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Consumption smoothing at business cycle frequency

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Abstract

This paper tries to disentangle the strength of the several sources of consumption smoothing in a panel of countries. For this purppose a factor model is applied to data from 23 OECD countries. This approach allows us to measure the strength of the different channels of consumption smoothing for the different countries rather than estimating an aggregate value for all. At the same time this method allows us to estimate the importance of the world and national components of the business cycle in deviations from trend of output and consumption.

Keywords: International risk sharing, Consumption smoothing, Business cycle synchronization, Bayesian methods, Factor models

JEL Classification:C11, C33, E21, E32

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1 Introduction

A substantial number of papers have been written on the symmetry of business cycles across countries[1]. While those papers concentrate on the symmetry of fluctuations in output or in general economic indicators, the agent's utility is usually depicted as a function of consumption and leisure. Therefore, if the agent can smooth her utility over the cycle by intertemporal substitution and/or international risk sharing, the degree of symmetry of the output business cycle is of little importance, as consumption should respond only to world-wide output variations. To accomplish this, there are several ways in which the agent is able to risk share the country specific shocks to output.

The first one is through portfolio diversification. As Obstfeld and Rogoff (1996) show, using a modified version of Lucas (1982) model, agents would optimally hold a diversified portfolio of financial assets in which the importance of each country's asset would be proportional to that country's economic wealth. In this framework the consumption level would only vary according to world output fluctuations and not to country specific ones. However, French and Poterba (1991), Lane (2000) and Kraay et al. (2000) show that countries do not optimally diversify their portfolios, having most of their wealth invested in home assets[2]. The main arguments given to explain this behavior are transaction costs [3]; the existence of non-tradable goods[4] and the regulation of financial markets[5].

The portfolio diversification channel is an ex-ante insurance mechanism, as it will work automatically in the presence of asymmetric shocks. We will call it the portfolio diversification or asset market channel.

Even if agents do not optimally diversify their portfolio, they can still engage in risk sharing

[1] Some recent studies on business cycle syncronization at an European level are Artis et al. (1999 and 2003), Wynne and Koo (2000), Altissimo et al. (2000) and Forni and Reichlin (2001).At a world level we have Gregory and Head (1997), Andreano and Savio (2002), Helbling and Bayoumi (2003), Bordo and Helbling (2003), Lumsdaine and Prasad (2003), Mansour (2003), Kose et all. (2003) and Cerqueira (2005).

[2] In the literature this is known as the home bias puzzle.

[3] Cole and Obstfeld (1991) estimated that the welfare gains from portfolio diversification are very small, therefore small impediments can avoid the agents to diversiy their portfolios. However, Van Wincoop (1994) and Tesar and Werner (1995) dismissed this argument. The first by showing that the gains from portfolio diversification can be much higher than those estimated by Cole and Obstfeld; the second by noting that the turnover rate on equities is higher for non-residents than for residents.

[4] Therefore consumption of this kind of goods would not be risk-sharable.

[5] In every year from 1966 to 1994 the proportion of countries with international capital market restricitons was around 75%, Lewis (1996) .

behavior by using the international credit markets (by lending and borrowing) adjusting their consumption level. In fact, in general equilibrium models with imperfect financial markets, where only an international bond can be traded and in the absence of other costs/rigidities, the cross country consumption correlations are higher than output correlations, indicating that there is some amount of risk sharing (see Baxter and Crucini (1995) or Kollman (1996)). Even if we introduce some modifications to the base model like imperfect substitutability between home and foreign goods it is only for very low levels of the elasticity of substitution that the cross-correlation of consumption is lower than the one for output, see Corsetti et al. (2004). In the case of trade costs (as for example in Mazenga and Ravn(2004) [6]) or the existence of non-tradables (for a recent paper where tradability is endogenous see Melitz and Ghironi (2004)), the consumption cross-correlation level drops but continues to be, in most cases, higher than the output cross-correlations. There are some exceptions as in the models presented by Ubide (1999) and Olivero (2004), the first by introducing shocks on the firms mark-up and government expenditures, the second by introducing an oligopolist banking system.

The use of the credit markets is an ex-post insurance mechanism, as it is put in practice after the revelation of asymmetric shocks. Moreover in practical terms it is difficult to disentangle this risk-sharing mechanism from inter-temporal smoothing through savings, therefore in the empirical part of the paper we will call it the credit market or savings channel.

Notwithstanding the prediction of the majority of theoretical models, the observed cross-consumption correlation across countries is inferior to the output cross-correlation[7] giving rise to the consumption correlation puzzle[8]; moreover, a number of empirical studies that have tried to measure the amount of risk sharing [9] have found that the amount of risk sharing is relatively small, far from perfect and that the bulk of smoothing is done through the credit markets/saving channel. Even if those articles have shed some light on how risk sharing is achieved, the fact is that, when trying to measure the different channels they are only able to do aggregate estimations

[6] Even if Rogoff and Obstfeld(2000) argue that trade costs solve the consumption correlation puzzle. See also the criticism from Engel(2000).

[7] See Backus et al. (1995) or Hess and Shin (1997).

[8] We should refer that, adding to the previous exceptions, also the presence of taste shocks can reduce the gap between the cross-correlations observed and the ones given by the theoretical models as it is shown by Stockman and Tesar (1995), even in the presence of complete asset markets.

[9] See Lewis (1996), Asdruballi et all. (1996), Sorenson and Yosha (1998a, 1998b, 2000), Arreaza et all. (1998); Kalemli-Ozcanet all. (1999), Crucini (1999), Melitz and Zummer (1999), Del Negro (2000), Artis and Hoffman (2003) and Marinheiro (2004).

(the EMU area, the US States, etc.). Once the number of countries/regions is reduced the methods lose power making inference difficult.

In this paper I purpose to use a factor model[10] to perform this study using a Bayesian method purposed by Otrok and Whiteman (1999) to calculate the distributions of the estimated parameters. The use of factor methods has the advantage that panel information can be used in order to get more accurate estimators while it can retrieve estimators for each individual/country in the sample. In this way we will be able to estimate the different channels of risk sharing and consumption smoothing for each country.

The next section derives a simple theoretical framework of how international risk sharing is achieved and how can it be related to the empirical methods used. The following section describes the empirical method, the data and the results. The final section concludes the paper.

2 Risk sharing and international consumption smoothing: a simple theoretical model

The model presented is a "*demonstration model*" to illustrate how international risk sharing works and how can it be related to an empirical factor model. This section is divided into four subsections. The first presents a model where markets are complete and so risk sharing is complete too; the following considers that not all agents have access to the financial markets and so the risk sharing measured at country level is incomplete. The next section considers the case when only an international bond is traded and compares the results with those of the previous models. The last section considers the previous models in the presence of taste shocks, as this kind of shocks can account for the consumption correlation puzzle as is described by Stockman and Tesar (1995).

[10] The first to use a factor model to study this issue was Del Negro (2000), however the estimation methods used did not allow him to disentagle the parameters for individual regions.

2.1 Complete markets and full risk sharing

Consider an endowment economy with n different countries, where all produce the same internationally tradable homogeneous good, having in equilibrium the same GDP per capita ($\overline{Y}^i$). At each point the world economy is hit by a shock (ϵ_t^w) which causes world output (Y_t^w) to deviate from it's steady state ($\overline{Y}^w$):

$$Y_t^w = \overline{Y}^w(1+\epsilon_t^w) = \overline{Y}^w + \overline{Y}^w.\epsilon_t^w \tag{1}$$

Each country i is subject to this worldwide shock with different magnitudes that can vary through time (β_t^i) plus an asymmetric shock (ϵ_t^i):

$$Y_t^i = \overline{Y}^i(1+\beta_t^i.\epsilon_t^w + \epsilon_t^i) = \overline{Y}^i + \overline{Y}^i.\beta_t^i.\epsilon_t^w + \overline{Y}^i.\epsilon_t^i \tag{2}$$

such that $cov(\epsilon_t^w;\epsilon_t^i) = 0$. Aggregating the n economies we have that:

$$\begin{aligned} Y_t^w &= \sum_{i=1}^{n} Y_t^i = \sum_{i=1}^{n}\left(\overline{Y}^i + \overline{Y}^i.\beta_t^i.\epsilon_t^w + \overline{Y}^i.\epsilon_t^i\right) = \\ &= \sum_{i=1}^{n}\overline{Y}^i + \epsilon_t^w\sum_{i=1}^{n}\beta_t^i.\overline{Y}^i + \sum_{i=1}^{n}\overline{Y}^i.\epsilon_t^i \end{aligned} \tag{3}$$

Equating equations (3) and (1) :

$$\begin{cases} \sum_{i=1}^{n}\overline{Y}^i = \overline{Y}^w \\ \sum_{i=1}^{n}\beta_t^i.\overline{Y}^i = \overline{Y}^w \\ \sum_{i=1}^{n}.\overline{Y}^i.\epsilon_t^i = 0 \end{cases} \tag{4}$$

which implies that:

$$\frac{\sum_{i=1}^{n}\beta_t^i.\overline{Y}^i}{\sum_{i=1}^{n}\overline{Y}^i} = 1 \tag{5}$$

in words, the weighted average impact of the world shock is 1.

At each point in time, consumers in each economy will try to maximize their lifetime utility (small letters denote *per capita* values):

$$\max U_t = \max_{c_\tau^i} E_t \left(\sum_{\tau=t}^{+\infty} \delta^{\tau-t}.u(c_\tau^i) \right) \tag{6}$$

$$s.t: \sum_{i=1}^{n} P_i.y_\tau^i = \sum_{i=1}^{n} P_i.c_\tau^i$$

where: c_τ^i *per capita* consumption in country i

y_τ^i *per capita* output in country i and

P_i is the i^{th} country population and

E_t denotes the expectations at t. (7)

If we consider that there are complete asset markets, the optimal solution for each consumer would be equal to the social planner's problem that would maximize the sum of individual utilities:

$$\max \sum_{i=1}^{n} U_t^i = \max_{c_\tau^i} \sum_{i=1}^{n} w_i.E_t \left(\sum_{\tau=t}^{+\infty} \delta^{\tau-t}.u(c_\tau^i) \right) \tag{8}$$

$$s.t: \sum_{i=1}^{n} P_i.y_\tau^i = \sum_{i=1}^{n} P_i.c_\tau^i$$

$$w_i = \frac{P_i}{P_w}$$

where: P_w is the world population.

It can be shown that in this economy the agents consumption would depend only on the worldwide deviations from the equilibrium, and not on the asymmetric shocks. The first order conditions at each point in time of the problem depicted by (8) are:

$$\begin{cases} \frac{P_i}{P_w}\ u'(c_t^i) = P_i\lambda_t \Leftrightarrow\ u'(c_t^i) = P_w\lambda_t \\ \sum_{i=1}^{n} P_i.y_t^i = \sum_{i=1}^{n} P_i.c_t^i \end{cases} \tag{9}$$

The marginal utilities are all equalized, therefore $c_t^i = c_t^j$,implying[11]:

$$\begin{aligned} \sum_{i=1}^{n} P_i.y_t^i &= P_w.c_t^{i,*} \Leftrightarrow \\ &\Leftrightarrow c_t^{i,*} = \frac{Y_t^w}{P_w} \Leftrightarrow \\ &\Leftrightarrow P_i.c_t^{i,*} = P_i.\frac{Y_t^w}{P_w} \Leftrightarrow \\ &\Leftrightarrow C_t^{i,*} = w_i.Y_t^w \end{aligned} \tag{10}$$

and therefore:

$$C_t^{i,*} = w_i(\overline{Y}^w + \overline{Y}^w \epsilon_t^w) = \frac{P_i}{P_w}.(\overline{Y}^w + \overline{Y}^w.\epsilon_t^w) = \overline{Y}^i + \frac{P_i}{P_w}.\overline{Y}^w \epsilon_t^w \tag{11}$$

As GDP *per capita* in the steady state is equal across countries, then:

$$\frac{P_i}{P_w}.\overline{Y}^w = P_i.\overline{y}^w = \overline{Y}^i \tag{12}$$

Therefore equation (11) can be written as:

$$C_t^{i,*} = \overline{Y}^i + \overline{Y}^i.\epsilon_t^w \Leftrightarrow \Delta C_t^{i,*} = \epsilon_t^w \tag{13}$$

So, in this framework, the asymmetric shocks would be perfectly smoothed and consumption would respond to the worldwide average effect of the world shock and not to the specific impact on each country.

2.2 Limited participation in the financial markets

If we consider that in each country part of the population is excluded from the financial markets[12], living in financial autarky, the problem would have to be split into two parts: the optimization

[11] From now on the $*$ denotes the consumption level of the representative agent ($c_t^{i,*}$), the aggregate consumption country level ($C_t^{i,*}$), or the relative deviation from the steady state ($\Delta C_t^{i,*}$) when there is full risk sharing.

[12] Both internal and internationally. If they were able to access internal financial markets they could smooth consumption with the agents which have access to international markets. The latter would borrow more than they would need in order to lend to the other ones.

problem for the agents with access to financial markets (denoted by F) and for those who are living in financial autarky (denoted by FA) .

In this case we can define the world shock as the deviation of aggregate world income for agents with access to financial markets from its equilibrium:

$$Y_t^{w,F} = \overline{Y}^{w,F}(1+\epsilon_t^w) = \overline{Y}^{w,F} + \overline{Y}^{w,F}.\epsilon_t^w \tag{14}$$

Therefore in each economy, output evolves as:

$$Y_t^i = Y_t^{i,F} + Y_t^{i,FA} = \overline{Y}^{i,F}(1+\beta_t^i.\epsilon_t^w + \epsilon_t^i) + \overline{Y}^{i,FA}(1+\beta_t^i.\epsilon_t^w + \epsilon_t^i) \tag{15}$$

Linking equation (15) and (14) we have that:

$$\begin{cases} \sum_{i=1}^n \overline{Y}^{i,F} = \overline{Y}^{w,F} \\ \sum_{i=1}^n \overline{Y}^{i,F}\beta_t^i.\epsilon_t^w = \overline{Y}^{w,F}.\epsilon_t^w \Leftrightarrow \frac{\sum_{i=1}^n \overline{Y}^{i,F}\beta_t^i}{\overline{Y}^{w,F}} = 1 \\ \sum_{i=1}^n \overline{Y}^{i,F}.\epsilon_t^i = 0 \end{cases} \tag{16}$$

The world economy, as a whole, evolves as:

$$\begin{aligned} Y_t^w &= Y_t^{w,F} + Y_t^{w,FA} = \sum_{i=1}^n \left(Y_t^{i,F} + Y_t^{i,FA}\right) = \\ &= \sum_{i=1}^n \left[\overline{Y}^{i,F}(1+\beta_t^i.\epsilon_t^w + \epsilon_t^i) + \overline{Y}^{i,FA}(1+\beta_t^i.\epsilon_t^w + \epsilon_t^i)\right] = \\ &= \overline{Y}^w + \left(\overline{Y}^{w,F} + \sum_{i=1}^n \overline{Y}^{i,FA}\beta_t^i\right).\epsilon_t^w + \sum_{i=1}^n \overline{Y}^{i,FA}\epsilon_t^i \end{aligned}$$

Note that if the share of people living in financial autarky is zero we would be back with our initial problem depicted by equations (1) to (8).

Those who live in financial autarky would consume:

$$c_t^{i,FA} = \overline{y}^i + \overline{y}^i.\beta_t^i.\epsilon_t^w + \overline{y}^i.\epsilon_t^i \tag{17}$$

As for the financially integrated agents the problem can be set as a social planner maximization problem:

$$\max U_t = \max_{c^i_\tau} \sum_{i=1}^{n} s^i_F.E_t\left(\sum_{\tau=t}^{+\infty}\delta^{\tau-t}.u(c^{F,i}_\tau)\right) \tag{18}$$

$$s.t: \sum_{i=1}^{n} P_i.(1-s^i_{FA}).y^i_\tau = \sum_{i=1}^{n} P_i.(1-s^i_{FA}).c^{F,i}_\tau$$

where s^i_{FA} is the share of people living in financial autarky

and $c^{F,i}_\tau$ is the per capita consumption of the financially integrated people

maximizing the previous problem we would get that $c^{F,i}_t$ would be equal in all countries therefore:

$$\begin{aligned} c^{F,i}_t &= \frac{1}{\sum_{j=1}^{n}(P_j.s^j_F)}.\sum_{j=1}^{n}\left(P_j.y^j_t.s^j_F\right) = \\ &= \frac{1}{\sum_{j=1}^{n}(P_j.s^j_F)}.\sum_{j=1}^{n}\left(P_j.\overline{y}^j.(1+\beta^j_t.\epsilon^w+\epsilon^i).s^j_F\right) = \\ &= \frac{1}{\sum_{j=1}^{n}(P^F_j)}.\sum_{j=1}^{n}\left(\overline{Y}^{j,F}.(1+\beta^j_t.\epsilon^w+\epsilon^i)\right) = \end{aligned} \tag{19}$$

The overall consumption in the economy would be:

$$\begin{aligned} C^i_t &= C^{i,FA}_t + C^{i,F}_t = \\ &= \left(\overline{Y}^i + \overline{Y}^i.\beta^i_t.\epsilon^w_t + \overline{Y}^i\epsilon^{i,FA}_t\right).s^i_{FA} + \frac{P^F_i}{\sum_{j=1}^{n}(P^F_j)}.\sum_{j=1}^{n}\left(\overline{Y}^{j,F}.(1+\beta^j_t.\epsilon^w+\epsilon^i)\right) = \end{aligned} \tag{20}$$

from equation (16) $\sum_{j=1}^{n}\left(\overline{Y}^{j,F}.\varepsilon^i\right) = 0$ and $\sum_{i=1}^{n}\overline{Y}^{i,F}\beta^i_t = \overline{Y}^{w,F}$, therefore:

$$C^i_t = \left(\overline{Y}^{i,FA} + \overline{Y}^{i,FA}.\beta^i_t.\epsilon^w_t + \overline{Y}^{i,FA}\epsilon^{i,FA}_t\right) + \frac{P^F_i}{P^{w,F}}.\overline{Y}^{w,F}.(1+\epsilon^w) =$$

As GDP per capita in steady state is equal $\left(\frac{\overline{Y}^{w,F}}{P^{w,F}} = \frac{\overline{Y}^{i,F}}{P^F_i}\right)$, then:

$$C^i_t = \left(\overline{Y}^{i,FA} + \overline{Y}^{i,FA}.\beta^i_t.\epsilon^w_t + \overline{Y}^{i,FA}\epsilon^{i,FA}_t\right) + \overline{Y}^{i,F}.(\epsilon^w.+1) =$$

$$= \overline{Y}^i + \overline{Y}^i\left(\left(s^i_{FA}.\beta^i_t + s^i_F\right).\epsilon^w_t + s^i_{FA}.\epsilon^i_t\right)$$

Therefore the evolution of each economy can be characterized as:

$$
\begin{aligned}
Y_t^i &= \overline{Y}^i(1+\beta_t^i.\epsilon_t^w+\epsilon_t^i) \\
C_t^i &= \overline{Y}^i+\overline{Y}^i\left(\left(s_{FA}^i.\beta_t^i+s_F^i\right).\epsilon_t^w+s_{FA}^i.\epsilon_t^i\right)
\end{aligned} \tag{21}
$$

re-labeling $\overline{Y}^i=\overline{C}^i$[13] in the second expression and dividing each by the equilibrium level we get[14]:

$$
\begin{aligned}
\Delta Y_t^i &= \beta_t^i.\epsilon_t^w+.\epsilon_t^i \\
\Delta C_t^i &= \left(s_{FA}^i.\beta_t^i+s_F^i\right).\epsilon_t^w+s_{FA}^i.\epsilon_t^i
\end{aligned} \tag{22}
$$

The non-smoothed ratio would be: $\frac{\Delta C_t^i-\Delta C^{i,*}}{\Delta Y_t^i-\Delta Y^{w*}}$ where $\Delta C^{i,*}$ and ΔY^{w*} are, respectively, the deviation of consumption from the equilibrium for country i and the world output deviation from equilibrium if risk sharing was complete, which from the model in section 2.1 would be $\Delta C_t^*=\Delta Y_t^{w,*}=\epsilon_t^w$:

$$
\begin{aligned}
\frac{\Delta C_t^i-\Delta C_t^*}{\Delta Y_t^i-\Delta Y_t^w} &= \frac{\left[\left(s_{FA}^i.\beta_t^i+s_F^i\right).\epsilon_t^w+s_{FA}^i.\epsilon_t^i\right]-\left[\epsilon_t^w\right]}{\left[\beta_t^i.\epsilon_t^w+\epsilon_t^i\right]-\left[\epsilon_t^w\right]}= \\
&= \frac{s_{FA}^i.(\beta_t^i-1).\epsilon_t^w+s_{FA}^i.\epsilon_t^i}{(\beta_t^i-1).\epsilon_t^w+\epsilon_t^i}=s_{FA}^i.\frac{(\beta_t^i-1).\epsilon_t^w+\epsilon_t^i}{(\beta_t^i-1).\epsilon_t^w+\epsilon_t^i}=s_{FA}^i
\end{aligned} \tag{23}
$$

We obtain the same result if we build the previous ratio due to the asymmetric shock:

$$
\frac{\left[s_{FA}^i.\epsilon_t^i\right]-[0]}{\left[\epsilon_t^i\right]-[0]}=s_{FA}^i \tag{24}
$$

or due to the asymmetric impact of the world shock:

$$
\frac{\left[\left(s_{FA}^i.\beta_t^i+s_F^i\right).\epsilon_t^w\right]-\left[\epsilon_t^w\right]}{\left[\beta_t^i.\epsilon_t^w\right]-\left[\epsilon_t^w\right]}=\frac{\left(s_{FA}^i.(\beta_t^i)+s_F^i\right).\epsilon_t^w-(s_{FA}^i+s_F^i).\epsilon_t^w}{\beta_t^i.\epsilon_t^w-\epsilon_t^w}=\frac{s_{FA}^i.(\beta_t^i-1)}{(\beta_t^i-1)}=s_{FA}^i \tag{25}
$$

[13] As we are working with an endowment economy, in the steady state total consumption in country i is equal to its own total production.

[14] Note that, if the percentage of people with access to finantial markets is equal across countries, the consumption equation would be:

$$\Delta C_t^i=\epsilon_t^w+\epsilon_t^i.s_{FA}$$

2.3 Incomplete financial markets

The smoothing performance of the consumption behaviour depicted in the previous sections was done through international diversification of portfolios (in the national accounts this smoothing would be measured by comparing GDP with GNI). Even if complete markets do not exist, and there was only trade in an internationally bond, in an endowment economy, the same result holds as it is showed by Crucini(1999). In this case this smoothing would be measured by comparing DNI with Consumption. The problem for a given agent at time t would be:

$$\max U_t = \max_{c^i_\tau, b^i_\tau} E_t \left[\sum_{\tau=t}^{+\infty} \delta^{\tau-t}.u(c^i_\tau) \right] \tag{26}$$

$$\text{s.t.:} \qquad y^i_\tau + b^i_\tau \geq c^i_\tau + (1 + r_{\tau-1}).b^i_{\tau-1}$$

and the market clearing equations:

$$\begin{aligned} \sum_{i=1}^{n} P^i.c^i_\tau &= \sum_{i=1}^{n} P^w.y^i_\tau \\ \sum_{i=1}^{n} P^i.b^i_\tau &= 0 \end{aligned} \tag{27}$$

The first order conditions at each point t are :

$$\begin{cases} u'(c^i_t) = \lambda_t \\ \lambda_t = \delta.E_t \left[\lambda_{t+1}.(1 + r_t) \right] \end{cases} \tag{28}$$

... the Euler equation is ...

$$u'(c^i_t) = \delta.E_t \left[u'(c^i_{t+1}).(1 + r_t) \right]$$

Considering that the intertemporal discount factor (δ) and the interest rate (r) are equal for all agents independently of the country, then all of them will choose the same level of c^i_t. The first market clearing condition can be written as

$$c^{i,*}_t \sum_{i=1}^{n} P^i. = Y^w_t \Leftrightarrow c^{i,*}_t P^w = Y^w_t \Leftrightarrow c^{i,*}_t = \frac{Y^w_t}{P^w} \tag{29}$$

Calculating each country aggregate consumption :

$$C_t^{i,*} = P^i.\frac{Y_t^w}{P^w}$$

which is the same condition as the one depicted in equation (11).

So, if we restrict the financial market participation and redefine the world shock accordingly, as we did in section 2.3, we will obtain the same results as the ones of that subsection.

2.4 Impact of taste shocks

Finally assume that in the complete markets model we insert additive taste shocks φ_τ^i :

$$\begin{aligned} \max U_t &= \max_{c_\tau^i} E_t \left(\sum_{\tau=t}^{+\infty} \delta^{\tau-t}.u\left(c_\tau^i \left(1+\frac{\varphi_\tau^i}{c_\tau^i}\right)\right)\right) \quad (30) \\ s.t &: \sum_{i=1}^{n} P_i.y_\tau^i = \sum_{i=1}^{n} P_i.c_\tau^i \end{aligned}$$

The first order conditions at time t are:

$$\begin{cases} u'(c_t^i+\varphi_t^i) = \lambda_t \\ \sum_{i=1}^{n} P_i.y_t^i = \sum_{i=1}^{n} P_i.c_t^i \end{cases} \quad (31)$$

So c_t^i+ φ_t^i is equalized across countries (re-label as ct_t) , so $c_t^i = ct_t - \varphi_t^i$, so from the clearing market equation:

$$\begin{aligned} \sum_{i=1}^{n} P_i.y_t^i &= \sum_{i=1}^{n} P_i.\left(ct_t - \varphi_t^i\right) \Leftrightarrow \quad (32) \\ &\Leftrightarrow \sum_{i=1}^{n} P_i.y_t^i = ct_t \sum_{i=1}^{n} P_i - \sum_{i=1}^{n} P_i.\varphi_t^i = \\ &\Leftrightarrow Y^w = ct_t.P_w - \sum_{i=1}^{n} P_i.\varphi_t^i \Leftrightarrow ct_t = y^w + \frac{1}{P_w}\sum_{i=1}^{n} P_i.\varphi_t^i \end{aligned}$$

which implies:

$$\begin{aligned}
C_t^i &= P_i.y^w + \frac{P_i}{P_w}\sum_{i=1}^{n} P_i.\varphi_t^i - P_i.\varphi_t^i = \\
&= P_i\left(\overline{y}^w + \overline{y}^w.\epsilon_t^w\right) + \frac{P_i}{P_w}\sum_{i=1}^{n} P_i.\varphi_t^i - P_i.\varphi_t^i = \\
&= \overline{Y}^i + \overline{Y}^i.\epsilon_t^w + P_i.\left(\overline{\varphi}_t^w - \varphi_t^i\right) \\
&\Leftrightarrow \Delta C_t^i = \epsilon_t^w + P_i.\frac{\left(\overline{\varphi}_t^w - \varphi_t^i\right)}{\overline{C}^i}
\end{aligned} \tag{33}$$

where $\overline{\varphi}_t^i$ represents the worldwide average taste shock.

If we consider that part of the population is living in financial autarky the problem for those with access to the financial markets may be written as:

$$\begin{aligned}
\max U_t &= \max_{c_\tau^{F,i}} E_t\left(\sum_{\tau=t}^{+\infty} \delta^{\tau-t}.u\left(c_\tau^{F,i}\left(1+\frac{\varphi_\tau^i}{c_\tau^{F,i}}\right)\right)\right) \\
s.t &: \sum_{i=1}^{n} P_i^F.y_\tau^i = \sum_{i=1}^{n} P_i^F.c_\tau^{F,i}
\end{aligned} \tag{34}$$

Solving the problem gives that:

$$C_t^{F,i} = \overline{Y}^i s_F + \overline{Y}^i.s_F.\epsilon^w + \frac{\overline{\varphi}^{w.F} - \varphi^{F,i}}{\overline{Y}^i}.P_i^F \tag{35}$$

where $\overline{\varphi}^{w,F}$ is the world weighted average of the taste shock of the people with access to financial markets and equal to $\frac{\sum_{i=1}^{n} P_i^F.\varphi^{F,i}}{\sum_{i=1}^{n} P_i^F}$.

The people that live in financial autarky will consume their income:

$$C_t^{FA,i} = \overline{Y}^i s_{FA} + \overline{Y}^i.\beta_i.\epsilon^w.s_{FA} + \overline{Y}^i.\epsilon^i.s_{FA} \tag{36}$$

Aggregating terms gives:

$$C_t^i = \overline{Y}^i + \overline{Y}^i.(s_F + \beta_i.s_{FA}).\epsilon^w + \overline{Y}^i.\epsilon^i.s_{FA} + \left(\overline{\varphi}^{w.F} - \varphi^{F,i}\right).P_i^F \tag{37}$$

consumption and output deviation are:

$$\begin{cases} \Delta Y_t^i = \beta_t^i.\epsilon_t^w + \epsilon_t^i \\ \Delta C_t^i = (s_F + \beta_i.s_{FA}).\epsilon^w + \epsilon^i.s_{FA} + \frac{\overline{\varphi}^{w,F} - \varphi^{F,i}}{\overline{C}^i}.P_i \end{cases} \tag{38}$$

Note that if we compute the share of non-smoothed consumption, applying directly the formula of equation (23) we would get:

$$\begin{aligned} \frac{\Delta C_t^i - \Delta C_t^*}{\Delta Y_t^i - \Delta Y_t^w} &= \frac{\left[(s_F + \beta_i.s_{FA}).\epsilon^w + \epsilon^i.s_{FA} + \frac{\overline{\varphi}^{w,F} - \varphi^{F,i}}{\overline{C}^i}.P_i\right] - \left[\epsilon_t^w + P_i.\frac{\left(\overline{\varphi}_t^w - \varphi_t^i\right)}{\overline{C}^i}\right]}{\left[\beta_t^i.\epsilon_t^w + .\epsilon_t^i\right] - \left[\epsilon_t^w\right]} = \\ &= s_{FA+}\frac{\left[\frac{\overline{\varphi}^{w,F} - \overline{\varphi}_t^w}{\overline{C}^i}.P_i\right] + \left[\frac{\left(\varphi_t^{i,F} - \varphi_t^i\right)}{\overline{C}^i}\right]}{\left[\left(\beta_t^i - 1\right).\epsilon_t^w + .\epsilon_t^i\right]} \end{aligned}$$

Therefore the taste shocks might produce a bias if the taste shocks of people with access to the financial markets are different from those living in financial autarky ($\varphi_t^{i,F} \neq \varphi_t^i$) or if the world weighted average of the taste shock differs from the world weighted average of the taste shock of the people with access to financial markets:

$$\overline{\varphi}^{w,F} \neq \overline{\varphi}_t^w \Leftrightarrow \frac{\sum_{i=1}^n P_i^F.\varphi^{F,i}}{\sum_{i=1}^n P_i^F} \neq \frac{\sum_{i=1}^n P_i.\varphi_t^i}{P_W}$$

So to calculate the non-smoothed ratio of consumption we have to use the national asymmetric shock or the differentiated impact of the world shock as in equations (24) or (25).

The models presented in this section are simple but their main purpose is to show how can the level of international risk sharing be estimated. More complex models, with a production function and capital as in Baxter and Crucini (1995) or Kollman(1996), with trade costs as in Mazenga and Ravn(2004) or endogenous tradability as in Melitz and Ghironi (2004) do not yield a closed form solution. However from their simulations we can see that those extensions do not solve the consumption correlation puzzle.

3 The empirical study

In this section we will show how the consumption smoothing implied by the previous model can be estimated and present the results. The next subsection will present the link between the theoretical model and the empirical methodology. The next subsection will describe the data and the following presents the empirical results.

3.1 The methodology

The model in equation (38), has a natural empirical counterpart in a factor model:

$$\Delta x_{j,t}^{i} = \lambda_{j}^{i,w}.F_{t}^{w} + \lambda_{j}^{i}.F_{t}^{i} + \varepsilon_{j,t}^{i} \tag{39}$$

where F_t^w and F_t^i would be, respectively, the global factors that would affect all the series of all countries (the world shocks) and the country i factor affecting the series of each country (the asymmetric country shocks), $\lambda_j^{i,w}$ is the loading of the world factor on series j of country i, λ_j^i is the loading of the country i factor on series j and $\varepsilon_{i,t}^{j}$ would represent the idiosyncratic components of each series[15].

Connecting the model of equation (38) with the factor equation of (39) we have for output:

$$\begin{aligned} \text{World component:} \quad & \beta_t^i.\epsilon_t^w = \lambda_y^{i,w}.F_t^w \\ \text{National Component:} \quad & \epsilon_t^i = \lambda_y^i.F_t^i \\ \text{Idiosyncratic component: } [\varnothing] = \quad & \varepsilon_{y,t}^i \end{aligned} \tag{40}$$

and for consumption:

$$\begin{aligned} \text{World component :} \quad & \left(s_{FA}^i.\beta_t^i + s_F^i\right).\epsilon_t^w = \lambda_c^{i,w}.F_t^w \\ \text{National Component :} \quad & s_{FA}.\epsilon_t^i = \lambda_c^i.F_t^i \\ \text{Idiosyncratic component} \quad : \quad & .\frac{\overline{\varphi}^{w,F} - \varphi^{F,i}}{\overline{C}^i}.P_i = \varepsilon_{c,t}^i \end{aligned} \tag{41}$$

in the end, the consumption smoothing parameter from the theoretical model is $1 - s_{FA}$. As

[15] In case of the consumption they can represent the taste shocks depicted in equation (38) that would alter the consumption level but are unrelated to shocks in total production.

we saw in the theoretical model this value can be obtained in several ways; however, from the estimation method we can recover it from the comparison of the national components:

$$b = 1 - s_{FA} = 1 - \frac{\left[s^i_{FA}.\epsilon^i_t\right]}{\left[\epsilon^i_t\right]} = 1 - \frac{\lambda^i_c F^i_t}{\lambda^i_y F^i_t} = 1 - \frac{\lambda^i_c}{\lambda^i_y} \tag{42}$$

To estimate the different channels of consumption smoothing we will use the same channels as described by Sorensen and Yosha (1998b). Therefore the smoothing from GDP to Gross National Income(GNI) will be considered as the one that is achieved due to international portfolio diversification or the asset markets channel. The smoothing from GNI to National Income (NI) measures the smoothing due to the variation of capital depreciation. The third layer is from NI to Disposable National Income (DNI), this will take into consideration international transfers from countries that are experiencing booms to ones that are experiencing recessions (this layer is more likely to exist among regions that have a joint budget like the states of US). Finally the last channel, due to the credit market/saving channel, is measured from DNI to Private Consumption (C).

Therefore the estimated factor model will be:

$$\begin{cases} \Delta GDP^i_t = \lambda^{i,w}_{GDP}.F^w_t + \lambda^i_{GDP}.F^i_t + \varepsilon^i_{GDP,t} \\ \Delta GNI^i_t = \lambda^{i,w}_{GNI}.F^w_t + \lambda^i_{GNI}.F^i_t + \varepsilon^i_{GNI,t} \\ \Delta NI^i_t = \lambda^{i,w}_{NI}.F^w_t + \lambda^i_{NI}.F^i_t + \varepsilon^i_{NI,t} \\ \Delta DNI^i_t = \lambda^{i,w}_{DNI}.F^w_t + \lambda^i_{DNI}.F^i_t + \varepsilon^i_{DNI,t} \\ \Delta C^i_t = \lambda^{i,w}_{C}.F^w_t + \lambda^i_{C}.F^i_t + \varepsilon^i_{C,t} \end{cases} \tag{43}$$

where:

$$\begin{bmatrix} A(L)F^w_t = \epsilon^w_t \text{ and } \epsilon^w_t \sim N(0,\sigma^w) \\ A(L)F^i_t = \epsilon^i_t \text{ and } \epsilon^i_t \sim N(0,\sigma^j) \\ A(L)\varepsilon^i_{j,t} = u^i_{j,t} \text{ and } u^i_{j,t} \sim N(0,\sigma^i_j) \end{bmatrix} \text{and} \begin{bmatrix} E(\epsilon^w_t.\epsilon^i_t) = 0 \\ E(\epsilon^{i_1}_t.\epsilon^{i_2}_t) = 0 \\ E(\epsilon^w_t.u^i_{j,t}) = 0 \\ E(\epsilon^i_t.u^i_{j,t}) = 0 \\ E(u^{i_1}_{j_1,t}.u^{i_2}_{j_2,t}) = 0 \end{bmatrix} \text{for } j_1 \neq j_2 \text{ and } i_1 \neq i_2$$

with:

$i = 1, 2, 3, ..., N$ (countries)

$t = 1, 2, 3, ..., T$ (time frame)

$j = GDP, GNI, NI, DNI, C$

The model is patterned as a dynamic factor model as in Stock and Watson (1999), the dynamics enter through the fact that the factors are AR processes as the dependence of the series on the factor is static[16].

At this point we should note that the scale of the loadings and the factors cannot be estimated independently, therefore, we opted for normalizing the variance of the world and country factors to a constant.

As for the idiosyncratic components, one interpretation is that they are errors of measurement. However for that to be true, they would have to be independent across series. As GNI is derived from GDP , NI from GNI and DNI from NI, if we have an error measurement in one series it will contaminate all the series that are derived from it and mixed in the national component. Moreover the international transfers used to build the GNI, the NI and the DNI have to be consistent across countries. Errors of measurement in one country will also contaminate the other countries series. It is probable that most errors of measurement are mixed in the world and national components. The only way to be able to capture those errors would be to have data from two independent sources of the same aggregate which is not, in most cases, available. As for consumption they can be considered as a mix of errors of measurement and, as we saw before, taste shocks.

We should, also, note that if we estimate the model of equation (43) the national component will only be captured if it is not perfectly risk shared by portfolio diversification. If there is perfect risk sharing, the national shock to GDP will be captured in the idiosyncratic component and the model won't estimate any national component. Moreover, we can also assume that

[16] More general dynamic factor models(GDFM) where the relationship between the factors and the series is dynamic can be found in Forni et al. (2002).

national shocks to GDP are composed by several parts where some are completely risk-shared and will be captured in the idiosyncratic component and the others in the national component.

Also, for the other aggregates (GNI, NI, DNI) there might exist some shocks specific to those series that are completely smoothed at the following level; therefore, those components will be captured in the idiosyncratic component.

In order to take into account these aspects the estimated consumption smoothing at each layer should not only take into account the estimated national components but also the estimated idiosyncratic ones. Therefore the formulas used should be:

via international portfolio diversification (layer GDP/GNI):

$$\widehat{b}_f = 1 - \frac{cov(\lambda^i_{GDP}.F^i_t + \varepsilon^i_{GDP,t}\ ,\ \lambda^i_{GNI}.F^i_t)}{var(\lambda^i_{GDP}.F^i_t + \varepsilon^i_{GDP,t})} = \tag{44}$$

as the idiosyncratic component and the factors are orthogonal, the covariance and the variance can be written as:

$$= 1 - \frac{cov(\lambda^i_{GDP}.F^i_t\ ,\ \lambda^i_{GNI}, F^i_t) + cov(\varepsilon^i_{GDP,t}\ ,\ \lambda^i_{GNI}.F^i_t)}{var(\lambda^i_{GDP}.F^i_t) + var(\varepsilon^i_{GDP,t})} = 1 - \frac{\lambda^i_{GDP}.\lambda^i_{GNI}.var(F^i_t)}{\left(\lambda^i_{GDP}\right)^2 var(.F^i_t) + var(\varepsilon^i_{GDP,t})}$$

via depreciation of capital (layer GNI/NI):

$$\widehat{b}_d = 1 - \frac{\lambda^i_{GNI}.\lambda^i_{NI}.var(F^i_t)}{\left(\lambda^i_{GNI}\right)^2 .var(F^i_t) + var(\varepsilon^i_{GNI,t})} \tag{45}$$

via international transfers (layer NI/DNI):

$$\widehat{b}_t = 1 - \frac{\lambda^i_{NI}.\lambda^i_{DNI}.var(F^i_t)}{\left(\lambda^i_{NI}\right)^2 .var(F^i_t) + var(\varepsilon^i_{NI,t})} \tag{46}$$

via savings (layer DNI/C):

$$\widehat{b}_s = 1 - \frac{\lambda^i_{DNI}.\lambda^i_{C}.var(F^i_t)}{\left(\lambda^i_{DNI}\right)^2 .var(F^i_t) + var(\varepsilon^i_{DNI,t})} \tag{47}$$

and total smoothing (layer GDP/C):

$$\widehat{b}_{total} = 1 - \frac{\lambda^i_{GDP}.\lambda^i_C.var(F^i_t)}{\left(\lambda^i_{GDP}\right)^2.var(.F^i_t) + var(\varepsilon^i_{GDP,t})} \tag{48}$$

Note that if there is no idiosyncratic component on the GDP the above equation is:

$$\widehat{b}_{total} = 1 - \frac{\lambda^i_{GDP}.\lambda^i_C.var(F^i_t)}{\left(\lambda^i_{GDP}\right)^2.var(F^i_t)} = 1 - \frac{\lambda^i_{GDP}.\lambda^i_C}{\left(\lambda^i_{GDP}\right)^2} = 1 - \frac{\lambda^i_C}{\lambda^i_{GDP}}$$

which is exactly the same as equation (42).

To estimate this model and making inference we opted to use Otrok and Whiteman's(1998) approach[17]. This approach allow us to compute the ratio at each iteration recovering, in the end, the distribution of the smoothing parameter. However this approach has strong assumptions, as for instance the innovations not being cross-correlated and we cannot guarantee that the idiosyncratic components of consumption are not cross-correlated in the presence of taste shocks. From equation (41) the idiosyncratic component of the consumption deviation of country i is:

$$\left(\frac{\sum_{j=1}^n \left(P^F_j.\varphi^{F,j}\right)}{\sum_{j=1}^n P^F_j} - \varphi^{F,i}\right).\frac{P_i}{\overline{C}^i}.$$

Therefore if we assume that $\varphi^{F,j}$ are i.i.d. with variance equal to σ^2_φ the variance of this term is:

$$\left(\frac{\sum_{j=1}^n \left(P^F_j\right)^2 \sigma^2_\varphi}{\left(\sum_{j=1}^n P^F_j\right)^2} + \sigma^2_\varphi\right) \cdot \left(\frac{P_i}{\overline{C}^i}\right)^2$$

as the covariance of it between two countries is:

$$\frac{\sigma^2_\varphi}{\overline{c}^i.\overline{c}^j}\left[\frac{\sum_{s=1}^n (P_s)^2}{(P_w)^2} - \frac{P_i}{P_w} - \frac{P_j}{P_w}\right]$$

[17] An alternative approach would be the one described by Bai (2003). Bai's method is valid for a larger array of models; however, inference is only valid when $N, T \to +\infty$ (or in more stringent cases when $N, T \to +\infty$ when $\sqrt{N}/T \to 0$). However the estimation of the smoothing parameters is rather complex, as they are ratios involving several estimators, and with the Bai approach we can only have the asymptotic distribution of the parameters in the model and not for the smoothing ratios.

If we consider that all countries are equally populated we would have for the variance:

$$\left(\frac{n.\sigma_{\varphi}^{2}}{n^{2}}+\sigma_{\varphi}^{2}\right).\left(\frac{P_{i}}{\overline{C}^{i}}\right)^{2}=\left(\frac{\left(n+n^{2}\right).\sigma_{\varphi}^{2}}{n^{2}}\right).\left(\frac{P_{i}}{\overline{C}^{i}}\right)^{2}=\frac{\left(1+n\right).\sigma_{\varphi}^{2}}{n}.\left(\frac{P_{i}}{\overline{C}^{i}}\right)^{2}$$

and for the covariance:

$$-\frac{\sigma_{\varphi}^{2}}{\overline{c}^{i}.\overline{c}^{j}}.\frac{1}{n}$$

So as $n \to \infty$ the covariance tends to zero and the variance tends to $\sigma_{\varphi}^{2}.\left(\frac{P_{i}}{\overline{C}^{i}}\right)^{2}$, therefore the correlation tends to zero. So, at least, these idiosyncratic components are asymptotically not cross correlated.

Because Otrok and Whiteman's approach can be used to compute the smoothing ratios distributions while it is recovering the parameters distributions and at least asymptotically the idiosyncratic terms of the consumption deviations are not cross correlated we opted to use this one[18].

3.2 The data used

To estimate the equations of the model implied by equation (43) we used annual data from 1970 to 2001 for a sample of 23 countries[19] of OECD. The data collected were those of GDP, GNI, NI, DNI and private consumption at current prices taken from the OECD Main Indicators 2003. Then we calculated the *per capita* values at constant prices using the population and consumption price index taken from the same source.[20].

Afterwards we de-trended the data in order to take the deviation cycles. We used a band pass filter as is described in Artis et al. (2003) and retain the fluctuations between 2 and 8 years. This interval follows Baxter and King (1999), as they used the interval between 6 and 32 months (in year terms 1.5 and 8).

[18] See appendix A for a short description of the method.

[19] The countires used were: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany , Greece, Ireland, Italy, Japan, South Korea, Mexico, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States .

The data for Germany was corrected for the break in 1990 by the OECD Secretariat.

[20] It should be noted that we did not transform the data by accounting the purchasing power parity. We can think that some risk sharing can be done through relative price movements. This transformation and comparision with the present results are left for future work.

We should note that the same study can be done with different cycle intervals. This might allow us to see how the consumption smoothing differs when we use different time horizons.

3.3 Results

From the method used we can get as a by-product a measure of the world business cycle and its importance relative to the national one in the different series. This analysis allows us to compare the estimated world business cycle with those from other studies and see if they coincide. We can, also, check if the relative importance of the national component versus the world one diminishes when we move from GDP to Consumption. This will give us a first idea of how much smoothing is done through the different channels. These points will be the subject of the first part. The second part will report the estimation of the smoothing parameters for the different countries in the sample, and a third subsection will relate the differences found to different economic and financial indicators.

3.3.1 Business cycle symmetry

Figure (1) displays the median of the estimated world component[21], as well as the 33^{rd} and 66^{th} percentile[22] of the estimations.

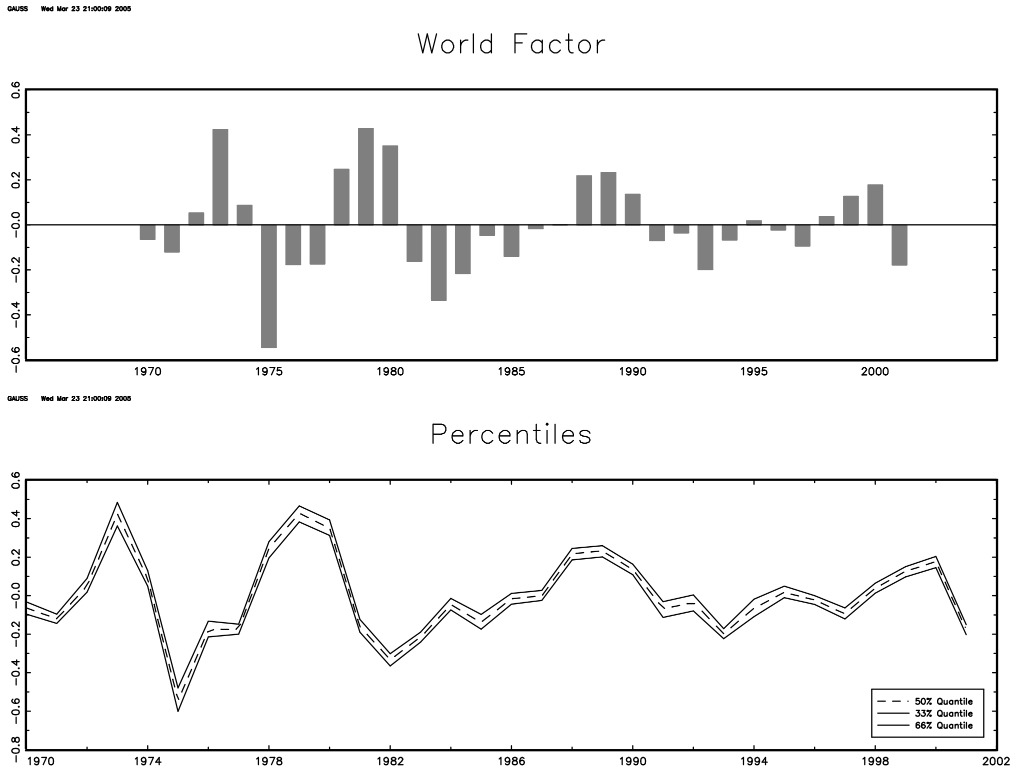
From this figure we can see that the estimation shows troughs on 1975, 1982/85, 1991/1993 and a recession in 2001. It depicts peaks in 1973, 1979, 1989, 1995 and 2000. There is also a period covering all the eighties were the world economy was in a downturn cycle.

These estimates are similar to other estimates using different methods. Gregory et al. (1997) studying the G7 countries with quarterly data from 1970:1 to 1993:4, found recessions in 1975, 1982 and a slowdown in the early nineties, upturns in the early and late seventies and late eighties. They also found during the mid-eighties a long period where the cycle deviation was negative. Helbling and Bayoumi (2003) when estimating the G7 weighted gap using GDP quarterly data from 1973 to 2000 found troughs in 1974, 1982, 1986 and 1992 and peaks in 1978/1979, 1985, 1990 and 2000. Their sample end also depicts a slowdown, even if it is much smaller than the

[21] As we said before, the size and signal of the loadings and of the factors are not estimable idependently of each other. As for the size we fixed the variance of the factors as explained before. As for the signal we considered that the world component would have a positive loading for the US GDP, and the national components a positive loading for the respective country's GDP.

[22] This percentile choice follows Otrok and Whiteman(1998).

Figure 1: World business cycle



one illustrated in our figure. Cerqueira(2005) using national indexes constructed from GDP, GFCF and consumption from 1970 to 2000 found that the first estimated common component[23] peaks in 1973, 1980, 1990 and 2000 and has troughs in 1975, 1983/6, 1993 and also reflects the slowdown at the beginning of the new millennium. Kose et al.(2003) using the same method for GDP, investment and consumption from 1960 to 1990 found similar results. The biggest difference was the relative size of the recession after the first oil crisis in respect to the one after the second oil crisis. They found the crisis in the eighties stronger than the one in the seventies, which was in contrast to most papers in the literature.

Table 1 shows the importance of the world factor for the different series.

[23]It should be recalled that Helbling and Bayoumi(2003) and Cerqueira(2005) found that the world business cycle was composed by two orthogonal factors. However, as the variance decompositions estimated by Cerqueira showed the second component was not as all as encompassing as the first, in fact it was only important for US, Germany and some german neighbours. The approach used in this paper allows for one common component, the second one, if exists, will be mingled in the national components. However, as the second component is not as global as the first we can think that the countries to which some of the cycle deviations are caused by it can smooth those deviations with the countries that are little or not affected by it.

Table 1: Importance of the World factor in the series variance, 1970-2001

	GDP			GNI			NI			DNI			Consumption		
	1/3	Med.	2/3	1/3	Med.	2/3	1/3	Med.	2/3	1/3	Med.	2/3	1/3	Med.	2/3
Aus	.094	.113	.137	.094	.112	.132	.086	.105	.126	.089	.108	.13	.003	.008	.019
Aut	.379	.436	.477	.379	.434	.475	.393	.449	.488	.416	.471	.511	.024	.033	.041
Bel	.559	.586	.619	.551	.578	.613	.633	.662	.693	.645	.675	.707	.29	.333	.378
Can	.171	.208	.254	.17	.207	.254	.185	.224	.273	.185	.224	.273	.261	.293	.342
Dnk	.154	.184	.207	.181	.214	.241	.204	.239	.268	.204	.239	.269	.034	.047	.061
Fin	.133	.154	.18	.14	.16	.186	.143	.163	.187	.141	.162	.185	.145	.159	.176
Fra	.602	.64	.672	.648	.688	.717	.661	.7	.731	.676	.717	.748	.301	.332	.356
Ger	.502	.567	.605	.527	.589	.627	.537	.599	.639	.687	.751	.785	.252	.296	.332
Gre	.298	.335	.359	.286	.324	.348	.27	.307	.33	.279	.315	.337	.241	.275	.297
Ire	.473	.509	.533	.479	.51	.535	.418	.447	.471	.469	.503	.526	.593	.614	.633
Ita	.361	.397	.433	.43	.466	.5	.506	.544	.58	.507	.543	.578	.188	.215	.249
Jap	.391	.433	.466	.383	.426	.459	.399	.446	.48	.4	.448	.481	.327	.364	.39
Kor	.029	.035	.041	.038	.044	.05	.028	.034	.039	.03	.036	.041	.006	.01	.015
Mex	.049	.063	.079	.058	.072	.089	.049	.061	.076	.052	.064	.079	.062	.077	.092
Nth	.466	.498	.523	.539	.572	.595	.525	.56	.581	.513	.545	.568	.431	.476	.51
Nzl	.109	.128	.152	.12	.139	.163	.123	.143	.167	.122	.142	.166	.098	.116	.14
Nor	.017	.023	.03	.008	.012	.017	.001	.003	.005	.001	.003	.006	.005	.009	.015
Por	.152	.18	.213	.174	.202	.235	.154	.183	.216	.239	.275	.316	.069	.087	.106
Spa	.333	.373	.416	.337	.377	.419	.379	.421	.463	.389	.43	.472	.165	.196	.237
Swe	.052	.068	.085	.079	.098	.118	.078	.097	.117	.076	.095	.115	.027	.033	.041
Swi	.378	.42	.46	.4	.437	.479	.418	.45	.487	.424	.455	.491	.374	.431	.478
UK	.494	.538	.57	.457	.502	.534	.448	.492	.523	.45	.495	.523	.46	.492	.519
US	.485	.528	.555	.511	.552	.577	.509	.549	.574	.514	.553	.578	.399	.443	.476

If we compare the median value across series, we can see that when we move from GDP to GNI, and from NI to DNI the sensitivity of the series to the world component, on average, increases, indicating that those channels of international risk sharing (through portfolio diversification in the first case and international transfers in the second) seem to be working. However, when moving from DNI to Consumption, the majority of the countries experience a decrease in the sensitivity to the world factor (the exceptions are Canada, Ireland, Mexico and Norway but for the last two the dependence of the world component is very weak for any series). Even if this replicates the consumption correlation puzzle, the fact is that it does not mean that there is no smoothing through the savings channel, as that sensitivity reduction can be due to the existence of errors of measurement on the consumption or taste shocks (either would reduce the sensitivity of consumption but not of DNI to the world component).

On the other hand, if we check for which countries the GDP commoves more with the world cycle, those are Belgium, Germany, Ireland, France, UK and US (with more than 50%) Austria, Japan, Netherlands and Switzerland (between 50 and 40%) and Greece, Italy and Spain (between 30% and 40%).

The importance of the national component on the variance of each series can be seen in table 2. As we saw in the model, if perfect risk sharing existed, through portfolio diversification, the importance of the national component in GNI should be very small. In fact we can see that the values are close to the ones for the GDP, reflecting that here is hardly any consumption smoothing of the national shocks due to portfolio diversification. The second channel (the savings mechanism) reflects a different story. When comparing the importance of the national component for DNI and Consumption we can see that in most countries (the exceptions are France, Germany, Italy and Spain[24]) consumption is less affected by this component than is DNI. This reduction is, however, not equal among all the countries. There are substantial reductions in some, as for instance New Zealand, Norway and Ireland, whilst for others it is very small, as in the case of the US (where the 33rd to 66th percentile interval of the variance decomposition of the national component in DNI and Consumption overlap).

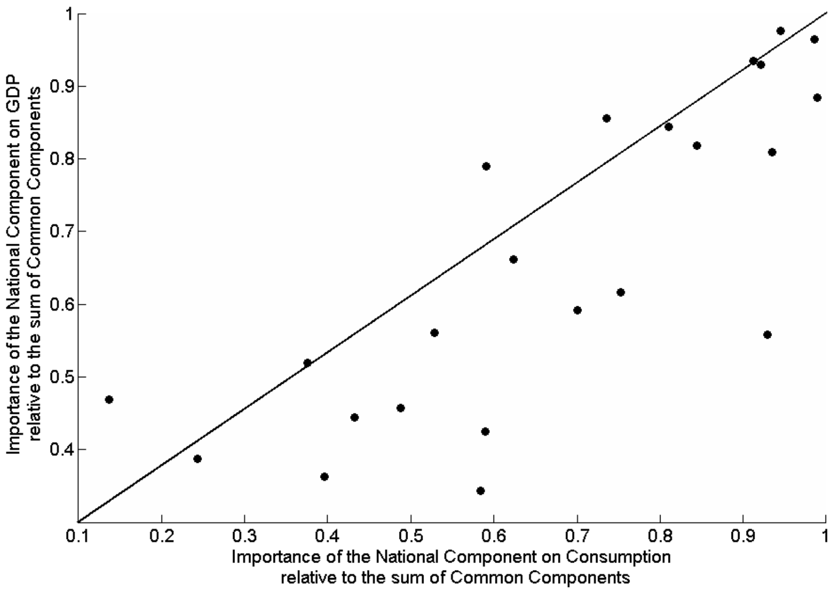
The question that arises from the two previous tables is how can the consumption be less

[24] Only for Italy and spain do the 33rd to 66th percentile interval of the importance of this component for either series overlap each other.

Table 2: Importance of the National factor in the series variance, 1970-2001

	GDP			GNI			NI			DNI			Consumption		
	1/3	Med.	2/3	1/3	Med.	2/3	1/3	Med.	2/3	1/3	Med.	2/3	1/3	Med.	2/3
Aus	.835	.859	.878	.853	.874	.892	.873	.894	.913	.869	.891	.910	.687	.702	.710
Aut	.510	.550	.607	.519	.559	.615	.507	.546	.602	.482	.521	.577	.415	.431	.449
Bel	.302	.333	.362	.338	.374	.401	.302	.333	.362	.286	.317	.348	.168	.218	.279
Can	.735	.781	.818	.743	.790	.828	.724	.774	.813	.725	.775	.814	.379	.423	.455
Dnk	.759	.782	.812	.755	.782	.815	.728	.757	.793	.721	.751	.786	.660	.676	.690
Fin	.806	.832	.853	.810	.836	.857	.812	.836	.856	.813	.837	.858	.661	.680	.694
Fra	.303	.335	.374	.277	.306	.345	.265	.295	.335	.246	.277	.318	.434	.465	.501
Ger	.379	.418	.483	.368	.406	.469	.356	.395	.458	.181	.214	.276	.384	.425	.472
Gre	.632	.656	.693	.650	.674	.712	.669	.692	.729	.657	.680	.715	.434	.456	.490
Ire	.425	.450	.485	.457	.481	.512	.519	.542	.572	.433	.457	.492	.086	.097	.114
Ita	.539	.576	.612	.490	.524	.560	.412	.449	.486	.412	.447	.483	.464	.503	.534
Jap	.520	.553	.598	.529	.562	.608	.514	.548	.594	.512	.546	.593	.383	.408	.446
Kor	.945	.951	.958	.945	.952	.958	.954	.960	.966	.954	.959	.965	.677	.686	.692
Mex	.880	.896	.910	.897	.914	.928	.922	.938	.950	.920	.935	.948	.790	.804	.819
Nth	.292	.315	.347	.395	.417	.450	.412	.434	.468	.424	.446	.478	.131	.153	.190
Nzl	.734	.758	.779	.821	.845	.864	.828	.852	.873	.828	.852	.872	.302	.323	.340
Nor	.941	.948	.953	.971	.976	.980	.993	.996	.998	.993	.996	.997	.153	.155	.157
Por	.774	.807	.836	.758	.791	.820	.776	.809	.838	.657	.697	.733	.431	.470	.493
Spa	.557	.600	.641	.571	.614	.655	.534	.576	.618	.524	.567	.608	.550	.595	.628
Swe	.877	.894	.909	.875	.895	.914	.882	.902	.921	.884	.904	.922	.380	.388	.396
Swi	.413	.453	.495	.502	.543	.580	.511	.548	.580	.506	.543	.574	.220	.259	.306
UK	.400	.431	.476	.461	.493	.538	.472	.503	.548	.466	.494	.539	.347	.375	.409
US	.417	.444	.487	.419	.444	.485	.423	.448	.488	.416	.442	.481	.388	.422	.469

Figure 2: Relative size of the national component to the sum of world and national component



dependent on the world cycle than GDP (giving rise to the consumption correlation puzzle), but at the same time be also less dependent from the national component (indicating that there is some risk-sharing and consumption smoothing across countries)? The answer is that, for consumption the idiosyncratic component of the series is much more important than for the other series. This may reflect errors of measurement or taste shocks. That is what we can observe in table (3).

We can see that for all series, except consumption, the idiosyncratic component is very small (except for the GDP of Netherlands, N. Zealand and Switzerland). For consumption the figure is quite different, ranging from 11.9% for Mexico to 83.5% for Norway.

These last tables allow us to analyze the existence or not of a consumption correlation puzzle. We have seen before that consumption is subject to more idiosyncratic shocks (that can come from taste shocks or measurement errors) than GDP. The question is to know what are the relative sizes if we compare only the national and world component. Figure (2) presents the relationship of the relative size of the national component to the sum of the common components (world plus national) for GDP and consumption.

Table 3: Importance of the idiosyncratic component in the series variance, 1970-2001

	GDP			GNI			NI			DNI			Consumption		
	1/3	Med.	2/3	1/3	Med.	2/3	1/3	Med.	2/3	1/3	Med.	2/3	1/3	Med.	2/3
Aus	.027	.028	.029	.014	.014	.015	.000	.001	.001	.001	.001	.001	.282	.289	.295
Aut	.012	.013	.014	.004	.005	.006	.004	.004	.005	.006	.007	.008	.520	.534	.548
Bel	.076	.081	.084	.045	.048	.051	.002	.003	.005	.004	.005	.007	.403	.437	.453
Can	.010	.011	.012	.002	.003	.003	.001	.002	.002	.001	.001	.002	.279	.285	.290
Dnk	.032	.034	.036	.003	.004	.005	.003	.003	.004	.009	.010	.011	.268	.276	.285
Fin	.013	.014	.015	.003	.003	.004	.001	.001	.001	.001	.001	.002	.160	.162	.163
Fra	.023	.024	.026	.004	.005	.006	.003	.003	.005	.004	.005	.006	.199	.208	.220
Ger	.014	.015	.016	.002	.003	.004	.003	.004	.005	.032	.035	.039	.277	.283	.289
Gre	.008	.009	.009	.001	.001	.002	.001	.001	.002	.005	.005	.006	.267	.268	.270
Ire	.039	.041	.043	.006	.008	.010	.009	.010	.012	.038	.041	.043	.274	.285	.295
Ita	.024	.028	.032	.008	.010	.012	.005	.006	.008	.007	.009	.012	.272	.281	.291
Jap	.009	.017	.019	.008	.014	.016	.002	.004	.009	.002	.004	.009	.220	.230	.235
Kor	.012	.013	.015	.003	.004	.005	.005	.006	.007	.004	.005	.006	.293	.302	.313
Mex	.041	.042	.042	.013	.014	.014	.001	.001	.001	.001	.001	.001	.118	.119	.120
Nth	.180	.184	.188	.009	.010	.011	.005	.006	.007	.007	.008	.009	.357	.368	.379
Nzl	.110	.114	.117	.014	.016	.018	.003	.004	.005	.004	.005	.006	.549	.557	.564
Nor	.028	.029	.031	.011	.012	.013	.001	.001	.001	.001	.001	.001	.830	.835	.839
Por	.012	.013	.014	.005	.006	.007	.007	.008	.009	.025	.028	.030	.403	.440	.489
Spa	.025	.027	.028	.008	.009	.010	.001	.002	.003	.002	.002	.003	.206	.211	.218
Swe	.038	.038	.039	.007	.008	.008	.001	.001	.001	.001	.001	.001	.577	.579	.580
Swi	.123	.125	.127	.018	.018	.019	.001	.001	.002	.001	.002	.003	.297	.308	.317
UK	.029	.030	.031	.003	.004	.005	.003	.004	.005	.009	.010	.011	.128	.131	.134
US	.026	.027	.028	.002	.003	.004	.001	.002	.003	.003	.004	.005	.131	.134	.136

If in fact consumption is less dependent on the national shocks than on the world shocks, then we should find the markers above the 45^0 degree line. On the contrary, if there was a clear consumption correlation puzzle we would find most of the markers bellow the 45^0 line. From the figure we can see that the number of markers bellow and above the 45^0 line is more or less equal and most are very close to that line. This indicates that once we account for the idiosyncratic components of the series the consumption correlation across countries is similar to that for GDP.

3.3.2 Consumption smoothing channels

From the previous section, it seems that countries engage in partial consumption smoothing through the savings channel, while the smoothing by portfolio diversification is very small or even non-existent. To look into more detail at the importance of each channel, table 4 show the estimated values[25] for the different smoothing channels using the formulas in equations (44) to (48).

As we can see from table (4), the amount of consumption smoothing achieved by international portfolio diversification ($\widehat{\beta}_f$) is small for most countries. The countries for which this channel is more important are Belgium (17.4%), France (8.8%), Italy (5.4%) and US (5.2%). However for a number of countries, this channel, has an unsmoothing effect: Netherlands (-16.4%), Sweden (-10.4%) , Portugal (-8.8%), Denmark (-6.0%), Finland (-5.5%) and Norway (-4.9%). From these lists, it seems that the countries that smooth more trough this channel are big countries (with the exception of Belgium) or countries where the GDP dependence on the world cycle is higher, but it does not include all of them (in that group Italy is the one for which the GDP is less related with the world component, 39.7%). The countries that unsmooth through this channel are small and/or with a lower dependence from the world component (the exception is Netherlands which is also the biggest one with 15,92 million inhabitants in 2000).

As for the second channel (variation of capital depreciation - $\widehat{\beta}_d$), it has an unsmoothing effect on all countries (being Norway the smallest with -0.06% and Finland the biggest with -14.1%). This is in line with previous studies(see referenced papers in footnote 8).

International transfers are not important for most countries. The fact that international

[25] In Appendix B we can see the 5^{th}, 10^{th}, 20^{th}, 25^{th}, 33^{th}, 50^{th} (the median), 66^{th}, 75^{th}, 80^{th}, 90^{th} and 95^{th} percentiles.

Table 4: Importance of Consumption Smoothing channels, 1970-2001

	β_f			β_d			β_t			β_s			β_{total}		
	.33	Med.	.66	.33	Med.	.66	.33	Med.	.66	.33	Med.	.66	.33	Med.	.66
Aus	-.010	.006	.023	-.059	-.049	-.040	-.005	-.002	.001	.397	.424	.450	.357	.387	.417
Aut	-.012	.000	.012	-.055	-.044	-.033	.023	.033	.045	.170	.228	.284	.145	.205	.262
Bel	.133	.174	.213	.022	.054	.085	-.033	-.019	-.006	.309	.406	.507	.375	.462	.550
Can	-.008	.001	.010	-.085	-.080	-.074	-.003	.001	.005	.527	.558	.589	.487	.521	.555
Dnk	-.077	-.060	-.043	-.148	-.139	-.130	-.001	.009	.019	-.017	.025	.068	-.237	-.185	-.131
Fin	-.069	-.055	-.040	-.149	-.141	-.134	-.011	-.007	-.003	.524	.540	.555	.420	.439	.459
Fra	.064	.088	.111	-.096	-.082	-.067	.001	.016	.031	.241	.295	.353	.263	.307	.351
Ger	.004	.025	.046	-.098	-.085	-.071	.218	.268	.308	.159	.228	.297	.241	.288	.336
Gre	.012	.021	.031	-.042	-.038	-.034	-.015	-.008	-.001	.542	.566	.590	.529	.553	.578
Ire	.011	.033	.054	-.062	-.047	-.030	-.022	.000	.021	.341	.396	.452	.297	.357	.416
Ita	.035	.054	.072	-.115	-.097	-.079	-.013	.000	.012	.124	.177	.231	.055	.110	.166
Jap	-.029	-.011	.014	-.149	-.108	-.053	.001	.006	.012	.269	.303	.336	.169	.211	.250
Kor	-.056	-.045	-.034	-.073	-.064	-.055	.014	.022	.030	.104	.145	.186	.011	.056	.101
Mex	-.016	.000	.016	-.117	-.107	-.097	.010	.013	.016	.164	.191	.217	.072	.103	.134
Nth	-.237	-.164	-.094	-.138	-.123	-.109	-.019	-.005	.009	.488	.544	.597	.320	.386	.453
Nzl	-.042	-.017	.008	-.091	-.078	-.065	-.014	-.006	.003	.584	.613	.641	.529	.562	.595
Nor	-.073	-.049	-.027	-.197	-.185	-.174	-.031	-.027	-.023	.793	.829	.865	.731	.778	.825
Por	-.101	-.087	-.073	-.027	-.015	-.003	.106	.127	.146	.580	.635	.688	.565	.621	.676
Spa	-.041	-.021	-.003	-.081	-.067	-.054	-.007	-.002	.003	.200	.252	.304	.109	.165	.224
Swe	-.123	-.104	-.084	-.113	-.104	-.095	-.006	-.002	.001	.409	.444	.479	.270	.314	.359
Swi	-.060	-.028	.007	-.022	-.006	.010	.016	.020	.024	.551	.600	.652	.536	.586	.642
UK	-.054	-.033	-.012	-.100	-.090	-.080	-.006	.007	.020	.192	.230	.267	.072	.118	.163
US	.037	.052	.066	-.134	-.127	-.120	-.001	.006	.013	.273	.327	.396	.221	.279	.353

transfers aren't important for most countries is not surprising as this channel would depict the transfers made across states through international aid to catastrophes, automatic stabilizers through common budgets if they existed and private sector remittances[26]. In this sample, the only common budget arrangement is the one that encompasses the EU countries, but it is not built to provide automatic stabilization, therefore, even for most of the EU countries the effects are small. In the countries studied the exceptions are Germany with 26.8% (the biggest net contributor to the EU budget and an immigrant receiver) and Portugal with 12.7%. (one of the cohesion countries and a country that is at the same time an immigrant receiver - from the former African colonies - and an emigrant provider - mostly to France, Germany, USA and South America).

The bulk of the smoothing is done through the final channel, savings and credit markets $(\widehat{\beta}_s)$[27]. But the importance of it is not the same in every country. For some it smooths more than 50% of the cycle deviations- Norway (82.9%), Portugal (63.5%), New Zealand (61.3%), Switzerland (60%), Greece (56.6%) , Canada (55.8%), Netherlands (54.4%), and Finland (54%). For others it account for less than 20% - Denmark (2.5%), Italy (17.7%) South Korea(14.5%) and Mexico (19.1%).

Finally, comparing total smoothing from GDP to private consumption, the groups of countries that smooth more and less mimics the groups formed from the importance of the credit market channel as this one was the more important and heterogeneous[28].

3.3.3 Possible relations with economic and financial indicators

At this point we can raise the question as to why the values are different across countries[29]. One obvious justification would be the importance of the world component in the countries GDP cycle. We could think that the more a country commoves with the world cycle the less it has to

[26] Account code D75 of the 1993 SNA, see http://unstats.un.org/unsd/sna1993/toctop2.asp.
Previous studies about this issue have disregarded the existence of these private remmitances at this level. A more accurate look to these transfers might be a issue of future research.

[27] Moreover if we add to this, the fact that the importance of the national component for the consumption and GDP in respect to the sum of the common components (national plus world) is similar - see figure (2) - we can suspect that most of the smoothing is due to intertemporal smoothing and not by using the international credit markets.

[28] The total smoothing parameter does not have to be equal to the sum of the other parametres as at each level the idiosyncratic component of the series is considered in the smoothing process.

[29] The analysis presented are simple correlations between the median values founded and several indicators. They should be read as indicators of the differences found and directions that deserve further research.

gain by entering into smoothing mechanisms. Figures (3) and (4) show the relation between the importance of the world component for the GDP cycles and the smoothing parameters through asset markets ($\widehat{\beta}_f$) and credit markets ($\widehat{\beta}_s$).

From the first graph we can see that there is a positive relationship between the importance of the World cycle on the national GDPs and the total smoothing through the capital markets. The R^2 of the linear regression is 0.2318 and the parameters are significant at 5% level.

The second figure gives the impression that there is an inverse relationship, but the R^2 is only 0.0603 and the estimated parameters are insignificant at 5% level.

So, the idea that countries that commove less with the world cycle would smooth more is not confirmed, and if any relationship exists is through the asset markets but positive (the ones that commove more also smooth more through this channel).

A second idea that we could take from the previous tables, would be that there could be a relation between country size and consumption smoothing as most of the countries that have higher smoothing values through the savings/credit markets are small ones.

Figures (5) and (6) depict the relationship between population size and the consumption smoothing channels.

Although the regression lines seem to depict some relationships the R^2 are 7.95% and 11.95% and the parameters are insignificant at 5% level. However if we take out the US, the first relationship (asset markets channel vs population) continues to be unimportant, but the second (savings/credit market channel vs population) has a R^2 of 25.02% and the parameter is significantly negative at 5% level.

Another relationship that we can consider is the degree of openness[30]. We could think that countries that have a higher degree of openness are more financially integrated and have easier access to the capital markets and/or international credit markets.

Figures (7) and (8) depict the relationship between openness and the consumption smoothing channels.

From the first graph we can see that there is no relationship between the openness level and the smoothing through the capital markets. The R^2 of the linear regression is 0.0011 and the

[30]The openess indicator was calculated by averaging the ratio of (exports+imports)/GDP from 1970 to 2000.

Figure 3: Relation between the importance of the World component on the GDP cycle and the consumption smoothing through the asset markets

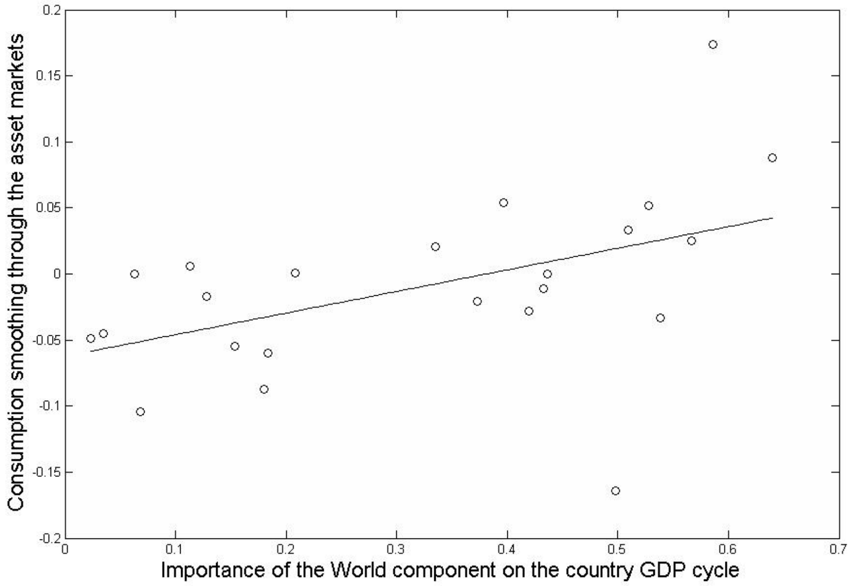


Figure 4: Relation between the importance of the World component on the GDP cycle and the consumption smoothing through the savings and credit markets

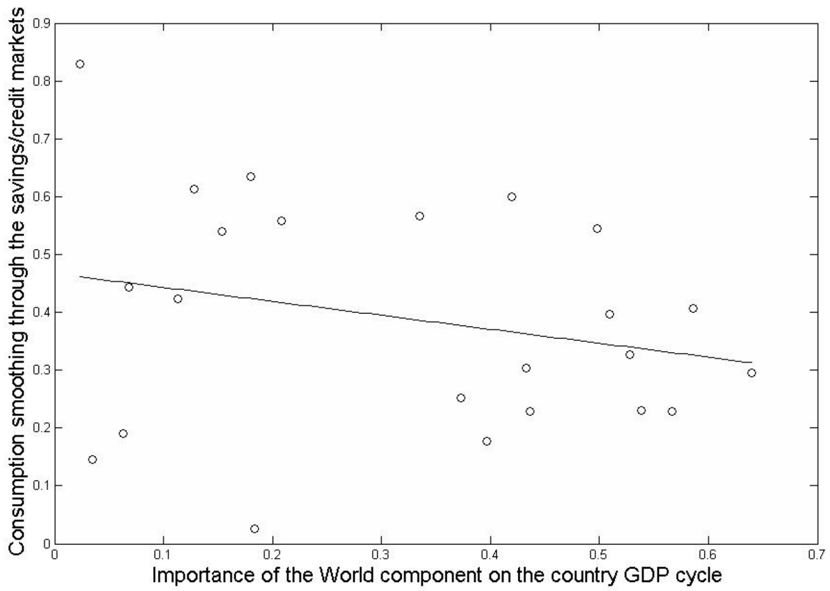


Figure 5: Relation between the population size and consumption smoothing through the asset markets

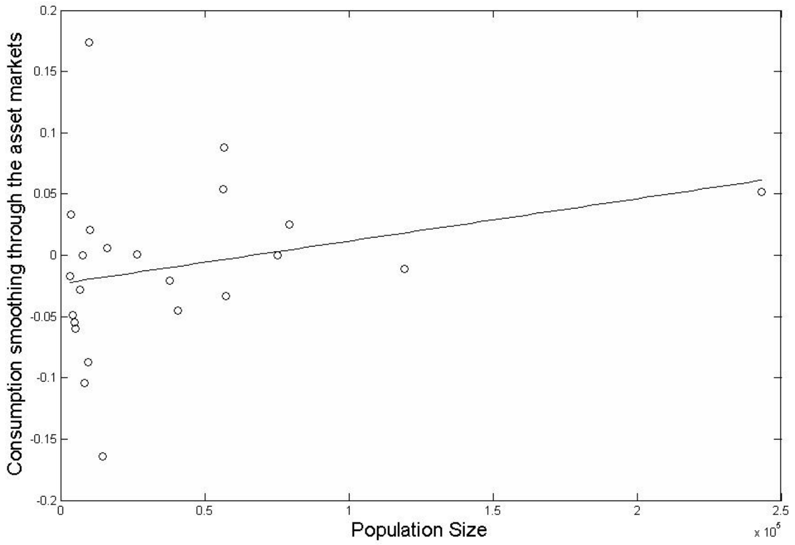


Figure 6: Relation between the population size and consumption smoothing through the savings and credit markets

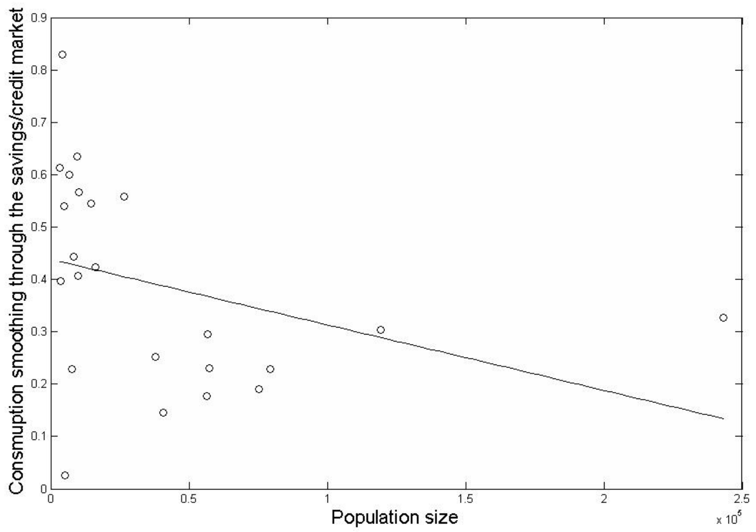


Figure 7: Relation between openness and consumption smoothing through the asset markets

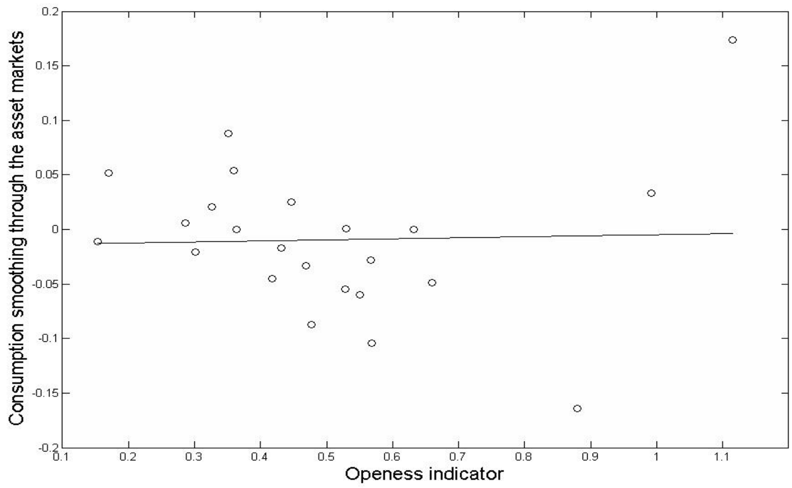
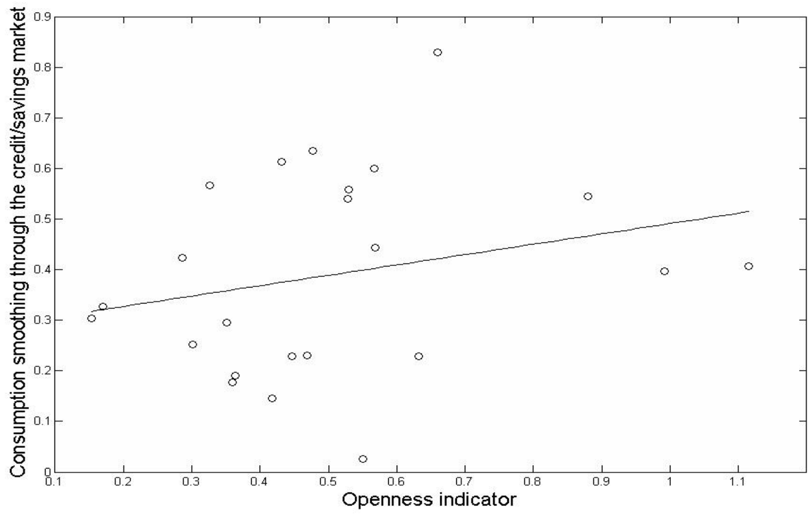


Figure 8: Relation between openness and the consumption smoothing through the savings and credit markets



regression parameter is zero. However, if we do the same regression without the three countries that have a higher level of openness (Belgium - 1.11 , Ireland - 0.99 and Netherlands -0.88), there is a negative relationship between openness and the smoothing channel. The R^2 is 0.2848 and the parameter is negative at 5% significance level.

The second figure gives the impression that there is a positive relationship, but the R^2 is only 0.0612 and the estimated parameters are insignificant at 5% level. If we do the same regression without the same countries as before, the R^2 increases to 0.092 but the estimated parameters continue to be insignificant.

Finally, and because the two main channels of consumption smoothing discussed in papers are through portfolio diversification and savings, we tried to relate the values found with some indicators of the financial structure of the countries studied. The indicators used were taken from the database on Financial Development and Structure revised in October 2003, for a description of this database see Beck and all.(1999), and the dataset on Bank Concentration & Competition[31]. However, from the whole batch of indicators few seemed to be significant.

As concerning the portfolio diversification channel only the 'Public bond market capitalization to GDP' indicator had a significant correlation with R^2 of 0.204, however the result was overmost due to the values of Belgium. If we do the same regression without Belgium the relation is insignificant at 5%.(see figure (9) - dotted line represents the regression without Belgium).

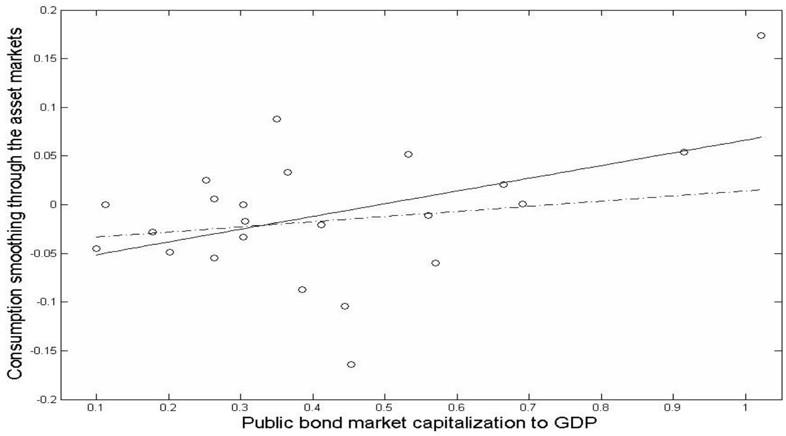
For the savings/credit market channel seems that the only significant indicators are : Net interest margin ($R^2 = 0.2259$) and Concentration ($R^2 = 0.2124$) (see figures(10) and (11)[32]).

From the first graph it seems that the more efficient are the commercial banks into channeling funds from savers to investors the more able are agents to use the savings/credit market to smooth the consumption through the business cycle.On the other side the relationship between concentration and consumption smoothing is positive. The concentration indicator might have two interpretations: highly concentrated commercial banking sector might result in lack of competitive pressure to attract savings and channel them efficiently to investors or a highly fragmented market might be evidence for undercapitalized banks. From the relationship depicted

[31] The indicator list used from each database and the weblink are transcribed in appendix C.

[32] The indicators of entry denials showed to be significant with a negative correlation. However most of the countries had a zero value for this index and the correlation coeficents were basically due to two or three countries.

Figure 9: Relation between Public bond market capitalization to GDP and consumption smoothing through the asset markets



by the graph it seems that a higher level of concentration actually improves the ability of agents to smooth consumption, it therefore appears that fears of a highly concentrated market leading to a reduction in efficiency may be misplaced.

4 Conclusion

In conclusion, we can say that the results found are in the aggregate not different from those existing in the literature. Asset markets are marginally important (if we aggregate the data the world value is zero), capital depreciation contributes to unsmooth consumption (-8% at world level), international transfers are not important (0% for the world) and the bulk of consumption is done through the savings/credit market mechanism (at the world level this accounts for 39%).

However these aggregations hide some differences among countries. Smoothing through the asset markets channel ranges from -17.4% to 16.4%, as the international transfers (with the exception of Germany and Portugal) are zero for most countries. The savings channel ranges from 2.5% to 82.9%.

When we tried to see to which indicators we could relate to those differences, we found that the asset markets channel is positively related with the importance of the world component in the country cycles and negatively (when we take out Belgium, Netherlands and Ireland) related

Figure 10: Relation between Net Interest Margin and consumption smoothing through the savings/credit market

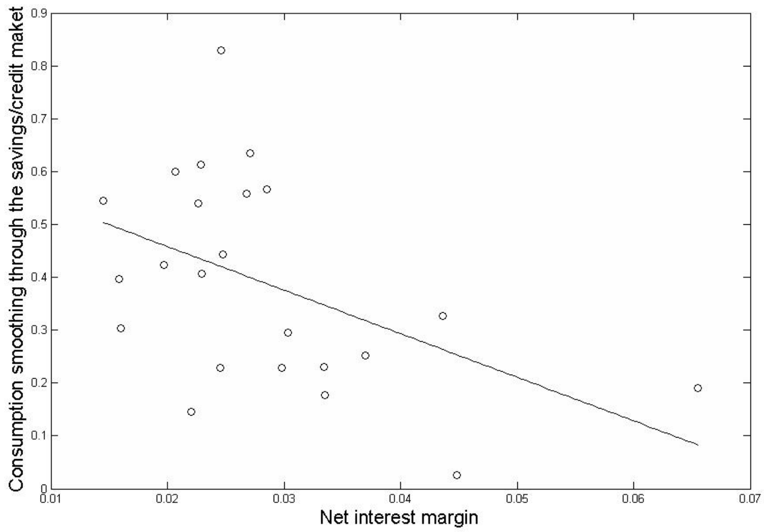
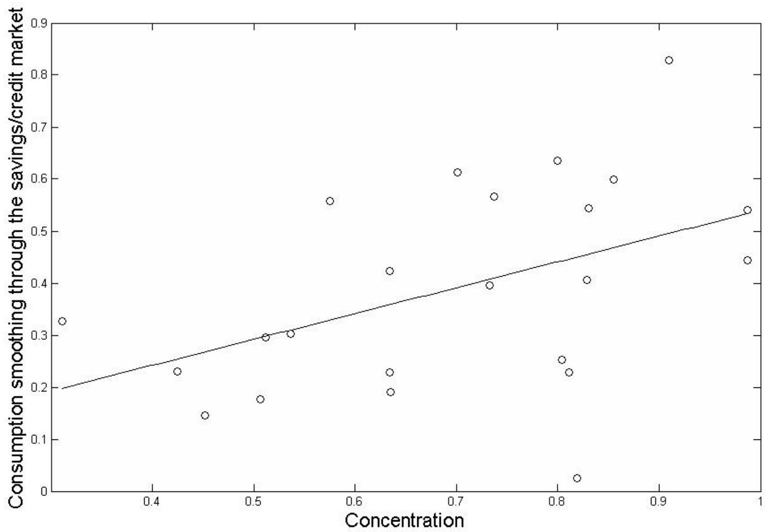


Figure 11: Relation between Concentration and consumption smoothing through the savings/credit market



to the degree of openness. Both results can be considered unexpected. First, we should think that the less important is the world component in the national cycle, the more the country has to gain from engaging in risk sharing through portfolio diversification, but we found the inverse relationship. As for the second result we might think that the more open is a country, the more integrated it is and therefore it would have easier access to international asset markets, however this hypothesis is not only not confirmed but, if anything, we found the inverse relationship.

When we did the same analysis for the saving channel we only found a negative relationship with the population size (when we do not consider US) indicating that smaller countries smooth more through this channel. This can be seen as expected, as smaller countries have a smaller impact on international credit markets and can lend/borrow to/from more agents.

On the other hand, when we relate the results to financial indicators we did not find any indicator that would be related to the asset market channel. This might indicate that the reasons for the differences through this channel are insensitive to financial market structure or that the indicators used do not capture the relevant differences to explain the heterogenous values found for this channel. As for the saving mechanism, we found that the indicator of efficiency (net interest margin) and of market structure (concentration) were related to this channel. More efficient banks (lower net interest margin) and a more concentrated market structure would lead to a more efficient consumption smoothing through the savings/credit channel.

However the previous relations should be read as indications of what is causing the heterogeneity found across countries on the smoothing mechanisms and which directions deserve further research.

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A Empirical methodology

The estimation of model depicted by equation (43) is accomplished through a MonteCarlo Markov Chain applied to dynamic factor models, as is described by Otrok and Whiteman(1998) and Kose et al. (2003).

If we consider a specification of a Gaussian probability density for the data $\{y_t\}$ conditional on a set of latent parameters $\{\varphi\}$ and a set of latent variables $\{f_t\}$, call this density function $g_y(Y|\varphi, F)$. In addition there is a Gaussian probability density function $g_f(F)$ for the F itself. Given a prior distribution for φ, $h(\varphi)$, the joint posterior distribution for the parameters and the latent variables (the factors) is: $h(\varphi, F|Y) = g_y(Y|\varphi, F) * g_f(F) * h(\varphi)$.

Otrok and Whiteman(ibidem) showed that, although $h(\varphi, F|Y)$ is hard to derive, under a conjugate prior for φ we can get $h(\varphi|F, Y)$ and $h(F|\varphi, Y)$.

So starting with a guess for F^0 (in the support of the posterior distribution) we generate a random drawing for φ^1 from $h(\varphi|F^0, Y)$. Then get a random drawing F^1 from $h(\varphi|F^1, Y)$

The sample produced is a realization of a Markov chain whose invariant distribution is the joint posterior $h(\varphi, F|Y)$.

In this paper we have an intermediate factor (the national factor) therefore the estimation was done in the following steps:

1. Get a guess for world factor (F_W^0) and country factors (F_C^0) in the support of their distributions. The priors used were $N(0, \sigma_i^2)$. For the world factor the variance was fixed to the average of the variances of all series, for the country factors it was fixed to the average of the variances of the countries series. Remember that the size of the loadings and the factors cannot be estimated independently By fixing the variance of the factors we also fix the size of the loadings.

2. Draw a random drawing φ^1 from $h(\varphi|F_W^0, F_C^0, Y)$

3. Draw a random drawing F_W^1 from $h(F_W|\varphi^1, F_C^0, Y)$

4. Draw a random drawing F_C^1 from $h(F_C|\varphi^1, F_W^1, Y)$

5. Go to step 2.

This iteration was done 100000 times, and then we eliminate the first 30000 iterations. The distributions were taken from the last 70000 iterations. We tried with smaller chain lengths, but from 10000 (eliminating the first 5000) onward the results were similar.

As in Kose et al.(ibidem) the prior used on the loadings was a $N(0,1)$ .The length of the idiosyncratic and factor autoregressive polynomials was 3 (I tried with larger polynomial orders with final similar results). The prior on the autoregressive polynomials parameters was $N(0,\Sigma)$ with $\Sigma = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0.5 & 0 \\ 0 & 0 & 0.25 \end{bmatrix}$ .As in Otrok and Whiteman(ibidem) the prior on the innovation variances in the observable equation is an Inverted Gamma(6,0.001).

For more details see the above cited papers.

B Estimated percentiles of the smoothing parameters distributions

In the next pages we can see the percentiles of the smoothing parameters distributions . In those tables the symmetric interval around the median where the parameter keeps the signal is in bold.

Table B1: bf - Asset market channel

	Percentile										
	1/20	1/10	1/5	1/4	1/3	1/2	2/3	3/4	4/5	9/10	19/20
Aus	-0.062	-0.045	-0.027	-0.020	-0.010	**0.006**	0.023	0.032	0.039	0.056	0.070
Aut	-0.049	-0.037	-0.024	-0.019	-0.012	**0.000**	0.012	0.019	0.024	0.038	0.049
Bel	**0.007**	**0.047**	**0.092**	**0.109**	**0.133**	**0.174**	**0.213**	**0.235**	**0.250**	**0.288**	**0.319**
Can	-0.040	-0.029	-0.018	-0.014	-0.008	**0.001**	0.010	0.016	0.020	0.031	0.041
Dnk	-0.123	**-0.109**	**-0.093**	**-0.087**	**-0.077**	**-0.060**	**-0.043**	**-0.032**	**-0.025**	**-0.005**	0.012
Fin	-0.111	**-0.098**	**-0.083**	**-0.078**	**-0.069**	**-0.055**	**-0.040**	**-0.032**	**-0.027**	**-0.012**	0.001
Fra	**0.003**	**0.020**	**0.042**	**0.051**	**0.064**	**0.088**	**0.111**	**0.123**	**0.132**	**0.154**	**0.172**
Ger	-0.047	-0.032	-0.014	-0.007	**0.004**	**0.025**	**0.046**	0.059	0.068	0.091	0.110
Gre	-0.015	-0.007	**0.003**	**0.006**	**0.012**	**0.021**	**0.031**	**0.037**	**0.040**	0.050	0.059
Ire	-0.055	-0.035	-0.010	-0.002	**0.011**	**0.033**	**0.054**	0.066	0.074	0.096	0.114
Ita	-0.020	-0.002	**0.017**	**0.025**	**0.035**	**0.054**	**0.072**	**0.082**	**0.090**	0.109	0.126
Jap	-0.141	-0.096	-0.050	-0.040	-0.029	**-0.011**	0.014	0.031	0.043	0.073	0.101
Kor	**-0.086**	**-0.077**	**-0.066**	**-0.062**	**-0.056**	**-0.045**	**-0.034**	**-0.029**	**-0.025**	**-0.013**	**-0.004**
Mex	-0.063	-0.049	-0.031	-0.025	-0.016	**0.000**	0.016	0.025	0.031	0.047	0.060
Nth	-0.470	-0.397	**-0.312**	**-0.281**	**-0.237**	**-0.164**	**-0.094**	**-0.058**	**-0.033**	0.030	0.080
Nzl	-0.110	-0.090	-0.066	-0.056	-0.042	**-0.017**	0.008	0.023	0.033	0.060	0.082
Nor	-0.143	-0.123	**-0.097**	**-0.087**	**-0.073**	**-0.049**	**-0.027**	**-0.014**	**-0.006**	0.015	0.031
Por	**-0.144**	**-0.131**	**-0.115**	**-0.110**	**-0.101**	**-0.087**	**-0.073**	**-0.065**	**-0.059**	**-0.044**	**-0.031**
Spa	-0.104	-0.083	-0.060	-0.052	**-0.041**	**-0.021**	**-0.003**	0.008	0.015	0.036	0.055
Swe	**-0.178**	**-0.161**	**-0.142**	**-0.134**	**-0.123**	**-0.104**	**-0.084**	**-0.073**	**-0.065**	**-0.044**	**-0.027**
Swi	-0.144	-0.120	-0.089	-0.077	-0.060	**-0.028**	0.007	0.028	0.044	0.091	0.141
UK	-0.115	-0.096	-0.074	-0.066	**-0.054**	**-0.033**	**-0.012**	0.000	0.008	0.031	0.051
US	**0.008**	**0.006**	**0.022**	**0.028**	**0.037**	**0.052**	**0.066**	**0.075**	**0.080**	**0.094**	**0.105**

Table B2: bd – Capital depreciation

	Percentile										
	1/20	1/10	1/5	1/4	1/3	1/2	2/3	3/4	4/5	9/10	19/20
Aus	**-0.086**	**-0.077**	**-0.068**	**-0.064**	**-0.059**	**-0.049**	**-0.040**	**-0.035**	**-0.031**	**-0.021**	**-0.012**
Aut	**-0.092**	**-0.079**	**-0.066**	**-0.061**	**-0.055**	**-0.044**	**-0.033**	**-0.028**	**-0.023**	**-0.013**	**-0.004**
Bel	-0.134	-0.071	-0.015	**0.001**	**0.022**	**0.054**	**0.085**	**0.102**	0.115	0.147	0.175
Can	**-0.104**	**-0.098**	**-0.091**	**-0.089**	**-0.085**	**-0.080**	**-0.074**	**-0.070**	**-0.068**	**-0.061**	**-0.053**
Dnk	**-0.174**	**-0.166**	**-0.157**	**-0.153**	**-0.148**	**-0.139**	**-0.130**	**-0.125**	**-0.122**	**-0.112**	**-0.104**
Fin	**-0.173**	**-0.166**	**-0.157**	**-0.154**	**-0.149**	**-0.141**	**-0.134**	**-0.129**	**-0.126**	**-0.119**	**-0.113**
Fra	**-0.134**	**-0.122**	**-0.109**	**-0.104**	**-0.096**	**-0.082**	**-0.067**	**-0.058**	**-0.052**	**-0.035**	**-0.022**
Ger	**-0.135**	**-0.124**	**-0.110**	**-0.105**	**-0.098**	**-0.085**	**-0.071**	**-0.064**	**-0.058**	**-0.043**	**-0.031**
Gre	**-0.052**	**-0.049**	**-0.045**	**-0.044**	**-0.042**	**-0.038**	**-0.034**	**-0.032**	**-0.031**	**-0.026**	**-0.023**
Ire	-0.107	-0.093	**-0.077**	**-0.071**	**-0.062**	**-0.047**	**-0.030**	**-0.021**	**-0.015**	0.002	0.017
Ita	**-0.175**	**-0.156**	**-0.134**	**-0.126**	**-0.115**	**-0.097**	**-0.079**	**-0.070**	**-0.063**	**-0.045**	**-0.030**
Jap	-0.203	-0.189	-0.170	**-0.162**	**-0.149**	**-0.108**	**-0.053**	**-0.033**	**-0.022**	0.002	0.019
Kor	**-0.099**	**-0.091**	**-0.082**	**-0.078**	**-0.073**	**-0.064**	**-0.055**	**-0.050**	**-0.047**	**-0.038**	**-0.030**
Mex	**-0.146**	**-0.137**	**-0.126**	**-0.123**	**-0.117**	**-0.107**	**-0.097**	**-0.092**	**-0.088**	**-0.078**	**-0.069**
Nth	**-0.182**	**-0.168**	**-0.152**	**-0.146**	**-0.138**	**-0.123**	**-0.109**	**-0.100**	**-0.094**	**-0.078**	**-0.065**
Nzl	**-0.131**	**-0.118**	**-0.104**	**-0.098**	**-0.091**	**-0.078**	**-0.065**	**-0.058**	**-0.053**	**-0.040**	**-0.030**
Nor	**-0.239**	**-0.225**	**-0.210**	**-0.205**	**-0.197**	**-0.185**	**-0.174**	**-0.168**	**-0.163**	**-0.152**	**-0.143**
Por	-0.062	-0.051	-0.039	-0.034	**-0.027**	**-0.015**	**-0.003**	0.004	0.008	0.022	0.033
Spa	**-0.137**	**-0.117**	**-0.097**	**-0.090**	**-0.081**	**-0.067**	**-0.054**	**-0.047**	**-0.043**	**-0.030**	**-0.020**
Swe	**-0.139**	**-0.131**	**-0.121**	**-0.118**	**-0.113**	**-0.104**	**-0.095**	**-0.090**	**-0.086**	**-0.077**	**-0.069**
Swi	-0.074	-0.057	-0.038	-0.031	-0.022	**-0.006**	0.010	0.019	0.025	0.041	0.054
UK	**-0.129**	**-0.120**	**-0.109**	**-0.105**	**-0.100**	**-0.090**	**-0.080**	**-0.075**	**-0.071**	**-0.061**	**-0.052**
US	**-0.156**	**-0.149**	**-0.141**	**-0.138**	**-0.134**	**-0.127**	**-0.120**	**-0.116**	**-0.113**	**-0.106**	**-0.100**

Table B3: bt – International transfers

	Percentile										
	1/20	1/10	1/5	1/4	1/3	1/2	2/3	3/4	4/5	9/10	19/20
Aus	-0.013	-0.010	-0.007	-0.006	-0.005	**-0.002**	0.001	0.002	0.003	0.007	0.010
Aut	-0.010	0.000	**0.012**	**0.017**	**0.023**	**0.033**	**0.045**	**0.051**	**0.056**	0.068	0.079
Bel	-0.070	-0.059	-0.046	-0.040	**-0.033**	**-0.019**	**-0.006**	0.002	0.008	0.024	0.039
Can	-0.016	-0.012	-0.007	-0.006	-0.003	**0.001**	0.005	0.007	0.009	0.015	0.020
Dnk	-0.028	-0.020	-0.010	-0.006	-0.001	**0.009**	0.019	0.026	0.030	0.042	0.052
Fin	-0.023	-0.019	**-0.015**	**-0.013**	**-0.011**	**-0.007**	**-0.003**	**-0.001**	0.001	0.005	0.008
Fra	-0.037	-0.026	-0.012	-0.007	**0.001**	**0.016**	**0.031**	0.039	0.045	0.060	0.072
Ger	**0.053**	**0.098**	**0.160**	**0.184**	**0.218**	**0.268**	**0.308**	**0.329**	**0.343**	**0.380**	**0.411**
Gre	-0.034	-0.028	-0.021	-0.018	**-0.015**	**-0.008**	**-0.001**	0.003	0.005	0.012	0.018
Ire	-0.083	-0.064	-0.042	-0.034	-0.022	**0.000**	0.021	0.033	0.041	0.062	0.081
Ita	-0.052	-0.039	-0.025	-0.020	-0.013	**0.000**	0.012	0.020	0.025	0.041	0.055
Jap	-0.058	-0.026	-0.007	-0.003	**0.001**	**0.006**	**0.012**	0.017	0.022	0.049	0.075
Kor	-0.010	-0.002	**0.006**	**0.009**	**0.014**	**0.022**	**0.030**	**0.035**	**0.038**	0.047	0.055
Mex	**0.001**	**0.004**	**0.007**	**0.008**	**0.010**	**0.013**	**0.016**	**0.018**	**0.019**	**0.022**	**0.025**
Nth	-0.060	-0.047	-0.032	-0.027	-0.019	**-0.005**	0.009	0.017	0.023	0.039	0.052
Nzl	-0.039	-0.031	-0.022	-0.019	-0.014	**-0.006**	0.003	0.008	0.012	0.022	0.032
Nor	**-0.043**	**-0.039**	**-0.035**	**-0.034**	**-0.031**	**-0.027**	**-0.023**	**-0.021**	**-0.019**	**-0.014**	**-0.010**
Por	**0.047**	**0.065**	**0.087**	**0.095**	**0.106**	**0.127**	**0.146**	**0.158**	**0.166**	**0.187**	**0.206**
Spa	-0.024	-0.019	-0.013	-0.011	-0.007	**-0.002**	0.003	0.006	0.008	0.014	0.020
Swe	-0.016	-0.013	-0.009	-0.008	-0.006	**-0.002**	0.001	0.003	0.004	0.008	0.011
Swi	**0.002**	**0.007**	**0.012**	**0.013**	**0.016**	**0.020**	**0.024**	**0.026**	**0.028**	**0.032**	**0.036**
UK	-0.047	-0.034	-0.019	-0.014	-0.006	**0.007**	0.020	0.026	0.031	0.044	0.055
US	-0.021	-0.015	-0.007	-0.005	-0.001	**0.006**	0.013	0.017	0.020	0.027	0.034

Table B4: bs– Savings/Credit markets channel

	Percentile										
	1/20	1/10	1/5	1/4	1/3	1/2	2/3	3/4	4/5	9/10	19/20
Aus	**0.322**	**0.345**	**0.372**	**0.383**	**0.397**	**0.424**	**0.450**	**0.466**	**0.477**	**0.506**	**0.531**
Aut	-0.018	**0.043**	**0.112**	**0.135**	**0.170**	**0.228**	**0.284**	**0.315**	**0.337**	**0.392**	0.437
Bel	**0.039**	**0.121**	**0.219**	**0.256**	**0.309**	**0.406**	**0.507**	**0.565**	**0.605**	**0.716**	**0.812**
Can	**0.434**	**0.463**	**0.497**	**0.509**	**0.527**	**0.558**	**0.589**	**0.607**	**0.620**	**0.654**	**0.687**
Dnk	-0.133	-0.098	-0.056	-0.040	-0.017	**0.025**	0.068	0.094	0.112	0.161	0.204
Fin	**0.478**	**0.492**	**0.509**	**0.515**	**0.524**	**0.540**	**0.555**	**0.564**	**0.570**	**0.586**	**0.601**
Fra	**0.104**	**0.144**	**0.193**	**0.212**	**0.241**	**0.295**	**0.353**	**0.388**	**0.411**	**0.468**	**0.508**
Ger	-0.037	**0.023**	**0.094**	**0.120**	**0.159**	**0.228**	**0.297**	**0.334**	**0.358**	**0.417**	0.463
Gre	**0.470**	**0.493**	**0.519**	**0.528**	**0.542**	**0.566**	**0.590**	**0.603**	**0.612**	**0.636**	**0.656**
Ire	**0.178**	**0.228**	**0.287**	**0.309**	**0.341**	**0.396**	**0.452**	**0.483**	**0.504**	**0.561**	**0.612**
Ita	-0.029	**0.017**	**0.072**	**0.093**	**0.124**	**0.177**	**0.231**	**0.262**	**0.284**	**0.346**	0.399
Jap	**0.164**	**0.196**	**0.234**	**0.249**	**0.269**	**0.303**	**0.336**	**0.355**	**0.367**	**0.400**	**0.426**
Kor	-0.013	**0.022**	**0.065**	**0.081**	**0.104**	**0.145**	**0.186**	**0.210**	**0.226**	**0.268**	0.303
Mex	**0.089**	**0.113**	**0.140**	**0.150**	**0.164**	**0.191**	**0.217**	**0.232**	**0.242**	**0.270**	**0.294**
Nth	**0.318**	**0.371**	**0.432**	**0.455**	**0.488**	**0.544**	**0.597**	**0.627**	**0.647**	**0.697**	**0.740**
Nzl	**0.505**	**0.529**	**0.557**	**0.568**	**0.584**	**0.613**	**0.641**	**0.657**	**0.668**	**0.699**	**0.726**
Nor	**0.690**	**0.721**	**0.758**	**0.773**	**0.793**	**0.829**	**0.865**	**0.886**	**0.901**	**0.939**	**0.971**
Por	**0.397**	**0.457**	**0.523**	**0.547**	**0.580**	**0.635**	**0.688**	**0.718**	**0.738**	**0.790**	**0.834**
Spa	**0.061**	**0.102**	**0.152**	**0.172**	**0.200**	**0.252**	**0.304**	**0.334**	**0.355**	**0.412**	**0.462**
Swe	**0.310**	**0.339**	**0.375**	**0.389**	**0.409**	**0.444**	**0.479**	**0.499**	**0.513**	**0.551**	**0.583**
Swi	**0.437**	**0.468**	**0.509**	**0.526**	**0.551**	**0.600**	**0.652**	**0.684**	**0.706**	**0.765**	**0.813**
UK	**0.076**	**0.113**	**0.155**	**0.170**	**0.192**	**0.230**	**0.267**	**0.288**	**0.302**	**0.341**	**0.374**
US	**0.164**	**0.193**	**0.231**	**0.248**	**0.273**	**0.327**	**0.396**	**0.440**	**0.471**	**0.546**	**0.599**

C List of financial indicators used

From the database available on:

http://web.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/EXTPROGRAMS/EXTFINRES/...

...0,,contentMDK:20352338~menuPK:806638~pagePK:64168182~piPK:64168060~theSitePK:478060,00.html

Central Bank Assets to total financial assets

Deposit Money Bank Assets to total financial assets

Other Financial Institutions Assets to total financial assets

Deposit money bank vs. central bank assets

Liquid liabilities to GDP

Central Bank Assets to GDP

Deposit Money Bank Assets to GDP

Other Financial Institutions Assets to GDP

Private credit by deposit money banks to GDP

Private credit by deposit money banks and other financial institutions to GDP

Bank deposits

Financial system deposits

Concentration

Overhead Costs

Net Interest Margin

Life insurance penetration

Non-life insurance penetration

Stock market capitalization to GDP

Stock market total value traded to GDP

Stockmarket turnover ratio

Private bond market capitalization to GDP

Public bond market capitalization to GDP

From the database available on:

http://econ.worldbank.org/external/default/...

...main?theSitePK=478060&contentMDK=20347611&menuPK=806583&pagePK=64168182&piPK=64168060

Fraction of entry applications denied

Fraction of domestic entry applications denied

Fraction of foreign entry applications denied

Activity restrictions

Banking freedom

State ownership

Foreign ownership

Economic freedom

KKZ index (A composite of six governance indicators (1998 data): voice and accountability, political stability, government effectiveness, regulatory quality, rule of law. And corruption. Higher values correspond to better governance)

Private credit

Total value traded

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