Asymmetric Shocks and Risk Sharing in a Monetary Union: Updated Evidence and Policy Implications for Europe*

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Abstract

We find that risk sharing in the European Union (EU) has been increasing over the past decade due to increased cross-ownership of assets across countries. Industrial specialization has also been increasing over the last decade and we conjecture that risk sharing plays an important causal effect by allowing countries to specialize without being subject to higher *income* risk even though the variability of *output* may increase. We believe that lower trade barriers may not have played a dominant causal role during this decade because the effect of lower trade barriers has probably already played itself out. We further find that the asymmetry of GDP fluctuations in the EU has declined steeply over the last two decades. This may be due to economic policies becoming more similar as countries were adjusting fiscal policy in order to meet the Maastricht criteria, but a similar result was found for U.S. states so the finding may be due to a different nature of the shocks to the world economy in the 1990s. We expect to see a further rise in risk sharing between EU countries, accompanied by more specialization. However, the resulting increase in GDP asymmetry should be minor and will have small welfare costs because increased risk sharing should lower *income* (GNP) asymmetry.

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1 Introduction

Assessing the economic consequences of financial integration is high on the agenda of economists and policy makers around the world and, in particular, within the European Union (EU) where financial integration is expected to rapidly increase following trade integration and the advent of the Euro.

For the countries in the Euro area, a major concern is that adverse shocks to the economies of individual members of the currency union can no longer be blunted by monetary policy if such shocks only hit a single or a few countries. For example, if France happens to be in a recession while the rest of the Euro area is booming, the European Central Bank will not be able to lower the interest rate in order to stimulate the French economy. Such shocks, that hit only one or few countries, are denoted *idiosyncratic* (or state-specific) shocks and if idiosyncratic shocks are prevalent the economies are said to exhibit *asymmetry* of Gross Domestic Product (GDP). In the face of significant GDP asymmetry, monetary union may lead to a loss of welfare due to the lack of independent monetary policy, unless mechanisms for achieving international income insurance and consumption smoothing ("risk sharing") are in place.[1]

Mechanisms for sharing risk internationally include central fiscal institutions as well as market institutions. Fiscal institutions provide inter-country income insurance via a tax-transfer system that, typically, lowers taxes and increases transfers to individuals and grants to governments of countries that suffer an economic set-back. Market institutions include developed capital markets through which the members of a union can share risk by smoothing their income via cross-ownership of productive assets (portfolio diversification). Alternatively, consumers may smooth their consumption (given their income) by adjusting their savings rate; i.e., adjusting the size of their asset portfolio in response to shocks.

In this paper, we will focus on income smoothing using methods developed by Asdrubali, Sørensen, and Yosha (1996) who examine risk sharing among the states that make up the United States (a successful monetary union). For the period 1964–90, they find that 39 percent of idiosyncratic (state-specific) shocks to the per capita GDP of individual states

[1] In the long run, high GDP asymmetry may, in the absence of international risk sharing, even destabilize the monetary union by generating incentives for secession in order to regain monetary independence.

are smoothed on average through inter-state ownership patterns, i.e., through capital income flows across state borders. Their methods are based on measuring how closely personal income (adjusted for federal transfers and contributions) follow state-level GDP—the details are spelled out in the next Section.[2] They further find that the amount of insurance through inter-state capital income flows has been rising over time and we will examine if this trend is still continuing.

Using similar methods, Sørensen and Yosha (1998) explore risk sharing patterns among EU and OECD countries during the period 1966–90, finding that factor income flows do not smooth Gross National Product (GNP) across countries. These results suggest that EU capital markets have been less integrated than U.S. capital markets, at least until a decade ago.

We update some of the above empirical results through the end of the 1990s, focusing on income insurance from factor income flows. Two major findings emerge. First, the amount of insurance through inter-state capital income flows in the United States has been rising further. Second, in the latter part of the 1990s there is non-negligible insurance through international capital income flows in the EU—about 10 percent of idiosyncratic (country-specific) shocks to the GDP of individual countries are smoothed on average through this channel. In this respect, the EU is beginning to converge towards the United States. This result is one of the first that actually corroborates empirically that unified Europe is becoming more similar to the union of U.S. states in terms of integration at the macroeconomic level![3]

The process of economic and monetary integration itself may affect the symmetry of GDP fluctuations and it is of interest to explore this issue in the European context. Kalemli-Ozcan, Sørensen, and Yosha (2003a) demonstrate empirically that inter-country income insurance (which may itself be a result of economic integration) induces higher specialization in production.[4] The simple intuition for this result is that as long as ownership is diversified,

[2] They also find that 13 percent of shocks are smoothed by the federal tax-transfer and grant system, 23 percent via saving or borrowing and lending, and 25 percent of shocks are not smoothed. Therefore, although perfect insurance is not achieved, there is considerable risk sharing among U.S. states.

[3] A closely related literature, originating with Feldstein and Horioka (1980), finds a high correlation between aggregate investment and aggregate saving for most OECD countries and argues that such correlation is an indicator of lack of financial integration. Giannone and Lenza (2003) find that investment-saving correlations have become lower in the 1990s—a finding that is consistent with our results.

[4] "Specialization" here refers to specialization *relative* to other countries (or states) within a group.

countries or regions can be very specialized, with potentially high GDP volatility, while still have low volatility of income.

Subsequently, Kalemli-Ozcan, Sørensen, and Yosha (2001) establish empirically that higher specialization in production translates into more asymmetry of GDP fluctuations. This result may not be surprising but, nonetheless, seems not to have been verified previously. Together, these findings substantiate an effect of income insurance on industrial specialization which, other things equal, results in less symmetric output fluctuations.

We update the empirical analysis of specialization and GDP asymmetry, asking specifically whether specialization and GDP asymmetry have risen in the EU as a result of better risk sharing. We find that country-level specialization in the EU has been increasing during the 1990s; however, GDP asymmetry has declined in the 1990s relative to the 1980s. At least for this sample period, the effect of specialization on asymmetry has been overwhelmed by other forces that we do not attempt to identify in the present article.

However, asymmetry of *output* (GDP) may not be important for the members of the EU if there is substantial risk sharing between members of the union. Rather, the asymmetry of income and of consumption are, arguably, the relevant indicators of potential losses of welfare. Kalemli-Ozcan, Sørensen, and Yosha (2003b) demonstrate that asymmetry of *personal income* across U.S. states is substantially lower than asymmetry of *output* corroborating the empirical relevance of this observation. In this paper, we update the calculations for U.S. states and further estimate the level of GNP asymmetry for the EU. We find that, for the U.S. states, asymmetry of income remains much lower than asymmetry of GDP. Surprisingly, for EU countries, GNP is *more* asymmetric than GDP in spite of positive risk sharing in the 1990s. We conjecture that a further rise in risk sharing in the EU will reverse this result similarly to what we find for the U.S. states benchmark.

Overall, our results are encouraging in relation to concerns about the welfare effects of asymmetric shocks in the EU because they indicate that the *income* (and hence also consumption) of EU members is slowly becoming buffered against country-specific shocks to GDP. While this increase in risk sharing may encourage more industrial specialization and thereby more asymmetry of output (other things equal) this need not lead to more asymmetry of income (and consumption) across countries. Indeed, for the United States the asymmetry of state-level income is much lower than the asymmetry of state-level output. This last pattern

is, however, not yet observed for the EU members. We argued previously that risk sharing may be particularly important for countries in the Euro area and we conjecture—no empirical evidence is yet available—that the formation of a monetary union itself will facilitate further risk sharing, for instance, by increasing international diversification of mutual funds through removing costs of currency hedging and through greater transparency.

In the next Section, we give a fuller discussion of the existing empirical literature. In Section 3, we present the updated empirical analysis and in Section 4, we discuss implications for policy in Europe.

2 Literature Review

U.S. States as a Benchmark for the EU

There is by now a fairly substantial literature studying U.S. states, and sometimes also regions within other countries, as examples of successful currency unions that can fruitfully be used as a benchmark for the countries in the EU and, in particular, the Euro area. Among the first papers in this tradition were Eichengreen (1990) and De Grauwe and Vanhaverbeke (1993), who contrast regional and national data on macroeconomic variables such as employment and output growth rates, labor mobility, and the real exchange rate.[5] A recent volume that continuous this tradition, and provides many more references, is edited by Hess and van Wincoop (2000). A particularly influential early paper, that aims at measuring the amount of risk sharing provided to U.S. states by the U.S. federal government through federal transfers to individuals and taxes, is that of Sala-i-Martin and Sachs (1992), who estimates that a one dollar drop in the income of a state would be compensated by an increase in transfers minus taxes of more than 60 cents. Their (very large) estimate of risk sharing through federal government fiscal policy has been disputed by, *inter alia*, von Hagen (1992), who finds significant but much smaller risk sharing from the federal government.[6]

[5]The literature initiated by Eichengreen (1990), Sala-i-Martin and Sachs (1992), and others, is inspired by Mundell's (1961) classic analysis of Optimum Currency Areas. Alesina and Barro (2002) provide a modern analysis of currency unions. They focus on the volume of trade within a currency union, assessing how trade costs affect the desirability of a union, and on the fact that joining a currency union can commit a country to monetary stability.

[6]These authors were concerned with estimating the amount of income insurance provided by the U.S. federal government to U.S. states as a benchmark for the income insurance role that might be required from

Testing for Full Risk Sharing

The characterization of full risk sharing has been known for many decades since the seminal work of Arrow and Debreu. Yet, the empirical implications of full risk sharing, also known as perfect or efficient risk sharing, were not investigated until recently. A good place to start is Cochrane (1991) and Mace (1991), who point out that if idiosyncratic risk is fully shared among a group of consumers, then a consumer's consumption should be affected only by aggregate fluctuations and not by any idiosyncratic shock that hits the consumer such as job loss, sickness, or a change in the consumer's income. These authors test this proposition using micro-data (person or household data) from the United States.[7] Many similar tests have been carried out since with the overall conclusion that the data do not support the full risk sharing hypothesis. Obstfeld (1994b) carries over this logic to the country level, testing for full risk sharing among G7 countries, also rejecting the hypothesis. His line of research was refined by several authors. Important contributions are Canova and Ravn (1996), who also reject full risk sharing, and Lewis (1996).

Channels of Risk Sharing

Asdrubali, Sørensen, and Yosha (1996) shift the focus from *testing* for full risk sharing to *measuring* the amount of risk sharing that is achieved through various channels. The first channel consists of income insurance through an inter-regionally or internationally diversified investment portfolio. The citizens or the government of a country can invest in stock markets overseas, or more generally, can own claims to output produced in other countries. For example, if mutual funds or pension funds in one country invest internationally, the income of the citizens in that country includes factor income from abroad and will partly co-move with the output in other countries. If financial intermediaries in one country lend to firms in other countries, the flow of interest payments smoothes the income of citizens in the lending country. If risk is not fully shared through factor income flows, there is scope for further

a future central fiscal authority in the EU. We endorse von Hagen's estimate, which is close to the number obtained by Asdrubali, Sørensen, and Yosha (1996). For further work on income insurance through fiscal policy, see Gavin and Perotti (1997), Fatas and Mihov (2001), Sørensen, Wu, and Yosha (2001), and Buettner (2002). See also Atkeson and Bayoumi (1993) and Goodhart and Smith (1993).

[7] Townsend (1994) tests the full risk sharing proposition using micro-data from villages in India.

income smoothing through taxes and transfers of a supra-national government (e.g., the U.S. federal government). This channel is the one identified first by Sala-i-Martin and Sachs (1992), except that Asdrubali, Sørensen, and Yosha measure all risk sharing in relation to shocks to *output* since shocks to income—used by Sala-i-Martin and Sachs—already reflect risk sharing from cross-ownership of assets. If risk is still not fully shared, there is scope for further consumption smoothing through saving behavior. (Such consumption smoothing through saving is governed to a large extent by inter-temporal considerations.)[8] Finally, some fraction of shocks may not be smoothed at all. If this fraction is statistically significant this constitutes a rejection of full risk sharing with an interpretation similar to the tests popularized by Mace (1991).

The method developed by Asdrubali, Sørensen, and Yosha (1996) has been extended recently by Mélitz and Zumer (1999), who allow for risk sharing to depend on such country-specific (or state-specific, depending on the case) features such as demographics, size, and wealth. They apply the method to U.S. states, obtaining results that are quite similar to those obtained by Asdrubali, Sørensen, and Yosha (1996), as well as to other federations and countries for which regional data are available (for instance, Canada and France). In all countries, there are non-negligible amounts of risk sharing via the various channels but full risk sharing is rejected.

Another important extension was recently suggested by Becker and Hoffmann (2002), who focus on dynamic aspects of risk sharing. In particular, they estimate permanent and transitory components of a three-dimensional model involving country-level GDP, GNP, and consumption. Their results indicate that permanent shocks are insured (ex-ante), while transitory shocks are mainly smoothed (ex-post) via saving behavior. We believe that this is

[8] According to models of forward looking consumer behavior, if shocks to GDP are highly persistent, and not smoothed through international factor income flows and/or through taxes and transfers, individuals will optimally choose to engage in very little consumption smoothing through saving. If the shocks to GDP are transitory, and not smoothed through international factor income flows, individuals will optimally choose to engage in much consumption smoothing through saving. Baxter and Crucini's (1995) insight is relevant here. If, for some reason, there is no income insurance through factor income flows but agents can trade in a risk-less bond, then—if shocks to GDP are transitory—full risk sharing will be closely approximated. That is, when shocks to GDP are transitory, a risk-less bond (i.e., the credit market) is a close substitute for income insurance (i.e., for capital markets). In contrast, if shocks to GDP are highly persistent, consumption smoothing through trade in a risk-less bond will not approximate the full risk sharing allocation, namely, the credit market will not closely mimic the role of capital markets—shocks that were not insured ex-ante on capital markets will, by the logic of the permanent income model of consumption, not be smoothed ex-post on credit markets.

a promising line of research.

Consumption Correlations and International Real Business Cycle Models

Closely related is the international real business cycle literature, most notably Backus, Kehoe, and Kydland (1992) and more recently Baxter and Crucini (1995) and Stockman and Tesar (1995). These authors develop two-country general equilibrium models with complete financial markets. A central prediction of these models is that consumption correlations across countries should be high. These authors have taken this prediction to international macroeconomic data, finding that inter-country consumption correlations are nowhere close to unity. In fact, these consumption correlations are not higher than country GDP correlations, as we would expect if there were only partial international risk sharing—a phenomenon that has become known as the "international consumption correlation puzzle."[9]

Welfare Gains from Risk Sharing

Another closely related literature calculates welfare gains from (international) risk sharing. Testing for full risk sharing and measuring the amount of risk that is shared through various channels is of interest only if such welfare gains are non-negligible. Cole and Obstfeld (1991) find that these gains are tiny, but it soon became clear—see Obstfeld (1994c) and van Wincoop (1994)—that this result is due to their assumption that shocks to GDP are transitory. If shocks are permanent (or highly persistent) then the gains from insuring them are quite meaningful. van Wincoop (1994) estimates that under the more realistic assumption of permanent shocks (more precisely: Assuming that country-level GDP is well described by a random walk) the gain from perfect risk sharing would be equivalent to a permanent increase in consumption of about 2–3 percent. Obstfeld (1994c) provides a closed form solution for the welfare gains due to a reduction in consumption variability in a partial equilibrium setting under the assumption that agents have Constant Relative Risk Aversion (CRRA) utility functions. van Wincoop (1994) computes welfare gains from risk sharing in a general

[9] Stockman and Tesar (1995) suggest country specific taste shocks as an explanation of the puzzle. Sørensen and Yosha (1998) show that the low consumption correlations are consistent with taste shocks, although it cannot be ruled out that the low consumption correlations simply reflect noise (e.g., measurement error) in the consumption data.

equilibrium model—also assuming CRRA utility as well as more general types of utility functions—relying on approximation techniques. More precisely, van Wincoop calculates non-exploited gains from risk sharing using consumption data, measuring how much *further* gains from risk sharing can be achieved by moving from the observed consumption allocation (in the data) to the perfect risk sharing consumption allocation.

Risk Sharing and Home Bias

The finding of low international risk sharing is fully consistent with the well-known "home bias puzzle" documented by French and Poterba (1991) and Tesar and Werner (1995). In a world with full information, no moral hazard, no trading cost, and the same degree of risk aversion across agents, all agents should (according to basic theory) hold an identical "world" portfolio of assets. It is, however, observed that, for example, the English hold the vast majority of their assets in the form of U.K. equities and Americans hold the vast majority of their assets in the form of U.S. equities—an observation that is referred to as "home bias."[10]

Sørensen, Wu, and Yosha (2002) provide direct empirical evidence that these phenomena are indeed related: On average, risk sharing from international cross-ownership of assets, as measured by the smoothing of GNP, is higher in countries that hold a higher amount of foreign equity relative to GDP.[11] The lack of risk sharing across countries, and its relation to home bias, motivated Shiller (1993) to propose the issuance of assets with returns that are directly linked to the growth of GDP in various countries. International macro risk could then be alleviated via trade in such country-specific GDP-linked securities (by each country going short in the securities linked to its own GDP).

[10] Coval and Moskowitz (1999) even find "home bias at home." They find that U.S. institutional investors, while holding assets from all over the United States, still hold a more than proportional amount of assets issued in their own geographical region. (For a similar result, see Huberman (2001).) However, this home bias is much less severe than the home bias found in international data.

[11] See Milesi-Ferretti and Lane (2001) for data on international asset holdings.

Economic Integration, Industrial Specialization, and Asymmetry of Economic Fluctuations

Much of the debate on the desirability of economic integration centers on the degree of synchronization (symmetry) of macroeconomic fluctuations across countries. It has been noted that the process of economic integration itself will affect the symmetry of macroeconomic fluctuations. Frankel and Rose (1998) argue that removal of trade barriers will entail more correlated business cycles since a higher level of trade will allow demand shocks to spread more easily across national borders. They further mention that economic integration will render policy shocks more correlated and that knowledge and technology spillovers will increase (Coe and Helpman 1995). These factors should also contribute to fluctuations becoming more symmetric following economic integration. Krugman (1993), on the other hand, claims that lower barriers to trade will induce countries to specialize more rendering output fluctuations *less* symmetric.[12] We illustrate these various effects in Figure 1, adapted from Kalemli-Ozcan, Sørensen, and Yosha (2001).[13]

In the remainder of this article, we focus on updating our previous work on specialization and asymmetry, rather than attempting to provide a balanced view of the literature—in particular we say little about the important issue of the effect of lower trade barriers.

Theoretical Literature on Risk Sharing and Industrial Specialization

With uninsured production risk, the higher variance of GDP resulting from specialized output may entail a welfare loss that outweighs the benefits. The argument was first formulated by Brainard and Cooper (1968), Kemp and Liviatan (1973), and Ruffin (1974). In response, Helpman and Razin (1978) show that if production risk can be insured through trade in assets, the benefits of specialization will resurface.[14] This work has consequences for the theory of economic growth. Obstfeld (1994a) constructs a model in which countries choose

[12] Krugman corroborates his argument with the observation that U.S. states are more specialized in production than European countries.

[13] Imbs (2003) contributes to this debate by estimating a three-equation system with three endogenous variables—pairwise GDP correlations, bilateral trade, and industrial specialization. His results are generally in line with previous research.

[14] Further work on this topic includes Anderson (1981), Grossman and Razin (1985), and Helpman (1988). See also Heathcote and Perri (2001) for models along these lines.

between investing in risky projects with high average returns or in safe projects with low average returns. International asset trade allows them to hold a diversified portfolio and to shift investment towards high return projects. Acemoglu and Zilibotti (1997) stress that developing countries have fewer opportunities to diversify production and tend to specialize in safe technologies. Insurance permits them to take risks that—with some probability—will translate into an economic take-off. In Greenwood and Jovanovic (1990), financial intermediaries pool risks and help achieve higher and safer returns on investment. In Saint-Paul (1992), the basic trade-off is between the gains from specialization due to comparative advantage in production and a lower variance of output, while Feeney (1999) develops the idea that in the presence of learning by doing in production, specialization entails higher growth during a transition period.

Empirical Evidence on Risk Sharing and Specialization

Kalemli-Ozcan, Sørensen, and Yosha (2003a) demonstrates empirically that more insurance among regions (countries) is associated with higher industrial specialization of these regions (countries). They estimate a cross-sectional regression using about 150 regional-level observations and, to guard against potential endogeneity (reverse causality) of the amount of inter-regional risk sharing achieved, they used investor protection indices, suggested by La Porta, Lopez-de-Silanes, Shleifer, and Vishny (1998), as instruments.[15]

It is worth noting that Kim (1995) finds specialization in the United States (at the state level) has *decreased* continuously since the 1930s (after increasing in the late 19th century), while Asdrubali, Sørensen, and Yosha (1996) find risk sharing among U.S. states has increased over time. These findings, together with the results of Kalemli-Ozcan, Sørensen, and Yosha (2003a), would seem to predict an *increase* in specialization. Our interpretation is that the effects we identify are only parts of the picture and there are long-run technological changes that reduce the gains from specialization for a given level of risk sharing.[16] This

[15]Ramey and Ramey (1995) note that in the presence of *aggregate* uninsured risk, countries will take fewer additional risks. Therefore, the volatility of aggregate output may affect the regional specialization within a federation of regions. To control for this, Kalemli-Ozcan, Sørensen, and Yosha (2003a) calculate the volatility of group-wide GDP for each group of regions (countries) and include it as a control variable in the regression.

[16]Kim (1995) suggests that technological advances have made production less dependent on local resources and that factors of production have become more mobile.

process is likely ongoing in the United States as well as in the EU, although we expect it to be counteracted in the EU during the next decade or two as financial markets continue to integrate.[17] Our work does not allow us to predict which effect will dominate in the short run although we suspect that the effect of financial integration may dominate for a while due to stronger international financial integration and reduction in home bias.[18]

Economic Integration and Asymmetry of Output Fluctuations

Academic research on the asymmetry of shocks to regions and nations dates back at least to Cohen and Wyplosz (1989) and Weber (1991), who study country-level output growth-rate correlations for European countries and to Stockman (1988), who distinguishes between country-specific and industry-specific shocks. The latter paper inspired numerous studies, e.g., Kollman (1995), Fatas (1997), and Hess and Shin (1998). Bayoumi and Eichengreen (1993) focus on demand versus supply shocks and used a vector autoregression procedure to study them, whereas De Grauwe and Vanhaverbeke (1993) distinguish between region-specific and country-specific shocks. Massmann and Mitchell (2003) reconsider this literature and find that Eurozone business cycles have become more correlated in the late 1990s after a period of divergence in the early 1990s following German unification and the European currency crisis.

Industrial specialization will likely have implications for the amount of asymmetry of macroeconomic shocks. If industry-specific shocks are important then greater specialization should increase the asymmetry of shocks. Kalemli-Ozcan, Sørensen, and Yosha (2001) deal with this question empirically studying a cross-section of U.S. states and a cross-section of EU/OECD countries.[19] They point out that the welfare gain from moving from financial autarky to full risk sharing, where the value of output is fully pooled through financial cross-ownership, can be used as a measure of asymmetry. The intuition is that the greater the asymmetry in GDP fluctuations within a group of countries (or regions) the larger the benefit from smoothing these fluctuations through risk sharing within the group.

[17] The increase in specialization in the United States in the late 19th century fits this picture as the regional U.S. capital markets were becoming integrated during that time; see Davis (1965).

[18] Imbs and Wacziarg (2003) provide evidence that industrial specialization declines with GDP at early stages of development and increases with GDP at later stages of development. They do not relate their finding to risk sharing or risk taking.

[19] Kalemli-Ozcan, Sørensen, and Yosha (2001) provide a simple model that helps clarify the role of industry-specific versus other types of shocks.

These authors derive a simple *closed form* expression for the gains from risk sharing under the assumption of CRRA utility.[20] The advantage of this measure is that—subject to the simplifications needed to get analytical solutions—it can be interpreted as a measure of the dis-utility that such asymmetry will inflict on the average person.[21] They find that greater industrial specialization indeed leads to lower synchronization of GDP fluctuations (i.e., more asymmetry). They stress, though, that more asymmetry need not be detrimental to the welfare of the residents of an economic or monetary union because—in the presence of risk sharing—income is partly insured from GDP fluctuation and *income* (or GNP) fluctuations need, therefore, not be more asymmetric. In addition, although not the focus here, consumption may further be buffered from income fluctuations.

3 Measuring Risk Sharing, Specialization, and Fluctuations Asymmetry

3.1 Risk Sharing

We construct a measure of the amount of risk sharing obtained through cross-ownership of financial assets. The measure takes the value 1 if there is perfect risk sharing from cross-ownership, i.e., if the GNP of a typical country does not move with country-specific movements in its GDP and the measure takes the value 0 if GNP moves one-to-one with GDP—the situation with no risk sharing.

Consider the following set of cross-sectional regressions (one regression for each year t) for a group of countries indexed by sub-script i:

$$\Delta \log \text{GNP}_{it} - \Delta \log \text{GNP}_t \;=\; \text{constant} \;+\; \beta_{K,t} \;(\Delta \log \text{GDP}_{it} - \Delta \log \text{GDP}_t) \;+\; \epsilon_{it}\,, \qquad (1)$$

where GNP_{it} and GDP_{it} are country i's year t real per capita GNP and GDP, respectively,

[20] Kim, Kim, and Levin (2000), using a different approach, obtain analytical solutions for gains from risk sharing allowing for quite general dynamics, although their set-up is restricted to a two-country framework that makes it less applicable for actual empirical calculations.

[21] Kalemli-Ozcan, Sørensen, and Yosha (2001) also use simple measures of asymmetry based on pair-wise GDP correlations obtaining similar patterns.

and GNP_t and GDP_t are the year t average real per capita GNP and GDP for the group.[22] The coefficient $\beta_{K,t}$ measures the average co-movement of the countries' idiosyncratic GNP growth with their idiosyncratic GDP growth in year t; i.e., the co-movement of GNP and GDP growth rates when aggregate growth rates have been subtracted. The smaller the co-movement, the more GNP is buffered against GDP fluctuations. If income smoothing is perfect then idiosyncratic GNP does not co-move with idiosyncratic GDP at all. In fact, for each country GNP growth equals the group's GNP growth. Therefore, $\beta_{K,t}$ takes the value 0 simply because the left-hand side of equation (1) is always 0.

Since GNP equals GDP plus net factor income flows, this regression provides a measure of the extent to which net factor income flows provide income insurance—the lower $\beta_{K,t}$, the higher is income insurance within the group in year t.[23] We use $1 - \beta_{K,t}$ as a measure of risk sharing through international factor income flows. If no country-specific risk is hedged in international capital markets we would expect to find $\beta_{K,t} = 1$ because, for each country in the group, GNP would then equal GDP and our risk sharing measure, $1 - \beta_{K,t}$, would be 0.

Figure 2 displays a smoothed graph of the series $1 - \beta_{K,t}$ against time. The $\beta_{K,t}$ values are estimated year-by-year for the sample of EU member states (except Luxembourg) and the values at neighboring time-periods are smoothed (using a Normal kernel smoother) in order to focus on the trend-movements in the series. Surprisingly, the estimated risk-sharing is negative in the early 1990s—in those years a decrease in GDP was typically associated with an even larger decrease in GNP! In order to examine if this was due to the banking crisis in Finland and Sweden during these years, or to the impact of the Soviet break-up on Finnish foreign trade, we also display the graph leaving out those two countries. Clearly, the Scandinavian banking crisis explains much of the negative risk sharing in those years. We do not know exactly why, but the large negative shocks to GDP that those countries suffered in that period were accompanied by even larger negative shocks to the countries' GNP. At the

[22] "Real" GDP (GNP) refers to GDP (GNP) divided by the Consumer Price Index (CPI) of country i. We use the CPI, rather than a GDP deflator, because the relevant measure for risk sharing is value of GDP (GNP) in terms of consumption goods. The GDP deflator is typically quite similar to the CPI, although large differences in our sample can be found for countries (or states) in which proceeds from oil-extraction is a large fraction of GDP.

[23] See Asdrubali, Sørensen, and Yosha (1996), Sørensen, and Yosha (1998), and Mélitz and Zumer (1999).

time, the degree of financial integration in the EU was not large enough to compensate for this effect resulting in negative average risk sharing in the EU.

The main fact revealed by the graphs is that by the end of the 1990s international financial integration in the EU finally reached a level where GNP fluctuations are somewhat decoupled from GDP fluctuations. The increase in risk sharing from factor income flows is quite dramatic and seems much too steep to be driven by sample variation.

Alternatively, we estimate the amount of risk sharing over several years using the panel data regression (which pools the regressions over all the years in the sample):

$$\Delta \log \mathrm{GNP}_{it} - \Delta \log \mathrm{GNP}_t \;=\; \text{constant} \;+\; \beta_K \;\left(\Delta \log \mathrm{GDP}_{it} - \Delta \log \mathrm{GDP}_t\right) \;+\; \epsilon_{it}\,. \qquad (2)$$

In Table 1, we show results for the periods 1973–82, 1983–92, 1993–2000.[24] We estimated the regressions for the group of 8 long-time EU countries[25]—this group of countries may have developed closer financial integration during our sample periods than the more recent entrants to the EU.[26] Alternatively, the results are also given for the full set of current EU members (minus Luxembourg) and for the current Euro area (again leaving out Luxembourg). The results confirm the increase in risk sharing in the 1990s displayed in Figure 2. For the period 1972–82 risk sharing was basically nil among the EU countries (borderline positive for the smaller group), while risk sharing was significantly negative for the larger group as discussed previously. For the period since 1993, risk sharing is positive and clearly statistically significant in all three groups of countries. The amount of risk sharing is higher in the smaller group of long-time EU members for all sub-periods, although not strongly so except for the 1983–92 period. It is likely that mutual financial integration and risk sharing will increase faster for the countries that have adopted the Euro but more years are needed before this can be discerned by our statistical methods.

In Table 2, we display numbers for risk sharing among U.S. states. The numbers have

[24] The regression is similar to the one estimated by Asdrubali, Sørensen, and Yosha (1996). They included time-fixed effects (a dummy-variable for each year), rather than subtracting aggregate growth, but this makes little difference to the results so we choose the slightly more transparent form here.

[25] Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, and the United Kingdom (Luxembourg is left out because it is small and atypical).

[26] Sørensen and Yosha (1998) consider risk sharing among this group of EU countries. The results here will differ slightly for identical time-periods due to revisions of the National Accounts.

a slightly different interpretation than the numbers for risk sharing through international factor income flows among countries because GNP numbers are not available at the state level. Instead, numbers for income are used. Appendix A displays the relation between GDP, GNP, and personal income in the National Accounts.[27] In order to compare the OECD and the EU more closely to the U.S., Sørensen and Yosha (1998) also examine risk sharing between OECD countries and EU countries based on personal income and find that about 10-15% of GDP shocks are smoothed, so one may want to subtract this order of magnitude from the U.S. estimates of risk sharing in order to get a rough comparison with the estimates for the EU. Sørensen and Yosha find that the difference between the results obtained using GNP and the results obtained using personal income is mainly due to income smoothing through corporate savings.

In any event, the results of Table 2 are consistent with U.S. a highly significant amount of income smoothing between U.S. states with the amount of risk sharing increasing decade-by-decade as found by Asdrubali, Sørensen, and Yosha using data from 1963–1990. (Some of the results for that sample differ slightly from those presented in Asdrubali, Sørensen, and Yosha (1996) due to revisions of the state-level GDP data.) Clearly, the trend identified by those earlier authors is continuing through the 1990s with—according to the highly significant point estimate— more than half the variation of state-specific GDP shocks being smoothed through cross-state income flows in the 1990s.

As an alternative measure of risk sharing, we calculated (for the EU sample) simple correlations of country-level GDP and GNP with EU-wide GDP and GNP, respectively, as popularized by Backus, Kehoe, and Kydland (1992). (For brevity, we do not tabulate the details.) We find that the correlation of country-level GNP with EU-wide GNP increases in the late 1990s. This is the result that would be expected if international risk sharing is increasing and it is, therefore, consistent with the results presented above. This demonstrates

[27] More precisely, we use updated measures of "state income" as constructed for 1963–90 in Asdrubali, Sørensen, and Yosha (1996). State income consists of personal income after subtracting out all federal transfers and allocating all non-personal federal taxes to income (attempting to approximate what personal income would be without any federal taxes and transfers). Further, income of state governments that is not derived from personal taxes, like corporate- and severance-taxes, is available to the residents of states via the state governments and is also included in state income. We consider GNP the better "income" measure to use although the main patterns of risk sharing can be expected to be quite similar. The difference between GDP and GNP in the national accounts is mainly due to cross-border flows of dividends and interest, while personal income for given GDP is also affected by, e.g., patterns of corporate saving and capital depreciation.

that our results are not sensitive to the exact choice of empirical methods applied.

3.2 Specialization

We here explain how the index of specialization used by Kalemli-Ozcan, Sørensen, and Yosha (2003a) is calculated and update their results using the most recent data.

We calculate the specialization index for sectors at the 1-digit and 2-digit manufacturing International Standard Industrial Classification (ISIC) levels. The 1-digit sectors are manufacturing, agriculture, government, and so forth. The detailed sector definitions for the 1-digit and 2-digit manufacturing sectors are listed in Appendix B.[28] The degree of specialization at the 1-digit level is likely to be more important for overall diversification of shocks to the economy. However, we may get a clearer picture by looking at the manufacturing sub-sectors that respond mainly to market forces. The level of output in 1-digit sectors like agriculture and mining is determined primarily by endowments of fertile soil and extractable minerals, or the activities of agricultural lobbyists. The size of the government (1-digit) sector is primarily determined by social and political factors.

The specialization index for manufacturing is computed (for each country) for the relevant sample years as follows. Let GDP_i^s denote the GDP of manufacturing sub-sector s in country i, and GDP_i^M the total manufacturing GDP of this country. We measure the distance between the vector of sector shares in country i, $\text{GDP}_i^s \,/\, \text{GDP}_i^M$, and the vector of average sector shares in the EU-countries other than i:

$$\text{SPEC}_i = \sum_{s=1}^{S} \left(\frac{\text{GDP}_i^s}{\text{GDP}_i^M} - \frac{1}{J-1} \sum_{j \neq i} \frac{\text{GDP}_j^s}{\text{GDP}_j^M} \right)^2 , \tag{3}$$

where S is the number of sectors and J is the number of countries considered (the subset of the EU for which we were able to find the relevant data). Notice that SPEC_i measures how the composition of manufacturing in country i differs from the composition of manufacturing in the other countries of the EU. The index of 1-digit specialization is computed similarly using total country-level GDP rather than manufacturing GDP and 1-digit sectors rather

[28] The sectors used correspond to those used by Kalemli-Ozcan, Sørensen, and Yosha (2003a). In the first draft of this article we presented figures based on slightly more disaggregated 2-digit manufacturing sectors but some of those sectors were very tiny and this made the results somewhat fragile.

than manufacturing sub-sectors. We calculated similar indices for the 50 U.S. states for the same sub-period.

Figure 3 and Figure 4 display the average specialization index for the EU countries and the U.S. states, for 1-digit sectors and 2-digit manufacturing sectors, respectively, for the period 1991–2000. (We have data only for few countries before 1991. Belgium and the Netherlands are left out since our data source only included data for these countries from 1995 onwards.)

The Figures show that the U.S. states are much more specialized than the EU countries. This result is not surprising given that U.S. states are smaller on average than EU countries.[29] We focus on the time-trends of the indices. The more interesting results are found in Figure 3 for the 1-digit level: For the United States, specialization has declined, extending the trend that was found by Kim (1995). Importantly, this trend is *not* found for the EU countries where the degree of specialization has increased significantly at the 1-digit level. Our interpretation is that the downward trend found for the United States reflects the long-run technological factors identified by Kim (1995), but that this trend has (at least temporarily) been reversed due to financial market integration in the European Union.[30]

For the 2-digit manufacturing sectors we see—for both the EU and the U.S. states—an increase followed by a decline at the 2-digit manufacturing level. An inspection (not in the figure) of the 2-digit specialization pattern reveals that this pattern (in the EU case) is mainly driven by Ireland, which displayed very high growth during the 1990s, partly due to large inflows of foreign direct investment. Nonetheless, the (weak) overall trends at the 2-digit level is slightly upwards for the EU countries and slightly downward for the U.S. states consistent with the finding for the 1-digit level.

[29] A larger region is likely to be less specialized due to greater heterogeneity of population and of within-region geophysical characteristics such as climate, landscape, and natural resources. Furthermore, in larger regions, scale economies in production are more likely to be exhausted for some industries.

[30] This may also be the result of lower trade-barriers, see Krugman (1993), but since barriers to within-EU trade have been low for some time now, one might conjecture that the rise in financial integration in the late 1990s, as documented above, might have played an important role in the recent rise in country-level specialization.

3.3 Asymmetry of GDP versus Asymmetry of GNP and Income

Our measure of GDP asymmetry builds on the following counter-factual thought experiment:[31] Consider a group of countries each inhabited by a representative risk averse consumer who derives utility from consumption of a homogeneous non-storable good.[32] It is well known that under commonly used assumptions—symmetric information, no transaction costs, and identical CRRA utility and rate of time preference for all countries—perfect risk sharing among the countries in the group implies that $c_t^i = k^i gdp_t$.[33] Here c_t^i is the per capita consumption in country i, gdp_t is the aggregate per capita GDP of the group of countries under consideration, and k^i is a country-specific constant that does not vary with economic outcomes or over time.

For each country, we compare the expected utility of consuming the allocation under perfect risk sharing ($k^i gdp_t$) with that of consuming the output of the country (gdp_t^i). The difference represents *potential* gains from risk sharing that we will use as the basis for constructing our measure of fluctuations asymmetry. The logic is that the more a country can gain from sharing risk with other countries in a group, the more asymmetric are its GDP shocks relative to the group. (An analogous reasoning holds for U.S. states.)

To quantify these gains we must make distributional assumptions. Let the natural logarithm of the per capita GDP of the group and the per capita GDP of each country be random walks with drift. Further suppose that, conditional on gdp_0^i and gdp_0, the joint distribution of the log-differences of these processes is stationary, iid, Normal: $\Delta \log gdp_t \sim N(\mu, \sigma^2)$, $\Delta \log gdp_t^i \sim N(\mu^i, \sigma_i^2)$, and $\text{cov}(\Delta \log gsp_t^i, \Delta \log gdp_t) = \text{cov}^i$ for all t.[34] With these assumptions Kalemli-Ozcan, Sørensen, and Yosha (2001) derives closed form solutions for the

[31] See Kalemli-Ozcan, Sørensen, and Yosha (2001).

[32] In macro-theoretic parlance, this group constitutes a "stochastic endowment economy" in the sense that the GDP of these countries is regarded by consumers as exogenous and stochastic.

[33] The CRRA utility function, which includes the logarithmic utility function as a special case, is commonly used in macroeconomics and is generally considered as having good properties. The critical assumption here is that all countries or states are assumed to have the same attitude towards risk. If one region were less tolerant of risk than others it would be optimal for it to invest in international assets that would help lower the variance of consumption below that of "world" (EU or total U.S.) output in return for a lower average level of consumption. Note that we here abstract from investment, depreciation, etc. and simply assume that world consumption equals world output—our regressions are not affected by this short-cut that is made to simplify the discussion.

[34] This assumption involves an approximation since the aggregate GDP cannot, in general, be strictly log-normally distributed if each country's GDP is log-normally distributed.

potential gains from risk sharing assuming identical CRRA utility functions for all countries. We will here use the solution for log-utility, which yields simple and intuitive expressions.[35]

The potential gains from risk sharing are expressed in terms of consumption certainty equivalence. We do so by calculating the permanent percentage increase in the level of consumption that would generate an equivalent increase in expected utility. More precisely, the gain in utility (of moving from autarky to perfect risk sharing) equals the gain in utility that would be achieved by increasing consumption permanently from GDP_{i0} to $\text{GDP}_{i0} * (1+G_i)$. G_i is our country-by-country measure of fluctuations asymmetry and, for log-utility, is given by the expression:

$$G_i = \frac{1}{\delta}\left(\frac{1}{2}\sigma^2 + \frac{1}{2}\sigma_i^2 - \text{cov}^i\right). \tag{4}$$

The intuition for this formula is straightforward. First, the gain from sharing risk is higher for countries with a lower covariance between $\Delta \log gdp_t^i$ and $\Delta \log gdp_t$. The interpretation is that countries with "counter-cyclical" output provide insurance to other countries by stabilizing aggregate output and such countries are compensated accordingly in the risk sharing agreement. Second, the higher the variance of country i's GDP, other things equal the more it will benefit from sharing risk with other countries. Third, the higher the variance of the aggregate gross product of the group, keeping the variance of country i's GDP constant, the more other countries would be willing to "pay" country i for joining the risk sharing arrangement.

In the empirical implementation, the parameters σ^2, σ_i^2, and cov^i are estimated using country-level (or state-level) and aggregate GDP data. δ is the discount rate and we use a value of 2 percent. Because our measure is based on the utility that a country would obtain from consuming the value of its GDP we use, as our output measure, nominal GDP deflated by the Consumer Price Index (CPI).[36]

We calculate the asymmetry measure for EU countries and for U.S. states for the 1980s and the 1990s. We also calculate the measure using GNP data rather than GDP data. Note

[35] The empirical results are not very different for general CRRA utility.

[36] We stress the logic of deflating by the CPI rather than by a GDP-deflator: Since our measure is utility based, we want measured output to reflect consumption in autarky (with countries consuming the *value* of their GDP). Thus, we want to translate GDP to the amount of consumption that it can buy. This is obtained by deflating using the CPI.

that if risk sharing from factor income flows is perfect, such that the GNP of all countries (states) shows identical growth, the GNP-based measure of asymmetry will be zero, as no further gains from risk sharing are possible.

We show the results in Table 3. For both U.S. states and European countries the level of GDP asymmetry has declined dramatically from the 1980s to the 1990s. It seems that country-level and regional-level business cycles have become less asymmetric. We cannot tell what lies behind this observation, whether this is a "structural" more permanent pattern or is the result of the type of shocks driving GDP variation in the 1980s versus the 1990s (the early 1980s saw much turmoil in financial markets). If we were to venture a guess, we think the decline in asymmetry in the 1990s is due to different types of shocks hitting the economies in these two sub-periods.

For the U.S. states, high risk sharing is reflected in much lower asymmetry of income than of state-level GDP. Surprisingly, for the EU countries GNP is *more* asymmetric than GDP. Recall that GNP equals GDP plus net factor income (mainly profits, dividends, and interest) from other countries. If net factor income flows from other countries are as volatile as the GDP of those countries—as in the textbook case where countries directly trade rights to country level output—then GNP asymmetry *must* be lower than GDP asymmetry as long as these factor income flows from abroad are not perfectly correlated with domestic GDP and therefore smooth GNP (and income). The empirical finding that GNP asymmetry is higher than GDP asymmetry implies that the volatility of net factor income flows from abroad is higher than the volatility of GDP in the countries of origin. We speculate that this happens due to the high (some would say "excessive") volatility of financial returns and due to these returns not providing a hedge against domestic GDP fluctuations (i.e., foreign asset holdings are not acquired mainly for hedging domestic output risk and, thus, do not provide returns that are negatively correlated with the output of the home economy). As long as a substantial fraction of foreign asset holdings in EU countries takes the form of assets traded on foreign stock and bond exchanges, rather than foreign direct investment, it may be the case that the asset income from such international investments boosts the variance of GNP in each country, rather than stabilizing it. As financial integration deepens, and more foreign investments take the form of direct investment in productive assets, it is likely that the degree of GNP asymmetry will decline and fall below that of GDP asymmetry, as is the case in the

United States.

4 Implications for Europe

To start with one point that seems to have been somewhat ignored in the literature: Asymmetry of output shocks is not likely to create strains in a currency union unless it creates high asymmetry of *income* and consumption.[37] Asymmetry of output is obviously a determinant of income asymmetry, but this asymmetry is directly mitigated if inter-country risk sharing in significant. Our measure of risk sharing has the simple interpretation of measuring the percentage of country-specific shocks to output (in percent growth terms) that is passed on to income. In the United States, we find that less than 50 percent of output shocks are reflected in income shocks (which are further smoothed through federal taxes and transfers). We expect countries in the EU to reach similar levels of risk sharing and our results indicate that this process is currently gaining momentum.[38] It is worth noticing that the degree of risk sharing in the United States is still increasing in spite of having already reached a high level.

The impact of trade on asymmetry, stressed by Krugman (1993), has received much attention. Other things equal, lower trade barriers should lead to more inter-industry trade and greater industrial specialization which, in turn, should result in greater GDP asymmetry. Frankel and Rose (1998) argued that demand spillovers and (in particular) more intra-industry trade might dominate this effect and could render GDP asymmetry smaller, not larger. They show empirically that indeed, this effect dominates in the data. Their work does not take into account the direct effect of risk sharing on specialization documented by Kalemli-Ozcan, Sørensen, and Yosha (2003a) and the resulting effect on asymmetry documented by Kalemli-Ozcan, Sørensen, and Yosha (2001) and Imbs (2003).

The current paper does not update the analysis in these earlier papers but rather looks at

[37] Supra-national governments can smooth disposable income but, according to Asdrubali, Sørensen, and Yosha (1996), even in the United States where the federal government is quite big, this channel is less important than income smoothing on capital markets. Asymmetry of consumption fluctuations is, in our view, generally less reliable empirically because variation often seems to be caused by taste shocks making measures of consumption asymmetry suspect for evaluating welfare gains from risk sharing.

[38] The U.S. results are not directly comparable since they also include within-state income smoothing through earning retention (dividend payout) patterns.

the time-series patterns. These seem highly consistent with these earlier results, risk sharing in the EU has been increasing and so has industrial specialization. We speculate that risk sharing plays an important causal role because trade barriers have been low within the EU for a long period of time and the effect of lower trade barriers may, therefore, partly have played itself out. More empirical work will be needed to test this conjecture.

Surprisingly, output asymmetry has declined steeply over the last two decades. We cannot tell which of the channels we identify in Figure 4 is the cause of this result. It may be due to more coordinated policy as countries were adjusting their fiscal policy in order to meet the Maastricht criteria, but a similar result was found for U.S. states so the finding may be simply due to a different nature of the shocks to the world economy in the 1990s (inflation being conquered in the 1990s, the "new economy," ...).

We found higher asymmetry of GNP than of GDP among EU countries. As mentioned, one component of net factor income flows are returns from international equity investment. An active literature has documented that developed country stock and bond market returns have been highly correlated recently diminishing the stabilizing impact of diversification; see, for example, Goetzman, Li, and Rouwenhorst (2002) and Mauro, Sussman, and Yafeh (2002). It may be that these findings from financial markets have the same roots as our findings of declining GDP asymmetry although we leave empirical corroboration of this conjecture for future research. This does not rule out GNP asymmetry being higher than GDP asymmetry if international investments take place mainly through equity traded on stock markets because stock market volatility typically far exceeds the volatility of GDP. Our expectation is that as financial integration further progresses and cross-border investments become further diversified, the variance of factor income flows will decline and GNP will become less asymmetric than GDP. This conjecture is, of course, strongly influenced by the observation that risk sharing among U.S. states has led to sharply lower asymmetry of income relative to the asymmetry of state-level GDP.

All in all, we expect to see risk sharing between EU countries increasing further. This should lead to more specialization, and we expect the resulting increase in the asymmetry of GDP fluctuations to have small welfare costs as better risk sharing lowers the asymmetry of *income* (and GNP) fluctuations.

EU governments can help promote inter-country risk sharing by removing barriers to

international flows of credit (for example, by being more supportive of cross-border mergers of financial institutions). They can further provide risk sharing by strengthening funds that provide insurance against economic calamities that may affect whole countries. However—in light of the findings for the United States—the bulk of risk sharing within the EU can be expected to come from further private capital market integration. EU governments can help this process by removing any remaining barriers affecting the ability of mutual funds and, in particular, pension funds to diversify internationally.

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Appendix A: Relation between GDP and GNP of (say) the United States:

	U.S. GDP (Gross value of production physically *in* the United States)
+	Income from U.S. owned direct investment in other countries
–	Income of foreign owned direct investment in the United States
+	Income from U.S. owned portfolio investment in other countries
–	Income of foreign owned portfolio investment in the United States
+	Income from U.S. government investment in other countries
–	Income of foreign investment in United States government assets
+	Wage and salary earned in other countries by residents of the United States
–	Wage and salary earned in the United States by residents of other countries
=	U.S. GNP (Gross value of production *owned* by U.S. residents)
+	Subsidies - Indirect business taxes
–	Corporate saving
–	Net interest
+	Personal interest income
–	Contributions for social insurance
+	Government transfers to persons
=	Personal Income

Notes: (i) *Residents* of the United States contribute to U.S. GNP whether they are *citizens* of the Unites States or not and, while the number of foreign citizens in the United States is large, the total wage and salary of foreign residents in the United States is fairly small (less than 4% of total U.S. income payments to foreign countries in 2002).

(ii) Government investments abroad are mainly official currency reserves, while government liabilities are mainly treasury securities.

This Table is a simplified version, which leaves out some minor components. See, for example, the National Income and Product Accounts published by the U.S. Bureau of Economic Analysis for further details. Numbers for international income receipts and payments can be found at http://www.census.gov/prod/2002pubs/01statab/foreign.pdf, Table 1281.

Appendix B: Data

Data for U.S. states are collected from various sources (state level GDP data are from the Bureau of Economic Analysis) documented in Asdrubali, Sørensen, and Yosha (1996). National Accounts data for the EU are from the OECD National Accounts Volume 1, Revision 2002. To calculate the specialization index, we use data from the OECD National Accounts Volume 2, Revision 2002, in current prices. 10 1-digit ISIC sectors and 9 manufacturing GDP 2-digit ISIC sectors are shown below.

1-digit ISIC sectors

1. Agriculture, fishing, hunting and forestry
2. Mining and quarrying
3. Construction
4. Manufacturing
5. Electricity, gas and water supply
6. Transport, storage and communication
7. Wholesale and retail trade
8. Finance, insurance, and real estate
9. Services
10. Government

2-digit Manufacturing ISIC sectors

1. Food, beverages and tobacco
2. Textile, wearing apparel and leather industries
3. Wood and wood products, including furniture
4. Paper and paper products, printing and publishing
5. Chemicals and chemical petroleum, coal, rubber and plastic products
6. Non-metallic mineral products, except products of petroleum and coal
7. Basic metal industries
8. Fabricated metal products, machinery and equipment
9. Other manufactured products

Table 1: Risk sharing through international factor income flows: EU 1972–2000

Sample		1972–1982	1983–1992	1993–2000
EU8				
	Risk sharing (β_K)	4	2	11
		(2)	(1)	(3)
EU14				
	Risk sharing (β_K)	0	–7	6
		(0)	(4)	(2)
Euro area				
	Risk sharing (β_K)	2	–8	9
		(2)	(4)	(4)

Notes: β_K measures income insurance among the countries of the risk sharing group and is obtained from the panel regression $\Delta \log \text{GNP}_{it} - \Delta \log \text{GNP}_t = \text{constant} + \beta_K \ (\Delta \log \text{GDP}_{it} - \Delta \log \text{GDP}_t) + \epsilon_{it}$, where $\Delta \log \text{GDP}$ and $\Delta \log \text{GNP}$ are growth rates of per capita GDP and GNP. t-statistics in parentheses. The entry for risk sharing (β_K) is the percentage of a county-specific shocks to output (GDP) that is not reflected in GNP. EU8: Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, and the United Kingdom. EU14: EU8 plus Austria, Finland, Greece, Portugal, Spain, and Sweden. Euro area: EU14 minus Denmark, Sweden, and the United Kingdom .

Table 2: Risk sharing through capital markets: U.S. states 1964–1998

	1964–1970	1971–1980	1981–1990	1991–1998
Risk sharing (β_K)	29	42	48	55
	(7)	(8)	(10)	(14)

Notes: $\Delta \log y_{it} - \Delta \log y_t = \text{constant} + \beta_K \ (\Delta \log \text{GDP}_{it} - \Delta \log \text{GDP}_t) + \epsilon_{it}$, where $\Delta \log \text{GDP}$ and $\Delta \log y$ are growth rates of per capita GDP and personal income. t-statistics in parentheses. The entry for risk sharing (β_K) is the percentage of a state-specific shock to output (to state-level GDP) that is not reflected in state income (more precisely "state income" constructed as in Asdrubali, Sørensen, and Yosha (1996)). The difference between GDP and state income includes inter-state factor income flows, depreciation, and corporate saving.

Table 3: Asymmetry of GDP versus asymmetry of GNP and Income, U.S. and EU.

Sample		1983–1991	1991–1999
U.S.			
	Asymmetry (GDP)	2.99	0.89
	Asymmetry (Income)	0.82	0.42
Sample		1983–1991	1991–2000
EU14			
	Asymmetry (GDP)	1.23	0.61
	Asymmetry (GNP)	1.49	0.79

Notes: The asymmetry measure is calculated as $10^2 * \frac{1}{\delta}\left(\frac{1}{2}\sigma^2 + \frac{1}{2}\sigma_i^2 - \text{cov}^i\right)$, where $\sigma_i^2 = \text{var}(\Delta \log \text{GDP}^i)$ [in other words, it is $\text{var}(100 * \Delta \log \text{GDP}^i)$], where $\text{cov}^i = \text{cov}\left(\Delta \log \text{GDP}^i, \Delta \log \text{GDP}\right)$, and $\delta = 0.02$ and $\sigma^2 = 0.000839$. The entry for asymmetry is interpreted as the welfare gain that a state/country would obtain from fully diversifying any state/country-specific variance in output/GNP/Personal Income expressed in terms of the percent permanent increase in GDP that would result in the same utility gain. EU14: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

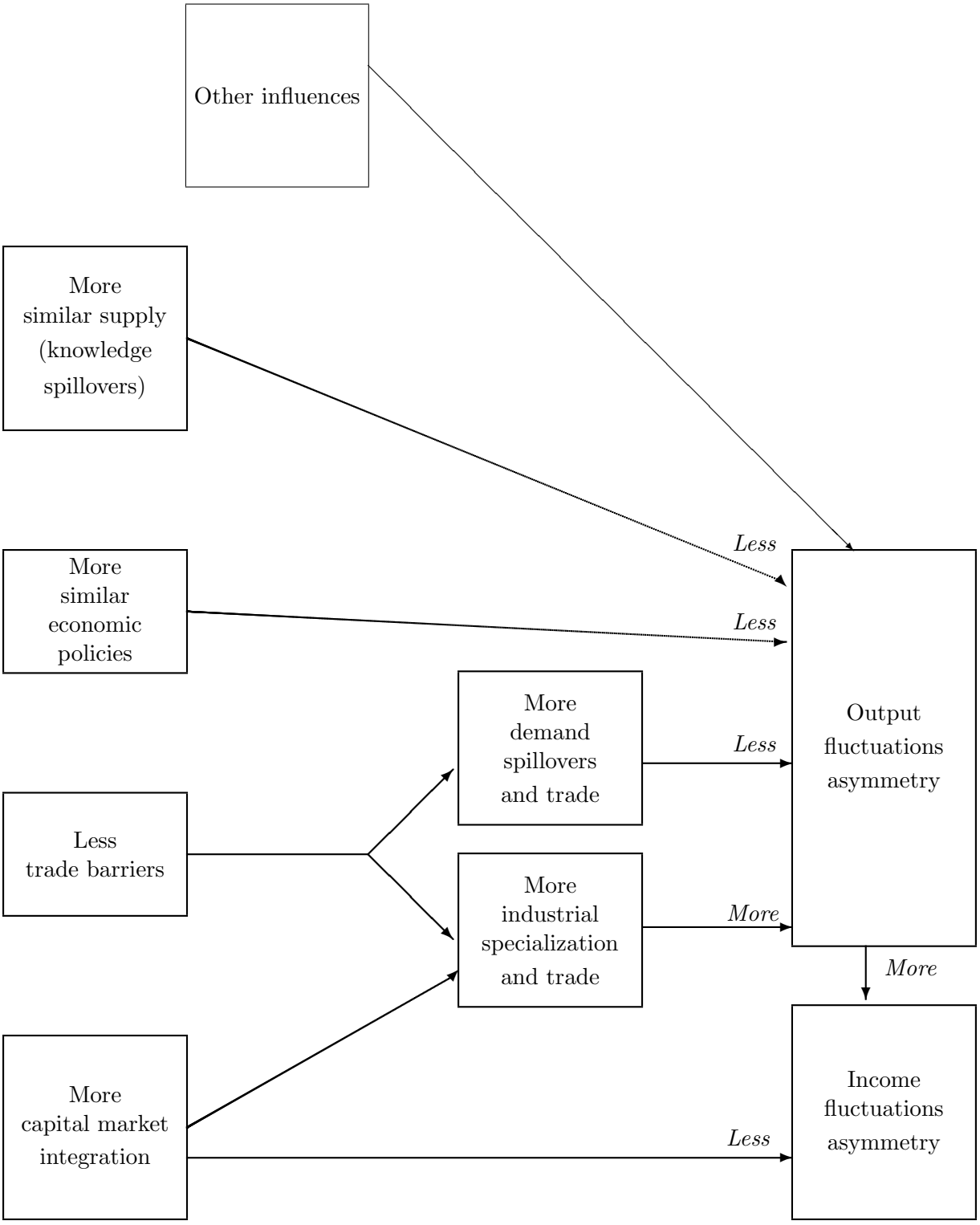
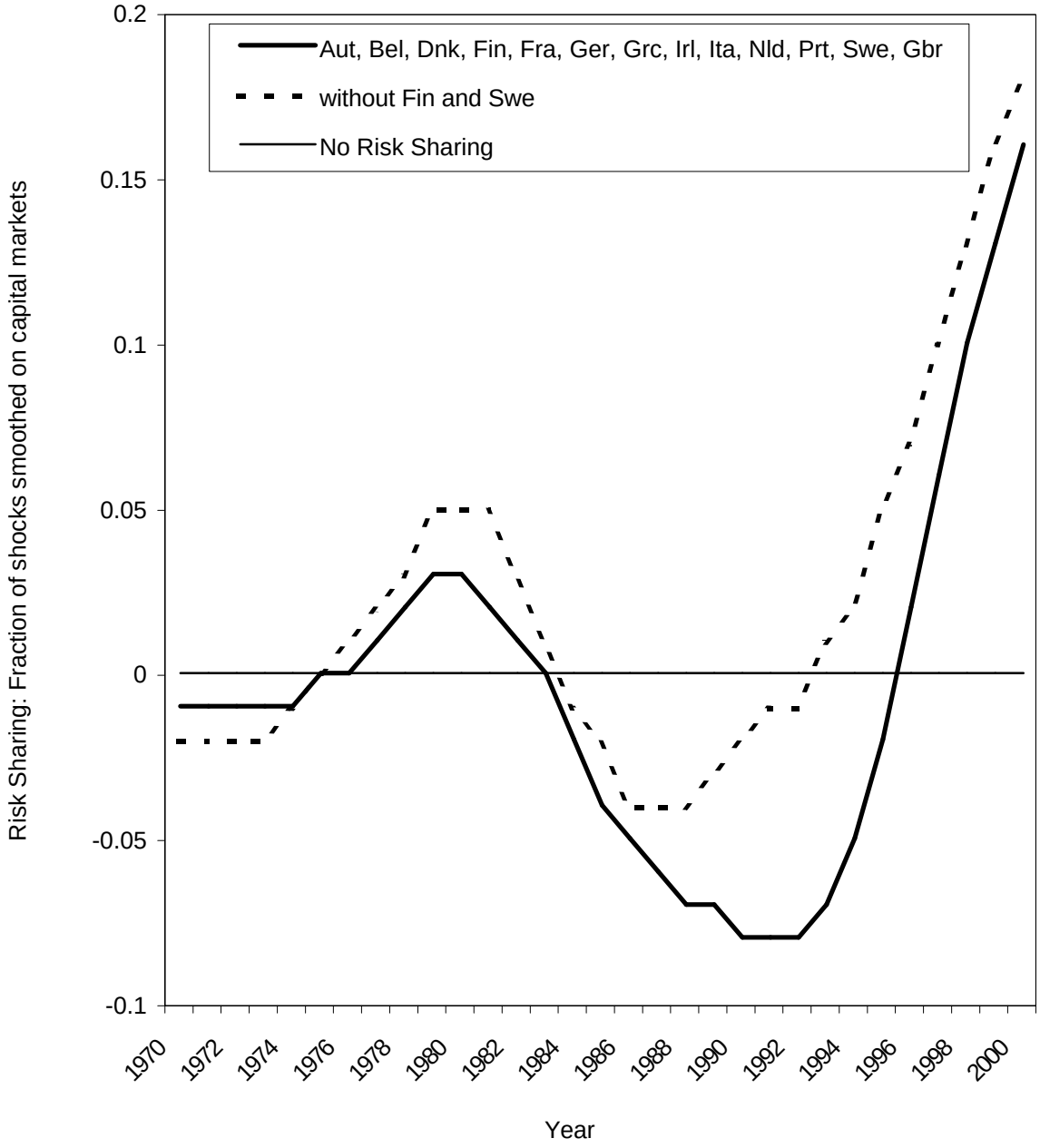


Figure 1: The Effects of Economic Integration on Fluctuations Asymmetry
(A stylized picture)

Figure 2: Risk Sharing in the EU



Notes: The solid line represents the average level of risk sharing between Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Sweden, and the United Kingdom. The dashed line represents the average risk sharing between countries in the same group without Finland and Sweden.

Figure 3a: Average Specialization in the EU: 1-Digit ISIC Level

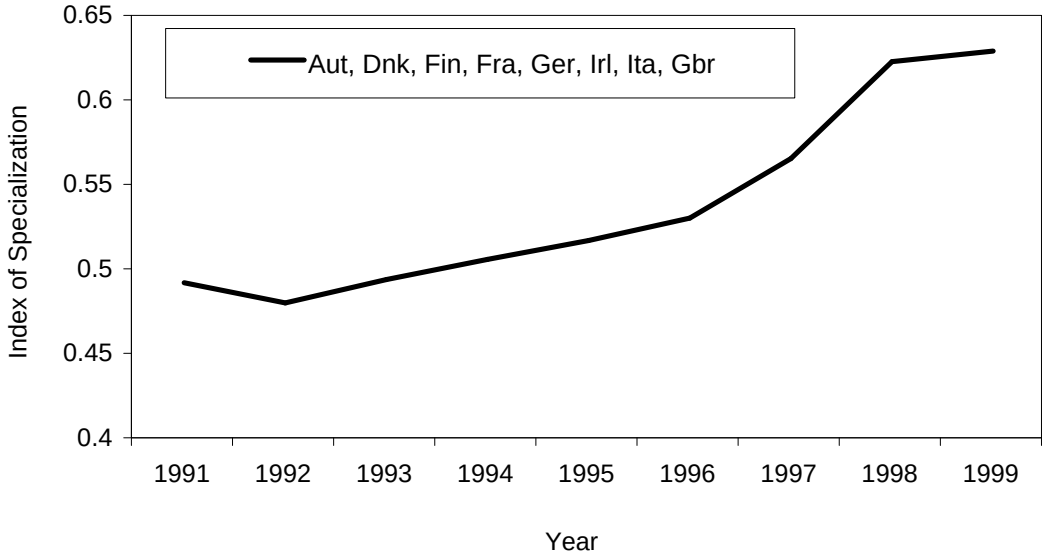
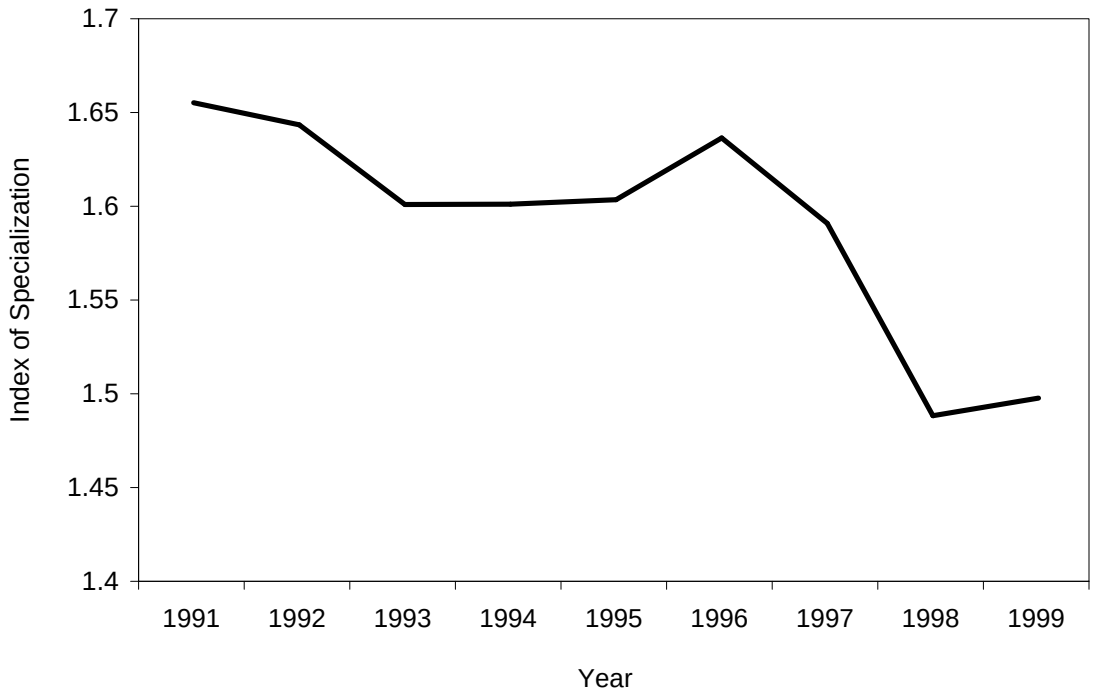


Figure 3b: Average Specialization in the U.S.: 1-Digit ISIC Level



Notes: In the upper panel the solid line represents the average level of specialization of Austria, Denmark, Finland, France, Germany, Ireland, Italy, and the United Kingdom.
In the bottom panel it represents the average level of specialization of U.S. states.

Figure 4a: Average Specialization in the EU: 2-Digit ISIC Level

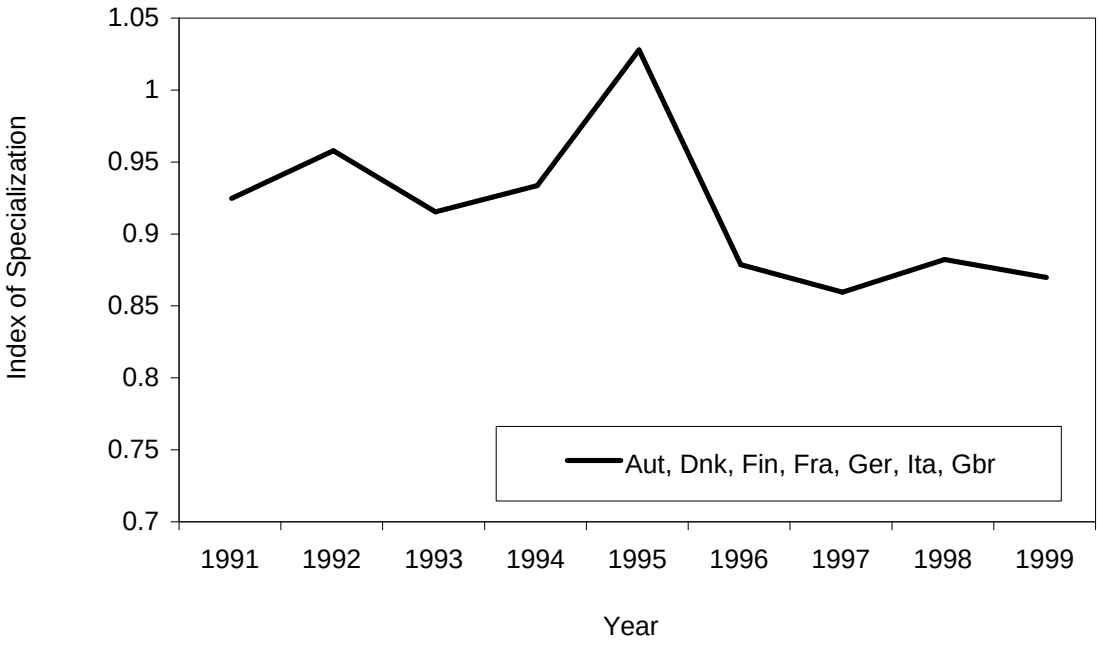
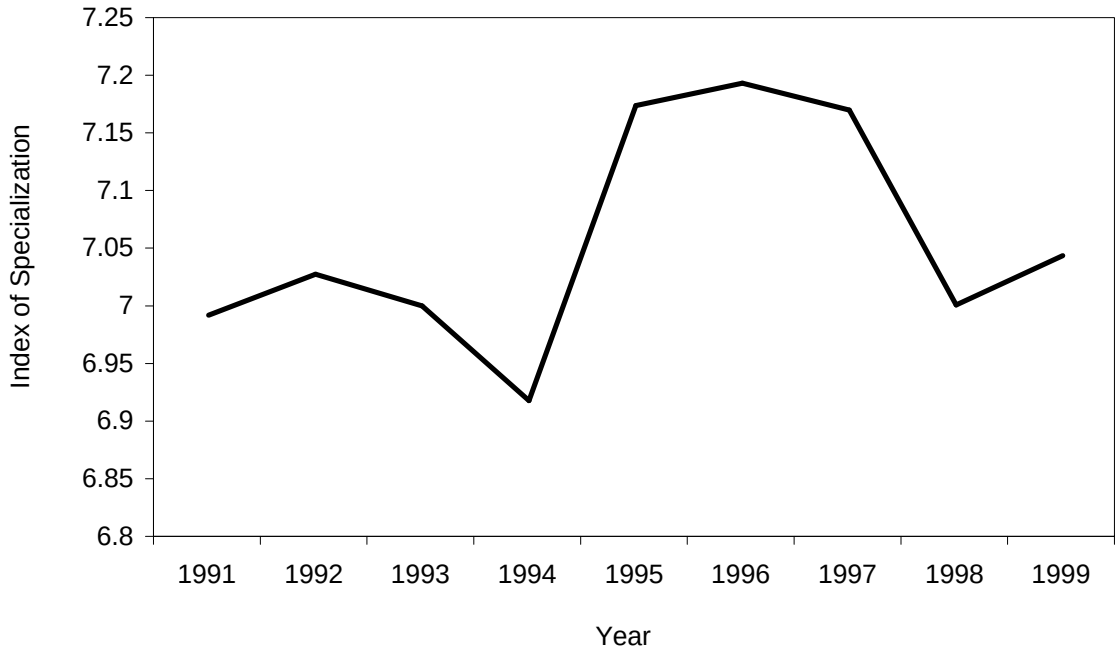


Figure 4b: Average Specialization in the U.S.: 2-Digit ISIC Level



Notes: In the upper panel the solid line represents the average level of specialization of Austria, Denmark, Finland, France, Germany, Ireland, Italy, and the United Kingdom.
In the bottom panel it represents the average level of specialization of U.S. states.