this sense, our analysis is closely related to Obstfeld (1994) who also analyzed consumption risk sharing among this group of countries. More recently, Fuhrer and Klein (2006) also studied risk sharing among the G7 countries and stress the role of habit formation.

Our results indicate that the evolution of risk sharing patterns is rather idiosyncratic across the G7 countries. Thus, averaging over countries - which is essentially done in most of the literature - hides a substantial amount of heterogeneity. While risk sharing generally increased since the mid 1990s for almost all countries in our sample, we find an increasingly higher exposure to macroeconomic shocks in Japan.

The paper is structured as follows: In Section 2 we describe the construction of our time varying measure of risk sharing as well as the estimation of the DCC model and the data. Section 3 represents the estimation results and discusses how risk sharing has changed over time in the G7 countries. Section 4 summarizes and concludes the paper.

2 A Time-Varying Measure of International Consumption Risk Sharing

Regression-based measures of international risk sharing exploit the result that under complete markets, consumption growth rates are equalized across countries:

$$\Delta \log c_{it} = \Delta \log c_{jt} \tag{1}$$

where c_{it} and c_{jt} denote real per capita consumption at time t in countries $i = 1, ..., N$ and $j = 1, ..., N$ and Δ is the first difference operator. Note that according to equation (1) $\Delta \log c_{it}$ does not respond to fluctuations in any idiosyncratic variables such as e.g. country-specific output. Thus, if country-specific shocks can be pooled across countries, consumption growth rates should be highly correlated, regardless of the correlation of any idiosyncratic variables. Based on this result, Asdrubali et al. (1996) go one step further and derive a measure that allows to quantify the extent of risk sharing, even if markets are incomplete. Since equation (1) has to hold for any two countries i and j, it also has to hold with respect to average consumption across countries in period t, which we denote by c_t. Therefore: $\Delta \log c_{it} = \Delta \log c_t$. If markets are incomplete, consumption growth may deviate from what it would be under complete markets and this deviation $\tilde{c}_{it} = \Delta \log c_{it} - \Delta \log c_t$, may vary systematically with idiosyncratic variables, such as country-specific output growth $\tilde{y}_{it} = \Delta \log y_{it} - \Delta \log y_t$, where y_t is average, per capita real output.

Asdrubali et al. (1996) regress $\tilde{c}_{it}$ on $\tilde{y}_{it}$ using panel data and show that the regression coefficient $\beta = cov(\tilde{c}_{it}, \tilde{y}_{it})/var(\tilde{y}_{it})$ can be interpreted as the exposure of consumption to country-specific output fluctuations. If risk sharing is perfect, then consumption is decoupled from output and $cov(\tilde{c}_{it}, \tilde{y}_{it}) = 0$ and therefore $\beta = 0$. If, in contrast, consumption perfectly tracks output due to a complete lack of risk sharing, then $cov(\tilde{c}_{it}, \tilde{y}_{it}) = var(\tilde{y}_{it})$ and $\beta = 1$. More generally, β represents the fraction of output fluctuations which are not pooled internationally.

In this paper, we essentially construct a time varying variant of this measure of risk sharing. We estimate the conditional covariance between $\tilde{c}_{it}$ and $\tilde{y}_{it}$, $cov_t(\tilde{c}_{it}, \tilde{y}_{it})$, as well as the conditional variance of $\tilde{y}_{it}$, $var_t(\tilde{y}_{it})$, using the the Dynamic Conditional Correlation (DCC) model of Engle (2002) for each of the G7 countries and calculate

$$\gamma_{it} = 1 - \frac{cov_t(\tilde{c}_{it}, \tilde{y}_{it})}{var_t(\tilde{y}_{it})}. \tag{2}$$

Intuitively, γ_{it} gives the fraction of output fluctuations which are shared across countries. If risk sharing is completely absent, country-specific consumption growth perfectly tracks country-specific output growth. In this case, $cov_t(\tilde{c}_{it}, \tilde{y}_{it}) = var_t(\tilde{y}_{it})$ and $\gamma_{it} = 0$. If country i manages to fully insure against country-specific macroeconomic shocks, then $\tilde{c}_{it}$ is completely decoupled from $\tilde{y}_{it}$ and $cov_t(\tilde{c}_{it}, \tilde{y}_{it}) = 0$. Hence, full risk sharing corresponds to $\gamma_{it} = 1$. In intermediate cases, $0 < \gamma_{it} < 1$, risks are shared to some, albeit limited, extent.

To obtain the time varying second moments, we estimate a bivariate DCC models for idiosyncratic consumption and output growth rates in each of the G7 countries. We construct $\tilde{c}_{it}$ as the fourth difference of the log of quarterly real per capita consumption and subtract the weighted rest-of-the-world average growth rate. We calculate the rest-of-the-world consumption as $c_t = \sum_{j=1\neq i}^{7} w_{jt}c_{jt}$, where $w_{jt} = pop_{jt}/\sum_{j=1\neq i}^{7} pop_{jt}$ and pop_{jt} is the population of country j at time t (see Asdrubali et al., 1996). We construct $\tilde{y}_{it}$ analogously based on the fourth difference of the log quarterly real per capita GDP. The series range from 1980:1 to 2009:3. Consumption and GDP series for the period from 1980:1 to 2009:3 are obtained from the OECD Main Economic Indicators.

To model the conditional means of $\tilde{c}_{it}$ and $\tilde{y}_{it}$ for each country in our sample, let $z_t = (\tilde{c}_{it}, \tilde{y}_{it})'$. Note that we drop the country subscript in the definition of the vector z_t to simplify the notation. We specify the conditional mean equations as: $z_t = \mu_t + \epsilon_t$, where μ_t, is the 2×1 conditional mean vector of z_t, and ϵ_t is the 2×1 vector of residuals (the latter based on the information set up to time $t-1$, Ω_{t-1}), which are normally distributed with zero mean and H_t variance. The conditional variance-covariance matrix, H_t, of the DCC is given by:

$$H_t \equiv D_t R_t D_t, \tag{3}$$

where D_t is a diagonal matrix of square root individual conditional variances defined as:

$$D_t = \begin{pmatrix} h_{ct}^{1/2} & 0 \\ 0 & h_{yt}^{1/2} \end{pmatrix}, \tag{4}$$

where each h_{kt}, $k = c, y$, follows a univariate GARCH(1,1) process (see below), and R_t is a 2×2 symmetric positive definite matrix containing the time-varying conditional correlations defined as:

$$R_t = \begin{pmatrix} 1 & \rho_{cyt} \\ \rho_{cyt} & 1 \end{pmatrix}, \tag{5}$$

or

$$R_t = diag(q_{ct}^{-1/2}, q_{yt}^{-1/2}) Q_t diag(q_{ct}^{-1/2}, q_{yt}^{-1/2}). \tag{6}$$

Q_t is a 2×2 symmetric positive definite matrix given by:

$$Q_t = (1 - \alpha - \beta)\bar{Q} + \alpha u_{t-1} u'_{t-1} + \beta Q_{t-1}, \tag{7}$$

where u_t is the vector of standardized residuals, $\bar{Q}$ is the unconditional covariance matrix of u_t, and α and β are nonnegative scalars such that $\alpha + \beta < 1$.

We estimate the conditional variance-covariance matrix, H_t in two steps: in the first step univariate volatility models are specified for z_t and estimates of h_{kt} are obtained;[1] in the second-step we use the standardized residuals, $u_{kt} = \epsilon/\sqrt{h_{kt}}, k = c, y$, of z_t obtained in the first step, to estimate the parameters of the condition variance matrix.

We repeat the estimation process for each of the countries in our sample. In addition, we estimate each of the seven bivariate DCC models using the Quasi-Maximum Likelihood estimator under the multivariate normal distribution. The two-step approach to maximizing the likelihood involves finding

$$\theta = \arg\max\{L_V(\theta)\}, \tag{8}$$

(where θ denotes the parameters in D_t, and L_V is the volatility term of the log-likelihood) and then taking this value as given in the second step:

$$\max\{L_C(\hat{\theta}, \phi)\}, \tag{9}$$

[1]Specifically, a GARCH(1,1) model was specified for each z_t series given by: $h_{kt} = \omega_k + \alpha_{k1}\epsilon^2_{kt-1} + \beta_{k1} h_{kt-1}$, where $k = c, y$. This specification is also supported by various tests on the (squared) standardized residuals.

where ϕ denotes the parameters in R_t, and L_C is the correlation term of the log-likelihood. Under reasonable regularity conditions (Newey and McFadden, 1994), consistency in the first step will ensure consistency of the second step.

3 Estimation Results

The estimation results for the DCC models for consumption and output growth are presented in Table 1.[2] We see, that the estimates of the two sets of DCC parameters, α and β, are always statistically significant, which suggests that the second moments of the country-specific consumption and output growth series are indeed time-varying in the G7 countries. This result is also supported by the two tests for constant correlations of Tse (2000) and Engle and Sheppard (2001) reported on the bottom of Table 1. Both tests reject the null hypothesis of constant correlations at the 1% level of significance, which is a first indication that the extent of risk sharing has changed over time. According to the Table 1, we estimate the most pronounced dynamic correlation between consumption and output growth rates, $\hat{\rho}$, for the US, and the lowest for UK. Note that each of the DCC models is well specified as the multivariate versions of the Portmanteau statistic of Hosking (1980)and Li and McLeod (1981) do not reject the null hypothesis of no serial correlation in the standardized and squared-standardized residuals, respectively, up to 10 lags.

How did risk sharing in the G7 countries evolve over time? Figures 1 - 7 show how our measure of risk sharing, γ_{it}, has evolved over time, for

[2] For the sake of brevity, the GARCH estimation results for the first step are not presented here. Detailed results are available upon request.

each of the G7 countries. Since the γ_{it} display substantial short-run fluctuations, each figure is augmented by the fitted values of a regression of each γ_{it} on a constant, a trend, and a squared trend to better judge low-frequency movements in risk sharing. These estimation results are reported in Table 2.

We see from Figure 1 that Canada has managed to increase the amount of risk it shares internationally over time. While we observe a γ of around 0.3 in 1980, meaning that 30 percent of the risk associated with country-specific output fluctuations were shared internationally, risk sharing has increased to slightly above 60 percent in 2010.

Figure 2 reveals that the fraction of internationally diversified risk evolved rather differently in France. In particular, risk sharing does not appear to have increased. In fact, the fitted trend suggests that risk sharing has evolved in a u-shaped fashion. In 1980, around 30 percent of country-specific risks were diversified internationally. Note that this number is similar to what we find for Canada in 1980. However, in contrast to Canada, the fraction of diversified risk declined in France until the mid 1990s, when the trend level of risk sharing reached a minimum.

For Germany and to a lesser extent also for Italy, Figures 3 and 4 show that the trend in risk sharing also follows u-shaped patterns. Note, however, that in the Italian case, the evolution of the trend appears to be driven by two sharp, but short-lived declines in risk shairng in 1991 and in 1997, where γ_{it} was negative. Although in Germany and Italy, the fraction of diversified risk is somewhat higher on average than in France, it is substantially below what we find for Canada.

For Japan, Figure 5 shows a different pattern. According to our estimate of γ, consumption risks were well diversified during the beginning of our sample. For 1980, we find that slightly more than 60 percent of consumption risks were diversified across countries, a value which is well above what we obtain for the remaining countries in our sample, except for the UK (see below). However, since 1980, risk sharing worsened steadily until the trend level of γ reached a minimum of around 20 percent in 2005.

UK consumption risks are relatively well diversified as indicated by the generally high values of γ displayed in Figure 6. The figure also shows the trend follows a u-shaped pattern reaching a mimimim in 1995.

For the US, Figure 7 shows a similar, albeit less pronounced pattern. Although the trend in γ also shows a decline in risk sharing until the early 1990s, this decline is marginal. Since around 1990, risk sharing has increased and reached a level of just below 50 percent in 2010. Note, however, that while the trend increased steadily during this period, γ itself shows some marked fluctuations, from above 0.7 in 2001 to around 0.1 in 2005.

Overall, we find that the trends in risk sharing have been rather heterogeneous across the G7 countries. We find evidence in favor of a clear improvement in risk sharing only in Canada and to a lesser extent also in the US. In these two countries, the trend level of risk sharing has increased throughout the sample period.

For the EU member countries in our sample, France, Germany, Italy and the UK, the trend in risk sharing follows a u-shaped pattern and our results suggest that improvements occurred mostly since the mid 1990s. Thus, it appears that the ongoing process of European integration has had a more pronounced effect on the extent to which consumption risks are shared internationally since the mid 1990s. Note however, that although the EU countries share a similar trend with respect to risk sharing, and appear to be homogenous in this respect, the levels of risk sharing remain heterogeneous.

For Japan, our results suggest a rather steady decline in the extent to which consumption is smoothed in the face of macroeconomic shocks. This may result may, to some extent, mirror the fact that the Japanese financial system, and in particular the banking sector, was under severe pressure during the 1990s. Since a well-functioning financial system is necessary to provide the instruments to share risks across countries, it appears conceivable that the Japanese financial system was simply not able to provide the necessarily instruments to share risks efficiently across countries.

4 Concluding Remarks

For most countries in our sample we find that risk sharing follows a u-shaped trend where risk sharing improves since the mid 1990s. A clear increase in the trend level of risk sharing can only be detected for Canada, where the risk improved from 30 to 60 percent form 1980 to 2010. Another exception is Japan, where risk sharing declined over time and stabilized only at the end of our sample.

Our results cast some doubts on the idea that the integration of international financial markets has led to an increase in international risk sharing. Although we find that risk sharing has increased in most of the G7 countries, it appears that the extent of risk sharing has declined in most countries until the mid 1990s, despite the fact globalization is generally thought to have started in the early 1980s. Hence, if globalization did lead to higher risk sharing, it remains puzzling why the increases have occurred with such a substantial delay. Moreover, in most of the G7 countries, with Canada being the main exception, we find that risk sharing has only recently reached the levels which where already observed during the early 1980s.

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Table 1: Estimation results of bivariate DCC models for output and consumption growth rates for each of the G7 countries, Period: 1980q1 - 2009q3

	CAN	FRA	GER	ITL	JPN	UK	US
ρ	0.503***	0.676***	0.574***	0.512***	0.530***	0.334**	0.678***
	(0.086)	(0.050)	(0.102)	(0.060)	(0.143)	(0.156)	(0.105)
α	0.082**	0.040**	0.014**	0.035***	0.032**	0.135**	0.102***
	(0.038)	(0.016)	(0.007)	(0.005)	(0.014)	(0.066)	(0.034)
β	0.904***	0.809***	0.953***	0.914***	0.969***	0.699***	0.776***
	(0.099)	(0.131)	(0.039)	(0.066)	(0.039)	(0.117)	(0.090)
Log-Lik	794.63	822.43	726.15	753.71	729.67	715.43	785.77
$H(10)$	35.30	37.24	32.73	36.32	36.60	34.22	40.01
	[0.50]	[0.45]	[0.56]	[0.47]	[0.47]	[0.52]	[0.38]
$H^2(10)$	36.79	42.38	47.03	48.59	39.19	36.60	32.36
	[0.53]	[0.34]	[0.15]	[0.12]	[0.42]	[0.53]	[0.73]
$Li-McL(10)$	35.58	36.98	33.35	36.21	36.04	34.63	41.61
	[0.49]	[0.46]	[0.55]	[0.47]	[0.48]	[0.50]	[0.37]
$Li-McL^2(10)$	37.21	41.24	46.34	47.94	39.54	36.79	32.98
	[0.51]	[0.36]	[0.17]	[0.13]	[0.40]	[0.52]	[0.70]
$LM-Tse$	8.83***	8.12***	11.93**	10.12***	10.32***	8.26***	18.36***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
$E-S\ Test(5)$	17.59***	21.16***	18.28***	16.21***	18.88***	19.12***	18.65***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

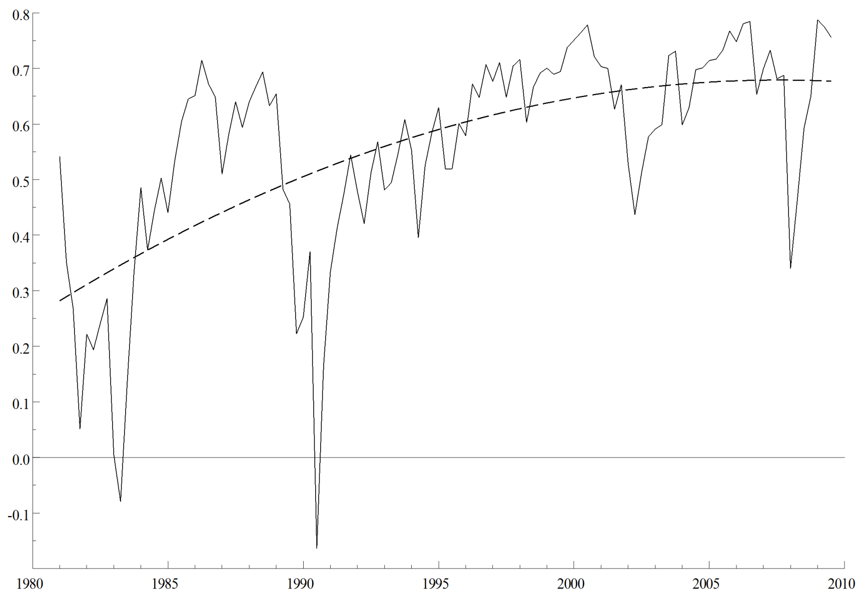
Notes: ρ is the conditional correlation of $\tilde{c}_{it}$ and $\tilde{y}_{it}$. $H(10)$, $H^2(10)$ and $Li-McL(10)$, $Li-McL^2(10)$ are the multivariate Portmanteau statistics of Hosking (1980) and Li and McLeod (1981), respectively, up to 10 lags. $LM-Tse$ and $E-S\ Test(5)$ are the LM test for constant correlation of Tse (2000) and Engle and Sheppard (2001) Test for dynamic correlation, respectively. t-values in parenthesis and p-values in square brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: Estimation results of augmented equation for each of the G7 countries, Period: 1980q1 - 2009q3

	CAN	FRA	GER	ITL	JPN	UK	US
const	0.2743***	0.2972***	0.4499***	0.5390***	0.6638***	0.7959***	0.4199***
	(0.0427)	(0.0457)	(0.0125)	(0.0738)	(0.0367)	(0.0457)	(0.0323)
trend	0.0075***	-0.0058***	-0.0020***	-0.0078***	-0.0090***	-0.0066***	-0.0017
	(0.0017)	(0.0018)	(0.0005)	(0.0029)	(0.0015)	(0.0018)	(0.0013)
$trend^2$	-3.51e-05**	5.70e-05***	1.63e-05***	7.12e-05***	5.10e-05***	5.89e-05***	2.09e-05*
	(1.41e-05)	(1.52e-05)	(4.16e-06)	(2.45e-05)	(1.22e-05)	(1.52e-05)	(1.07e-05)

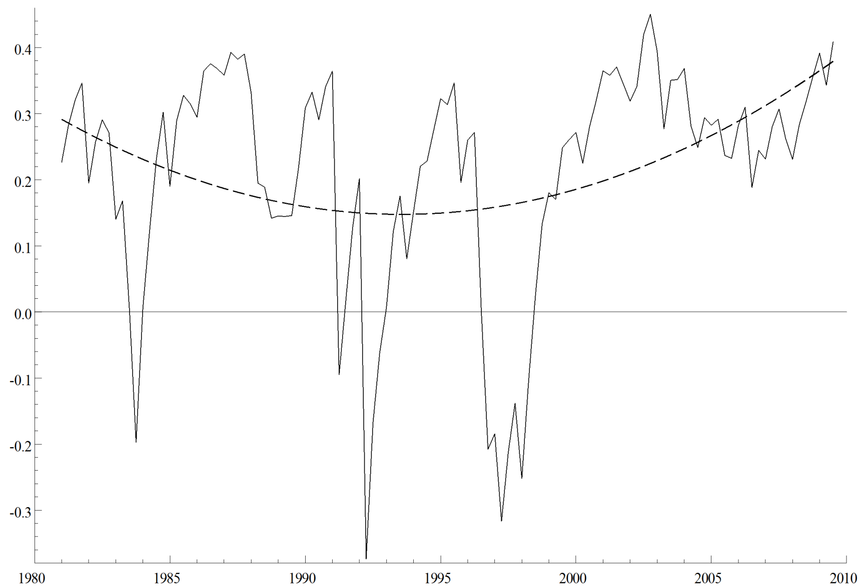
Notes: standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 1: Consumption risk sharing in Canada



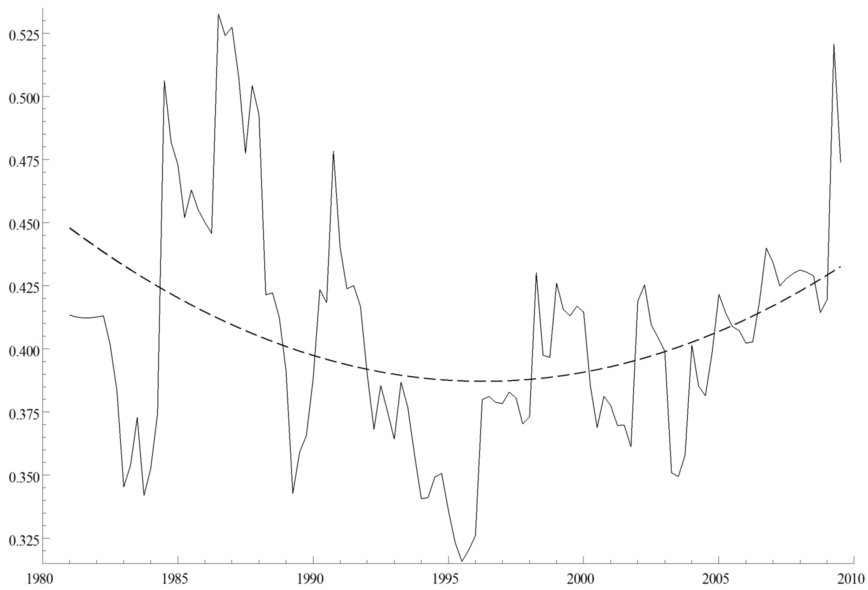
Notes: The solid line shows the exact of risk sharing measured as $\gamma_t = 1 - (cov_t(\tilde{c}_{it}, \tilde{y}_{it})/var_t(\tilde{y}_{it}))$. The dashed line shows the fitted values of a regression of γ_{it} on a constant, a linear trend and a quadratic trend.

Figure 2: Consumption risk sharing in France



Notes: The solid line shows the exact of risk sharing measured as $\gamma_t = 1 - (cov_t(\tilde{c}_{it}, \tilde{y}_{it})/var_t(\tilde{y}_{it}))$. The dashed line shows the fitted values of a regression of γ_{it} on a constant, a linear trend and a quadratic trend.

Figure 3: Consumption risk sharing in Germany



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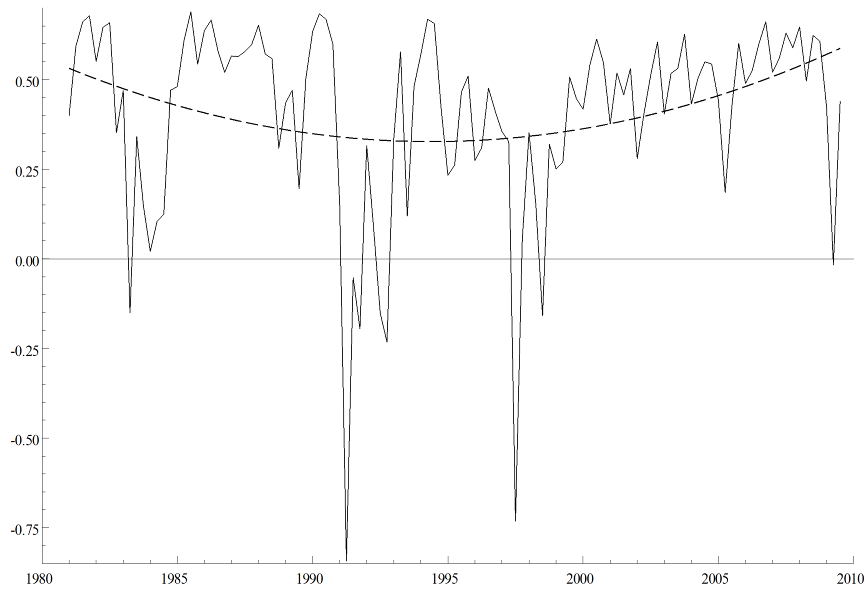
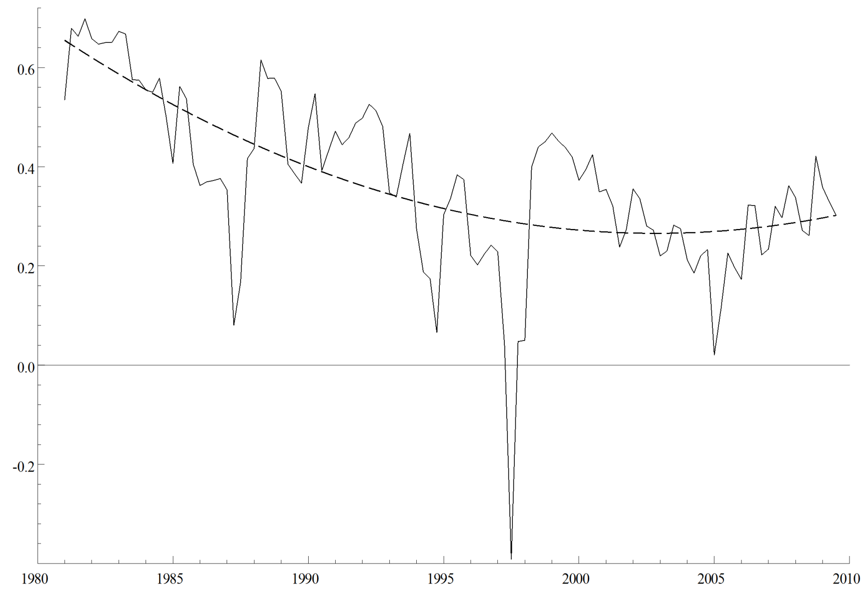
Notes: The solid line shows the exact of risk sharing measured as $\gamma_t = 1 - (cov_t(\tilde{c}_{it}, \tilde{y}_{it})/var_t(\tilde{y}_{it}))$. The dashed line shows the fitted values of a regression of γ_{it} on a constant, a linear trend and a quadratic trend.

Figure 4: Consumption risk sharing in Italy



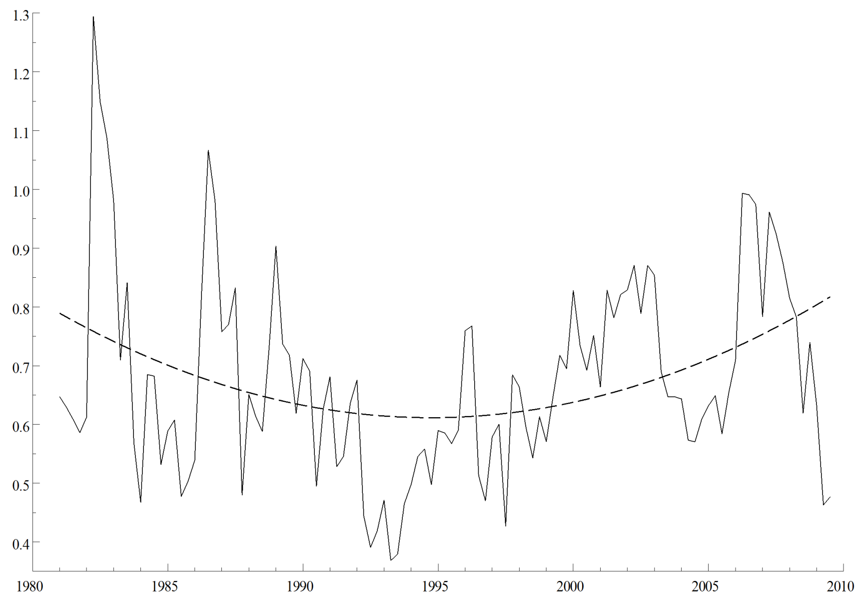
Notes: The solid line shows the exact of risk sharing measured as $\gamma_t = 1 - (cov_t(\tilde{c}_{it}, \tilde{y}_{it})/var_t(\tilde{y}_{it}))$. The dashed line shows the fitted values of a regression of γ_{it} on a constant, a linear trend and a quadratic trend.

Figure 5: Consumption risk sharing in Japan



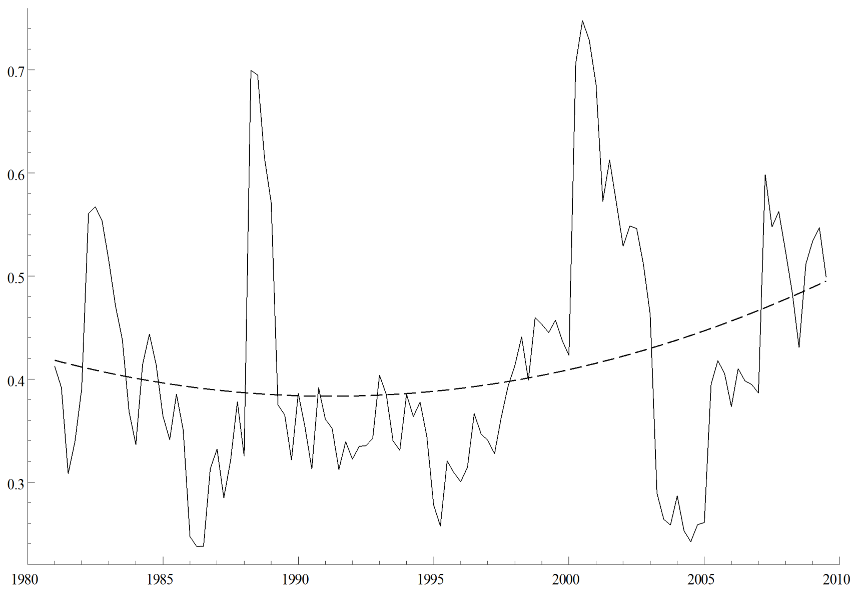
Notes: The solid line shows the exact of risk sharing measured as $\gamma_t = 1 - (cov_t(\tilde{c}_{it}, \tilde{y}_{it})/var_t(\tilde{y}_{it}))$. The dashed line shows the fitted values of a regression of γ_{it} on a constant, a linear trend and a quadratic trend.

Figure 6: Consumption risk sharing in UK



Notes: The solid line shows the exact of risk sharing measured as $\gamma_t = 1 - (cov_t(\tilde{c}_{it}, \tilde{y}_{it})/var_t(\tilde{y}_{it}))$. The dashed line shows the fitted values of a regression of γ_{it} on a constant, a linear trend and a quadratic trend.

Figure 7: Consumption risk sharing in US



Notes: The solid line shows the exact of risk sharing measured as $\gamma_t = 1 - (cov_t(\tilde{c}_{it}, \tilde{y}_{it})/var_t(\tilde{y}_{it}))$. The dashed line shows the fitted values of a regression of γ_{it} on a constant, a linear trend and a quadratic trend.