Macro Markets and Financial Security

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Today, people have a rich set of investment options, ranging from low-risk money market instruments to high-risk growth stocks. They can choose to invest in mutual funds, hedge funds, and pension plans. They can hedge themselves with options and other derivatives while investing both at home and across the globe. Plenty of opportunities are available for diversifying their portfolios and avoiding excess exposure to sectoral or geographic risk. Nonetheless, there is good reason to believe that most people's wealth is not well diversified. For example, although investors can diversify through equity markets, corporate profits account for less than 10 percent of national income. That figure suggests that about 90 percent of an average person's income is sensitive to sectoral, occupational, and geographic uncertainty.

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Shiller (1993) has proposed a new set of markets that could in theory provide much better diversification opportunities. These so-called macro markets would be large international markets trading, in the form of futures contracts, long-term claims on major components of incomes shared by a large number of people or organizations. For example, in a macro market for the United States, an investor could buy a claim on the U.S. national income and then receive, for as long as the claim is held, dividends equal to a specified fraction of U.S. national income. Such a claim is comparable to a share in a corporation, except that the dividend would equal a share of national income rather than a share of corporate profits. Such markets might exist for entire countries—the United States, Japan, and Brazil—or for regions—such as the European Union and North America. Even a market for claims on the combined incomes of the entire world could be formed. Prices would rise and fall in these markets as new information about national, regional, or global economies became available, just as

prices rise and fall in the stock market as new information about corporate profits is revealed.

The potential future importance of these markets is supported by the most basic principle of finance—diversification. People could use macro markets to hedge their own national income risks and to invest in the rest of the world. This investment strategy would reduce income growth uncertainty and lead to a more secure financial future.

We address several questions in this paper. First, how could macro markets be useful to the average person? Second, how large are the potential benefits from diversification if these markets were to be introduced and used optimally? Third, can existing financial markets achieve a similar degree of diversification when used optimally? Fourth, why don't these markets already exist?

How Would Investors Use Macro Markets?

The basic idea behind macro markets is a simple one. Consider the case of claims on national income. If macro markets existed for every country of the world, people could take short positions in their country's market, thereby hedging their own country's risk, and long positions in the markets of all other countries in proportion to each country's size, thereby completely hedging themselves. The short positions in their home country would exactly offset the long positions that they hold by virtue of living there, and the long positions in the world would mean that they were completely diversified. If everyone hedged risk in this way, it would all add up, that is, for every long in every country there would be a short, and demand would equal supply in each macro market. The dividends paid on the securities for each country would be paid by the people who live in that country and hold short positions. By definition, these people can always make the payments because they are earning the national income upon which the dividends are drawn.

Taking such positions in these markets is the best way for an individual to achieve diversification. After hedging, everyone earns a share of global income. It would be impossible for individuals to lower their risks any further. It is impossible for everyone to diversify away uncertainty about global income, because total income earned across all individuals equals global income itself.

Retail Institutions

Of course, most people are not accustomed to hedging. Thus, it would probably be unrealistic to expect the average person to hedge through macro markets without the assistance of intermediaries. Most people *are* familiar with insurance, and they readily buy insurance against other risks. Retail institutions, such as pension funds or insurance companies, could offer people contracts to hedge their aggregate income risk. These insurance companies and pension funds would trade in macro markets to sell off the risk incurred by writing the contracts in retail markets. These institutional investors would be hedging, much as institutions now hedge in stock index futures markets.

An Average Investor

We will now give an example of how these markets and retail institutions could serve the individual investor. Consider a person who earns income from wages and from returns on financial assets (such as stocks and bonds). The individual cares about the uncertainty of the future value of his or her *total wealth*, which is the sum of the future value of financial assets and the future value of "human capital." The value of human capital is equal to the present value of the stream of future wages earned by the individual. The value of the person's wealth can thus be written as

$$Wealth = PDV(\Pi) + PDV(W),$$

where *PDV* is present discounted value, Π represents the annual dividends and interest earned from financial assets, and W is wages plus noncorporate business income. Even if the individual were well diversified in the equity and bond markets, he or she would still be exposed to uncertainty associated with wages earned. Because wages plus noncorporate profits are at least nine times as great as corporate profits (in national income accounts), the largest component of wealth remains undiversified.

Let us further assume that the wealth of the individual is "average"—the value of the individual's financial

assets is average and his or her wages are equal to the average wage rate in the country plus an idiosyncratic component. The idiosyncratic component of wages depends on individual-specific effort as well as a dose of good or bad luck. Insuring against the idiosyncratic component is impossible because of moral hazard problems. If an individual were insured against all uncertainty about future wages, he or she would have little incentive to work hard and to put effort into a successful career. Given these assumptions, the value of wages is written as $W = W_C + W_I$, where W_C is the average wage rate in the country, and W_I is the idiosyncratic component. The sum of the idiosyncratic component over all individuals is zero. Moral hazard problems do not apply to insuring oneself against uncertainty about W_C because the individual has little control over the average wage rate earned in the country as a whole.

The individual clearly gains by hedging in macro markets to the extent that less uncertainty surrounds the growth rate of world output than the growth rate of the home country's output.

We also assume that the individual invests only in domestic stocks and bonds and that he or she is well diversified domestically. The absence of international diversification is not far from current practice: Japanese and U.S. investors hold at least 90 percent of their equity portfolio in domestic assets.[1] Because the individual's financial assets are average, the dividends earned on these assets, Π, are equal to the per capita value of total corporate profits in the country. We can then write the individual's wealth as

$$Wealth = PDV(GDP) + PDV(W_I),$$

where *GDP* is per capita gross domestic product, which equals $\Pi + W_C$. Wealth is therefore equal to the present discounted value of future per capita GDP plus the present discounted value of the idiosyncratic component of wages. Macro markets can be used to insure the uncertainty associated with per capita GDP.

As a matter of simplification, assume that the expected future per capita GDP of the country in which the individual resides is equal to that for the world as a whole (GDP_W) and that the "riskiness" of the country's future GDP is average. We will be more precise about what that means in a moment. Insurance companies and pension funds can allow people to hedge uncertainty about the country's per capita GDP by offering a hedging instrument with a yearly payoff of $GDP_W - GDP$. As we explain below, the price of this hedging instrument is zero. Although the expected payoff is zero, the actual payoff can be both positive or negative. If it is negative, the individual must make a payment. If the hedging instrument is offered by a pension fund, the payment could be made through a debit on the individual's account at the pension fund. This contract is attractive to a risk-averse individual because he or she will lose on the hedging contract only when the domestic economy is doing unexpectedly well. The individual will receive positive payments from the contract when the economy's performance is unexpectedly poor. If the individual opts to use this instrument, his or her net wealth will be

$$Wealth = PDV(GDP_W) + PDV(W_I).$$

The individual clearly gains by hedging in macro markets to the extent that less uncertainty surrounds the growth rate of world output than the growth rate of the home country's output.

Notice that in our example the individual invests only in domestic financial assets, then hedges uncertainty about both domestic financial returns and domestic wages through the hedging instrument. This investment strategy is attractive because it avoids the need to make decisions about investment in foreign financial assets. The problem of asymmetric information means that domestic investors are at a disadvantage relative to foreign investors when evaluating foreign stocks and bonds. Foreign investors tend to be better informed about companies trading in their own stock markets, particularly in the case of smaller companies. They can therefore adjust their portfolio more rapidly than domestic investors as new information becomes available to them. Gehrig (1993) shows that investors are reluctant to invest abroad if foreign investors receive a more precise price signal

about foreign stock returns than domestic investors. Asymmetric information is one of the most common explanations for the lack of observed international diversification in equity and bond markets. In macro markets, which are tied to aggregate incomes, asymmetric information is much less of a concern. Japanese investors are not likely to predict Japanese GDP growth rates more accurately than U.S. investors because the information needed to make such predictions is publicly available.

The diversification strategy outlined above is different from the type of diversification most investors are accustomed to. Most individual stock market investors diversify by investing their money in a wide basket of assets. With macro markets, diversification is achieved instead through a hedging contract.

Pricing in Macro Markets

So far we have left two issues unaddressed. First, the institutional investors that offer the hedging contract we just described will themselves be exposed to risk when offering the instrument. Second, we have yet to explain why the price of the contract will be zero. To understand how institutional investors will lay off the risk and what factors determine prices, we describe in more detail the macro markets on which the hedging instruments are based. These markets trade perpetual claims on a GDP index. Trade can take place either over the counter or on an exchange like the Chicago Board of Trade.

Existing theoretical research has laid out exactly what will determine prices in markets like these.[2] As with any asset, the price of a claim on a country's per capita GDP depends on two factors—expected payoff and risk. The expected payoff is the expected present discounted value of future per capita GDP. Risk is measured by the covariance between the present discounted value of a country's per capita GDP and the present discounted value of the world's GDP.

First consider a simple example in a symmetric world. Two countries have an equal number of residents. Assume that expected future per capita GDP is the same in both markets. If we also assume that the variance of the present discounted value of GDP is the same for both countries, then the covariance with the world claim will be identical for the two countries. Claims on the per capita GDP of both countries therefore will have the same price.

Let us say for the sake of simplicity that the only traders in these markets are pension funds, and let N be the size of the population in both markets. Domestic pension funds will sell $\frac{1}{2}N$ perpetual claims on domestic per capita GDP and buy $\frac{1}{2}N$ perpetual claims on foreign per capita GDP. Because these claims have the same price, the net cost will be zero. Foreign pension funds take the other side of the market. The per capita gross domestic product of the world, GDP_W, equals $\frac{1}{2}GDP + \frac{1}{2}GDP^*$, where GDP^* is foreign per capita GDP. Through their operations in the macro markets, domestic pension funds have effectively purchased N perpetual claims on $GDP_W - GDP$. Because the pension funds also sell N perpetual claims on $GDP_W - GDP$ to domestic individuals through the hedging instrument, domestic pension funds break even. The same is true for the foreign pension funds. The two countries have effectively agreed to swap a claim on half of each other's GDP. Under this arrangement, there is no cost or "insurance premium" to reducing risks. After risk sharing, the residents of both countries will hold claims on half the domestic country's per capita GDP plus half the foreign country's per capita GDP, which together add up to world per capita GDP. Residents' expected average income is the same as it was before, but the variability of income is lower.

Because people's exposure to national income risk differs, limiting trade in claims on a country's national income to the residents of that particular country would be beneficial.

So far everything in the example is very symmetric. Now suppose that the domestic country is much larger than the foreign country: its population N is a hundred times that of the foreign country. Accordingly, the covariance between

domestic GDP and world GDP will be higher than the covariance between foreign GDP and world GDP, even if the variance of per capita GDP in both countries is the same. The price of a perpetual claim on the foreign country's per capita GDP will therefore be lower than the price of a claim on the domestic country's per capita GDP.

If the prices of claims on the per capita GDP of both countries were still equal—as they were when both countries had the same population—then people in the larger country would want to swap half their income for half the per capita income of the people in the smaller country. But there are not enough people in the smaller country to take the other side of these transactions. Therefore, the price of a perpetual claim on the foreign country's per capita GDP will be higher than the price of a claim on the domestic country's per capita GDP. Consequently, the people in the larger country will be discouraged from demanding so many claims on the foreign country, and market clearing can take place.

In more technical terms, a claim on domestic per capita GDP can be exchanged for α claims on world per capita GDP, with $\alpha < 1$. Through trade in macro markets, domestic pension funds will buy N claims on $\alpha(GDP_W) - GDP$ (with a net price of zero) and sell those claims as hedging instruments to domestic individuals. After the hedge, domestic residents have a perpetual claim on α times per capita world GDP. Foreign pension funds will take the other side of the market by selling N claims on $\alpha(GDP_W) - GDP$, which is equivalent to buying $N/100$ (the foreign population) claims on $\beta GDP_W - (GDP)^*$. Here $\beta = 101 - 100\alpha > 1$. Foreign pension funds will sell these claims as hedging instruments to foreign individuals, who will then own a perpetual claim on β times per capita world GDP. The higher price of a claim on the foreign country's output leads to larger claims on world per capita GDP by foreign residents after risk sharing.

In the example above, we have assumed for simplicity that all individuals within a country have the same exposure to their country's national income risk. In reality, some individual's income is more sensitive to national growth rates than other people's income. The optimal hedge position that an investor takes through pension funds or insurance companies depends on his or her exposure to national risk. Because people's exposure to national income risk differs, limiting trade in claims on a country's national income to the residents of that particular country would be beneficial. Although this limitation would eliminate international risk sharing, it would allow individuals to share their exposures to national income risk. Ultimately, through the appropriate retail institutions, those individuals with high exposure to national income risk could sell perpetual claims indexed to national income to those individuals with low exposure to national income risk.

The Potential Risk-Sharing Benefits

Individuals are exposed to many types of aggregate risk. The most common risks are specific to a sector (occupational risk), to an age cohort (demographic risk), or to a geographic area in which someone works (geographic risk). For example, an auto worker is subject to auto industry risk. A decline in demand for automobiles will affect the entire industry. Geographic risk can be linked to a specific neighborhood or to a whole continent. To measure the potential diversification benefits of macro markets, we restrict our analysis to national income risk, abstracting from other types of aggregate risk. Because we limit ourselves to national risk, the measure of hedgeable aggregate income risk derived in this section is lower than the level achievable through aggregate income markets generally.

Because individuals cannot diversify away global income growth uncertainty, we focus on country-specific growth, that is, the difference between a country's growth rate and the world growth rate. As explained in the previous section, macro markets allow individuals to eliminate the country-specific component of their income growth uncertainty. We now quantify the size of this uncertainty.[3]

A Regression Model of Country-Specific Growth Uncertainty

To identify country-specific growth uncertainty, we estimate the following regression for each horizon s:

$$g_{i,\,t,\,t+s} - g^{w}_{t,\,t+s} = \lambda_s'\left(z_{it} - z^{w}_{t}\right) + u_{i,\,t,\,t+s}.$$

The left-hand side of the equation represents country *i*'s growth in real per capita GDP from year *t* to $t + s$ minus global growth in real per capita GDP over the same period. The first term on the right-hand side of the equation is the predictable component of the deviation of country growth from world growth. This component depends on the relevant information set available to the market, which is captured by the vector z_{it}, in deviation from its global counterpart. The term *u* is the unpredictable component of the country-specific deviation from world growth. We also refer to country-specific growth uncertainty as residual risk.

We apply this regression for various horizons using panel data for the postwar period (1955-90) from the Penn World Tables and the Barro and Lee (1994) data set.[4] In our application, we consider two different sets of countries that engage in risk sharing (and therefore make up our artificial "world"): a set of twenty-one OECD countries and a more comprehensive set of forty-nine countries (see appendix). The OECD countries are of interest because they would likely be the first countries to experiment with macro markets. Their income risk, however, is likely to fall below that of developing countries. The larger set of forty-nine countries provides us with an estimate of the potential risk-sharing benefits in the event that a broader array of countries introduced macro markets. Because we have only one growth observation per country for long horizons, we are unable to estimate country-specific growth uncertainty for each country separately. Thus, the results from the regressions, which combine data from all the countries in the sample, reflect "average" growth uncertainty across countries.

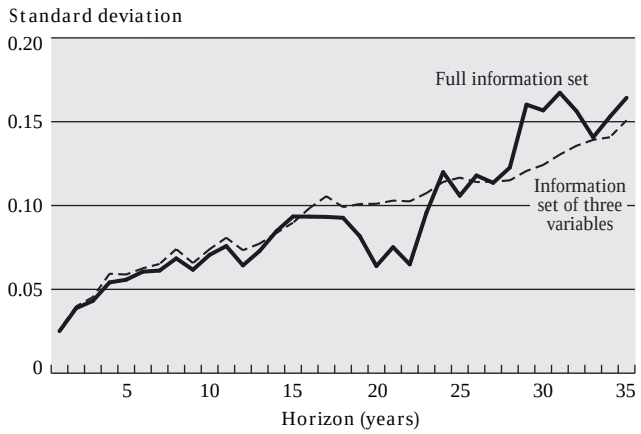
In choosing the variables that make up the information set, we draw on a large empirical and theoretical literature on economic growth.[5] Our base information set consists of thirteen variables: the log of per capita GDP; the most recent one- and five-year growth rates of per capita GDP; the most recent five-year population growth rate; the ratio of private consumption to GDP; the ratio of government consumption to GDP; the ratio of investment to GDP; openness as measured by exports plus imports as a fraction of GDP; gross enrollment ratios for primary, secondary, and higher education; the fertility rate; and life expectancy at birth.[6] We also consider a smaller information set consisting of the three variables with the most predictive power; that is, they led to the lowest estimated standard deviation of residual risk at a thirty-five-year horizon. For the set of forty-nine countries, these variables are the log of per capita GDP, the fertility rate, and the investment rate. For the OECD country set, the investment rate is replaced by enrollment in higher education.

Diversifiable Country-Specific Risk

Charts 1 and 2 show the standard deviation of residual risk as a function of the time horizon. For the base information set, the standard deviation of the growth rate at a thirty-five-year horizon is 16.4 percent for the set of OECD countries and 33 percent for the set of forty-nine countries. These numbers are very large, implying a 95 percent confidence interval of 66 percent for OECD countries and 132 percent for the forty-nine countries. The charts also show that the results for the smaller information set are almost the same as the results for the full information set. This similarity implies that adding more variables does not significantly help in predicting long-term growth rates.

Chart 1

Growth Uncertainty in the OECD Countries

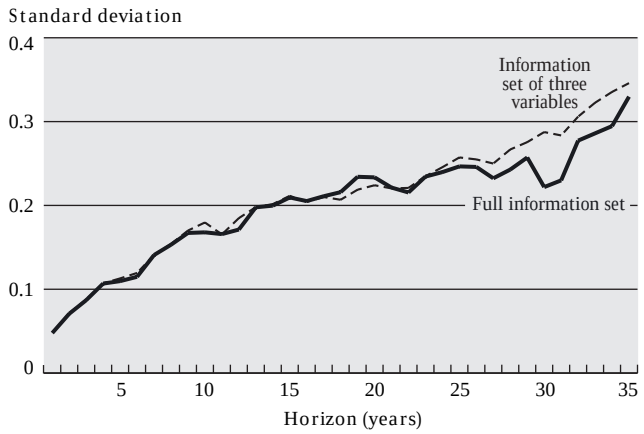


Source: Authors' calculations.

Notes: The chart shows the standard deviation of the unpredictable component of the difference between the per capita GDP growth of a representative OECD country and that of the world. The full information set used to predict growth consists of thirteen variables (see text). The information set of three variables consists of the log of per capita GDP, the fertility rate, and enrollment in higher education.

Chart 2

Growth Uncertainty in the Set of Forty-Nine Countries



Source: Authors' calculations.

Notes: The chart shows the standard deviation of the unpredictable component of the difference between the per capita GDP growth of a representative country and that of the world. The full information set used to predict growth consists of thirteen variables (see text). The information set of three variables consists of the log of per capita GDP, the fertility rate, and the investment rate.

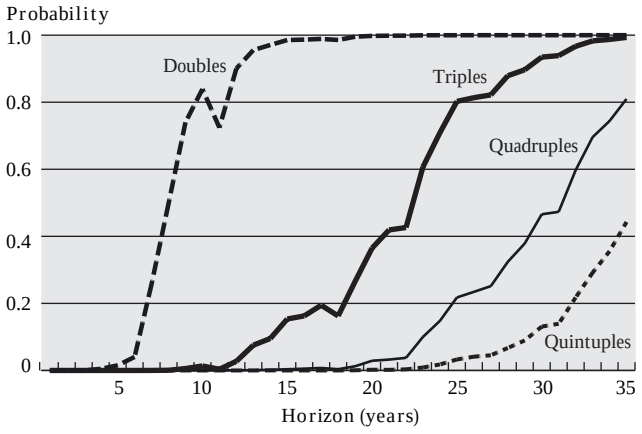
To get a better sense of the amount of uncertainty involved here, we perform a simple experiment. We take 10,000 draws from the distribution of residual risk for each country,[7] assuming that the draws are independent across countries and that each country's standard deviation of residual risk is the same. For the set of forty-nine countries, we use the results to compute the probability that per capita GDP of the best performing country will unexpectedly double, triple, quadruple, or quintuple relative to that of the worst performing country over the specified time horizon. The results are shown in Chart 3. The probability that the best performing country's per capita GDP doubles or triples relative to that of the worst performing country is practically 100 percent at the thirty-five-year horizon. The probability that the best performing country's per capita GDP quadruples or quintuples relative to that of the worst performing country is 81 percent and 44 percent, respectively. These results are striking. They suggest that, after controlling for the growth that had already been expected, per capita GDP of the best performing country is likely to rise by a factor of five relative to that of the worst performing country! Even at the short ten-year horizon, the probability that the per capita GDP of the best performing country would unexpectedly double relative to the per capita GDP of the worst performing country is 84 percent.

For the set of OECD countries, we report the probability that the per capita GDP for the best performing country rises by 30 percent, 50 percent, 70 percent, or 100 percent relative to that of the worst performing country (Chart 4). At a thirty-five-year horizon, the probabilities are 99.99 percent, 99.9 percent, 61 percent, and 13 percent, respectively. Although less spectacular, these numbers are still significant. Indeed, the best performing country's per capita GDP is likely to rise by 70 percent relative to the worst performing country's over a period of thirty-five years.

Because these figures only consider the very extremes, that is, the worst compared with the best performing countries, we also compute the probability that the unweighted average per capita GDP of the seven best performing countries doubles, triples, quadruples, or quintuples relative to the unweighted average of per capita GDP of the seven worst performing countries. For the set of forty-nine countries, at the thirty-five-year horizon the probabilities are 99.9 percent, 89.4 percent, 29 percent, and 3 percent, respectively. These results suggest that, contrary

Chart 3

Per Capita GDP: Best Performing Country versus Worst Performing Country
Forty-Nine Countries

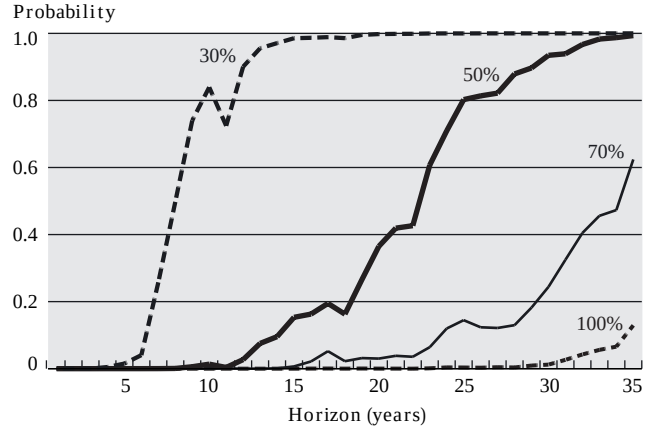


Source: Authors' calculations.

Notes: The chart shows the probability that the per capita GDP of the best performing country will unexpectedly double, triple, quadruple, or quintuple relative to that of the worst performing country. These probabilities depend on the growth horizon.

Chart 4

Per Capita GDP: Best Performing Country versus Worst Performing Country
OECD Countries



Source: Authors' calculations.

Notes: The chart shows the probability that the per capita GDP of the best performing country will unexpectedly rise by 30 percent, 50 percent, 70 percent, or 100 percent relative to that of the worst performing country. These probabilities depend on the growth horizon.

to expectation, the per capita GDP of the seven best performing countries as a group is likely to triple relative to that of the seven worst performing countries over thirty-five years. For the set of OECD countries, we find a probability of 88 percent that the unweighted average of per capita GDP of the three top-performing countries in the sample rises by 50 percent relative to that of the three worst performers. Note that in both of these cases we look at the best performing one-seventh and worst performing one-seventh of the countries in our sample.

To illustrate further that these numbers are not unrealistic, Chart 5 shows the expected deviation from world growth in 1955 for the thirty-five-year period 1955-90 (according to the information set of three variables) compared with the actual deviation from world growth over the same period. For the set of forty-nine countries, the best performing countries relative to the expectation in 1955 were Thailand and Japan. Several African and South American countries were the worst performers. Note that Thailand was expected to grow slightly less than Uruguay in 1955. In fact, however, Thailand's per capita GDP rose by a factor of 5.1 relative to that of Uruguay! Per capita GDP of the worst performing country in the sample, Nicaragua, dropped 22 percent over the period 1955-90. Some countries that are not in our sample performed even worse. Extreme cases include Nigeria, whose real per capita GDP declined 59 percent from 1976 to 1990, and Guyana, whose real per capita GDP dropped 59 percent from 1976 to 1990. For the world's poorest countries, hedging national income risks may truly be a matter of life and death for some citizens. In these countries, declines in national income have seriously harmed the quality of health care, nutrition, environmental protection, and law enforcement.

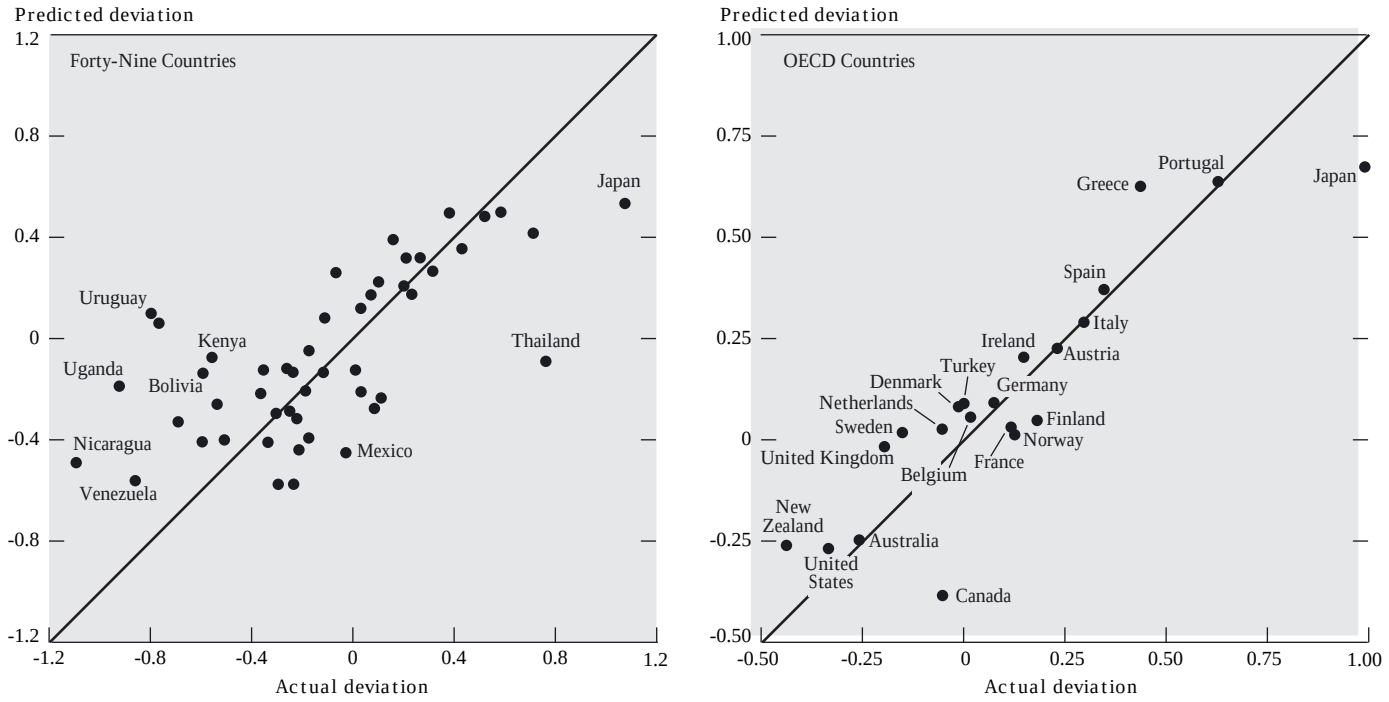
These results might leave the impression that only nations in Africa, South America, and East Asia are subject to large income shocks. Although these countries have experienced the most dramatic changes in per capita GDP during the past several decades, what matters today is uncertainty about *future* income. It is quite possible that over the next fifty years the biggest income surprises will come from other parts of the world. Large gains from risk sharing are therefore not necessarily limited to the set of countries that have faced the largest income shocks in recent years.

We see from Chart 5 that in our sample of OECD countries the best performing countries were Japan and Canada. In 1955, based on various indicators such as low investment, low school enrollment, high per capita income, and low recent growth rates, Canada was not expected to grow as fast as the average OECD country. Nonetheless, its growth rate turned out to be almost average. The worst performing countries were Greece, the United Kingdom, and New Zealand. Japan's per capita GDP grew 80 percent more than that of Greece, even though the two countries' expected growth rates were very similar in 1955. These results are suggestive of the significant uncertainty of relative performance among OECD countries. Of course, we caution against taking the results for individual countries too literally. The figures are somewhat sensitive to the precise information set and the countries considered. Nonetheless, this exercise provides a good sense of the degree of diversifiable uncertainty of future income.

Although our sample ends in 1990, a very recent and large growth surprise surfaced in Ireland. Ireland's economy stagnated during the first half of the 1980s. In 1987, its per capita GDP was 63 percent of Britain's. But

Chart 5

Predicted and Actual Deviation from World Growth, 1955-90



Source: Authors' calculations.

Notes: These figures show the actual and predicted deviation of individual countries' per capita GDP growth from world per capita GDP growth. Here "world" is defined as the sum of the countries in the sample. Countries below the 45 degree line performed better than expected. Countries above the 45 degree line performed worse than expected.

only nine years later, in 1996, Ireland's per capita GDP surpassed Britain's. The economy expanded 10 percent in 1995 and 7 percent in 1996. Relative to expectations in the mid-1980s, this remarkable growth episode was clearly unexpected. Foreign direct investment contributed to growth, but even now it is hard to fully explain Ireland's spectacular growth performance.[8]

Individual-Specific Risk

In addition to aggregate income uncertainty, individuals must contend with income variations that are specific to their situation. Individual-specific risk cannot be shared through macro markets. Indeed, no institution can completely eliminate this type of risk because of moral hazard problems. How important are these individual risks? How much income variation is left after people have completely hedged their aggregate risks?

Fortunately, individual-specific income risk appears to amount to less than half of total income risk. Shiller and Schneider (1998), using 1968-87 U.S. data from the Panel Study of Income Dynamics, estimate the variance of income changes that are not under the control of individuals. They categorize individuals into seven occupational groupings according to objective factors such as retirement, employment, and educational status. They then compute an index of labor income for the United States for each grouping. The results show that between half and three-quarters of the variance of five-year income changes can be explained by the aggregate indexes. Most of people's income risk could therefore be managed through macro markets, assuming that they were opened not just on national incomes but, within that, on occupational incomes.

Can Existing Financial Markets Do the Job?

In theory, existing financial markets could achieve most of the potential benefits from diversification if the aggregate return on domestic financial assets was highly

correlated with the return of a claim on the present discounted value of aggregate income. This is the case when the return on human capital is highly correlated with the return on domestic financial assets. Consider an average individual whose current wealth consists of $900,000 in nontraded assets. Nontraded assets include both human capital and noncorporate business assets, but, for simplicity, here we will simply refer to both as human capital. An additional $100,000 of the individual's wealth is in financial assets, including pension funds. Now assume that the return on domestic financial capital is perfectly correlated with the return on domestic human capital. The individual can then achieve full diversification as follows. First, if the financial return has the same standard deviation as the human capital return, selling short domestic financial assets by $900,000 eliminates all domestic risk. After that, $1 million is invested globally ($100,000 of financial wealth plus the $900,000 of revenue from selling short domestic assets).

The correlation between the return on human capital and financial capital, however, is much smaller than one. Bottazzi, Pesenti, and van Wincoop (1996) compute this correlation using data for the years 1970-92 for OECD countries. The return on human capital is defined as the innovation in the present discounted value of wages divided by the current value of human capital.[9] The innovation is computed using the results from a vector autoregressive process for the wage rate and the profit rate or for the wage rate and a broad measure of return on domestic financial capital. A trend is extracted from both the wage rate and the profit rate. Three measures of the return on domestic financial capital are used: the profit rate (profits divided by the capital stock); the present discounted value of the profit rate, again using the results from the vector autoregressive process; and the weighted average of returns on stocks, long-term bonds, and short-term deposits (a broad measure of financial returns). Across countries, the average of the estimated correlation between the return on human capital and financial capital for the three measures is 0.26, -0.34, and -0.43, respectively—the correlations are all much smaller than one.

It is important to note that these correlations are based on wages and profits after extracting a trend. A common stochastic growth trend is likely to exist across countries.[10] Because such a common trend represents global risk, it cannot be shared among countries. Therefore, controlling for such a trend is appropriate for our purposes. It is useful to note, however, that the negative correlation for two of the measures is not inconsistent with a positive correlation between the "raw" returns on human capital and domestic assets. An improvement in global technology raises both profits and wages.

Macro markets would also allow individuals to invest in firms and companies that are not traded publicly.

There are many possible explanations for the absence of a strong positive correlation. First, shocks to the bargaining power of labor or a change in government can significantly affect the income distribution. Second, if wages are less flexible than prices, positive demand shocks will affect real wages and profits asymmetrically. Third, standard trade theory predicts that the wage rate and return to capital move in opposite directions in response to terms of trade shocks (Stolper-Samuelson).

An important question that we do not address is how much of the country-specific income growth uncertainty documented in the preceding section can be shared through existing financial markets. No research has yet been done to address that question. Nonetheless, the low correlations between the return on human capital and financial assets reported above suggest that macro markets have an important role to play in the diversification of aggregate income growth uncertainty, a role that existing financial markets cannot completely fill.

Macro markets would also allow individuals to invest in firms and companies that are not traded publicly. Stock indexes only include companies after they have become successful. But productivity growth is influenced

by private firms and start-ups at least as much as by public companies. Thus, investment in stock indexes cannot capture the growth of these smaller companies. For an individual who wants to invest in a country because the fundamentals of the country are strong, buying a share of GDP would be more appropriate than buying a stock index.

Why Don't Macro Markets Exist?

If the potential benefits of aggregate income markets are so large, and the underlying risk management concepts are apparently so simple, why have they not already developed in the private sector? Surely, significant commissions could be earned if a large demand for these securities developed. Surely, there ought to be some niche for these securities somewhere in the world. And yet there is no evidence that markets like these have ever existed. In principle, macro markets would not be difficult to introduce. In 1997, the U.S. Treasury introduced inflation-indexed bonds. The only essential difference is that in macro markets the coupons would be indexed to a measure of aggregate income rather than to the consumer price index (CPI). It is important, therefore, to try and understand what barriers stand in the way of the creation of macro markets.

Not So Obvious

The first thing to note is that while the concept of risk management is very basic, the idea of markets that share income risks is not so obvious as to occur immediately to most people. The idea of markets in aggregate incomes is like other important inventions in the history of technology that have seemed extremely simple after they were implemented—simple, that is, from the vantage point of people viewing the final invention and not the idea that preceded it. For example, rejecting a proposal for investment in radio technology in the 1920s, David Sarnoff's Associates wrote, "The wireless music box has no imaginable commercial value. Who would pay for a message sent to nobody in particular?'' Between 1939 and 1944, more than twenty companies rejected the idea of Chester Carlson, inventor of the Xerox machine, to copy a document on plain paper. Although the idea was considered useless at the time, today Rank Xerox Corporation earns annual revenues of about $1 billion, and it is hard to imagine life without the machine.

Establishing markets for long-term claims on flows of income aggregates is no more obvious than other recent financial innovations. Even the concept of national income itself is a relatively new invention that has been perfected over many years. Developed earlier in this century by Kuznets (1937), Stone (1947), and others, the concept of national income as we know it did not become widely accepted until after World War II.

Similarly, many risk management institutions that are now commonplace have gotten off to slow starts. For example, markets in foreign currency swaps—which now account for about half the gross turnover in the foreign exchange market—did not develop until the early 1980s. A futures market in stock price indexes also did not develop until 1982. An even more recent innovation is the creation of indexed bonds. Economists have been pointing out the dangers of long-term nominal contracting for more than a hundred years, and yet in the United States long-term debt has been almost exclusively nominal. Indexed federal government debt did not exist in the United States until 1997, and it still only accounts for less than 1 percent of the federal debt.[11] Brainard and Dolbaer (1971) have long pointed out the advantages of creating contracts that allow people to share occupational income risks, but serious discussion of such contracts has only just begun.

Establishing markets for long-term claims on flows of income aggregates is no more obvious than other recent financial innovations.

Potential for Failure

Not only do market innovations take a long time to start, they also often fail. Those who contemplate taking the

time and effort to establish such markets may be deterred by past failures. A good example of such a failure is the CPI futures market, which bears some resemblance to the macro markets described here.

A CPI futures market allows an investor to hedge against a change in real income that occurs when nominal income is rigid and the price level changes. CPI markets were proposed in the 1970s by Lovell and Vogel (1974) at a time when U.S. inflation was high. The Lovell-Vogel proposal launched a discussion of the benefits of the CPI market, attracting endorsements from such prominent economists as Milton Friedman and Paul Samuelson. Despite this interest, it took a dozen years before the CPI market was established in the United States at the Coffee, Sugar, and Cocoa Exchange in 1985. Unfortunately, by the time the market was established, the inflation rate (as well as inflation uncertainty) had fallen to a fairly low level. As a result, the relatively short-term contracts had virtually no hedging function. Despite some early activity, the market was essentially dead by 1986.

The failure of the CPI futures market in the United States is often cited as evidence that the idea behind the market was flawed. A CPI market did succeed, however, in Brazil. The market started around the same time as in the United States, 1986, but inflation uncertainty was much higher in Brazil than in the United States. The Brazilian market flourished until it was shut down by the Brazilian government as an anti-inflation measure.[12] The lesson that can be learned from the CPI futures market is not that such markets cannot succeed but that they are slow to get started. Moreover, they must be started while the risks that the market is designed to manage are prominent.

Lack of Investor Awareness

It may be that people simply are not aware of long-term income growth uncertainty and the exposure of their own incomes to aggregate risk. Investors frequently emphasize short-term over long-term portfolio performance. One potential factor behind such a short-term focus is the agency problem associated with the delegation of financial market decisions. The difficulty in monitoring decisions carried out by an outside agency naturally leads to an overemphasis on easily observable short-term performance.

Individuals might not be aware of their exposure to aggregate income growth uncertainty because short-run fluctuations in their own income often appear to be independent of fluctuations in aggregate incomes. This narrow focus could lead them to underestimate the long-term correlation between individual income and aggregate income. Most people are probably not aware that over longer time intervals, individual's incomes tend to rise and fall with aggregate income. As we mentioned above, even at the relatively short five-year horizon, most of an individual's income growth uncertainty can be attributed to aggregate risk. Nonetheless, many people attribute these income fluctuations to their own efforts and abilities as well as to luck. This lack of awareness raises doubts about whether large-scale demand in macro markets would ultimately materialize, even though in principle the diversification benefits are high.

It may be that people simply are not aware of long-term income growth uncertainty and the exposure of their own incomes to aggregate risk.

Lack of Price History

We have yet to find a single example of a mutual fund that advertises a low or negative correlation of its returns with income aggregates as one of its selling points—even though finance theory suggests that such a correlation is one of the most important things to advertise. One explanation for the failure of mutual funds to advertise such a correlation is that claims on income aggregates have no market price and therefore no observable return. No one knows how volatile the price of aggregate income claims would be. Only the history of the income movements themselves is observable. Consider the case of investors who own corporate stock. If individuals could observe only

dividend announcements and not the price, no one would know the amount of volatility present in stock prices.[13]

The Importance of Public Debate and Leadership

One reason aggregate income markets do not exist is that there has been very little public debate about the potential goals of such markets. Kennickell, Starr-McCluer, and Sundén (1996) find that friends and relatives are the most important source of financial advice. Others' actions clearly provide an important signal for most people. Thus, a broad consensus on the value of macro markets among financial advisors, writers, commentators, lawyers, regulators, and lawmakers is very important if risk management contracts are to be sold to the public. Historical evidence suggests that professional leadership is an important factor in making risk management institutions a success. Consider, for example, disability risk insurance. In the early part of this century, private disability insurance was available but the public showed little interest in it. Only through the work of economists—notably John R. Commons, a cofounder of the American Economic Association—did the state-government institution of Worker's Compensation become established in the United States in all but six states by 1920.[14] Since then, disability insurance has become common among private employers as well. Today, disability insurance is a well-established institution that is not exclusively governmental, even though relatively little disability insurance is sold directly to individuals by insurance companies.

A Public Goods Problem

Another reason why these securities may not exist is that market innovators typically capture a very small fraction of the benefits and almost all of the costs of introducing a new market. Financial instruments or ways of doing business usually cannot be patented. Evidence indicates that when a firm successfully issues a new financial product, a competitor typically introduces a similar product within a period of less than two or three months.[15] At the same time, the introduction of aggregate income assets requires substantial initial investments from the innovator, including data collection, publicizing the product, experimenting with different types of contracts, and educating the public on how to use these markets.

Measurement Problems

What these contracts should cash-settle on is a serious issue that poses significant measurement problems. Per capita income measures can change based on shifting demographics alone. One solution may be to keep track of the incomes of a large group of individuals. Changes in quality are also notoriously hard to measure. Beyond such measurement issues is the question of how to deal with revisions. Shiller (1993) advances the theory of index numbers to address these questions. He proposes several kinds of chain indexes that are relatively robust to revision problems, and adjustments to national income measures could be made along these lines. Attempts to generate labor income indexes that are less sensitive to the changing composition of the labor force are reported in Shiller and Schneider (1998). The standardization of the indexes is essential to creating liquidity in these markets. A related problem is that governments collect most of the data to compute these indexes. If countries sell short claims on their own income, which they should do for the purpose of risk sharing, governments have an incentive to underreport GDP. It is not immediately clear how to resolve the problem of underreporting, although similar problems have not stopped the development of markets in indexed bonds and CPI futures.

Historical evidence suggests that professional leadership is an important factor in making risk management institutions a success.

Problems of Enforcement

Enforceability may also be a significant obstacle. In the formation of macro markets, contract designers need to avoid

incentives for investors to renege on contracts. Consider the hedging instruments discussed earlier, which yield an annual payoff of $GDP_W - GDP$. Domestic residents buy such securities from pension funds to eliminate their exposure to country-specific aggregate risk. But when per capita output in their own country unexpectedly grows faster than per capita world output, they lose on the contract. In order to guarantee their ability to pay, domestic residents must put up margin. These margin calls can be very large because the expected present discounted value of a country's per capita GDP can fluctuate widely. The amount of margin required shrinks as the margin is adjusted more frequently because at shorter time intervals the uncertainty about asset price changes is smaller. Nonetheless, as we saw in October 1987 and October 1997, sometimes very large asset price changes are observed even over very short periods of time. High levels of margin may push individuals who do not have sufficient liquid assets out of the market. One advantage of arranging these contracts through pension funds is that the money already invested in the fund can be applied as margin. Very young investors—whose pension accounts are still small—may not be able to fully diversify against aggregate income risk. This problem gradually improves as an investor gets older. Most middle-aged people have accumulated sufficient wealth to take full advantage of the option to hedge aggregate risk. But as an investor gets older, the horizon for hedging becomes shorter and the benefits from risk sharing decrease.

Macro Market Bubbles

An additional problem is that the price of the macro securities may be even more volatile than the underlying fundamentals. Asset price bubbles cannot be ruled out. An asset price bubble occurs when increasing optimism causes investors to bid up prices to unsustainable levels, eventually resulting in a bursting of the bubble and a sudden crash. By some accounts, bubbles are caused in part by individuals who overreact to past positive returns and flock into a bull market. Investors who enter the market because of excessive optimism typically choose to depart once they find that their optimism is unfounded and can cause a market to crash.

Stock market crashes have sometimes had significant repercussions on economic performance. The worldwide stock market crash of 1929, for example, appears to have triggered a public sense of great uncertainty and a desire to postpone expenditures until the economic outlook grew clearer (see Romer [1990]). This reaction may have been a factor in bringing on the Great Depression. The consequences of such price swings in macro markets, and safety measures to protect against such shocks, need to be considered and addressed.

Portfolio Management Problems

Finally, we would like to address a very practical question. Given the uncertainties surrounding a person's future income, future employment, and future career developments, how will he or she know what positions to take in these markets? In our earlier example, we assumed that the individual's wages are equal to the per capita wage rate plus an idiosyncratic component unrelated to aggregate risk. But in reality, some people's income is more exposed to the national business cycle than others'. This exposure depends on the location of someone's work as well as the sector in which he or she works. In general, the optimal positions in the aggregate income markets depend on how much one's future income is correlated with measures of aggregate income over long-term horizons. Depending on the sector and location of someone's work, information about long-term income fluctuations can be obtained from historical data. But what happens when someone moves to another part of the country or to another sector, or when someone changes careers altogether? Of course, every person's career has a significant idiosyncratic component. What is really needed, however, is a good estimate of the aggregate component of a person's future income that takes into

In the end, almost all people are sensitive to the growth performance of the aggregate economy, no matter where or in what sector they work.

consideration characteristics such as age, education, location, and the sector in which he or she works. Financial advisors can use this information, which can be obtained from longitudinal data sources, to determine optimal hedging strategies. Obtaining such measures of covariances is a very difficult task. We do not want to exaggerate this difficulty, however. Over longer horizons, which matter most for diversification purposes, people's incomes are more correlated than they are over short horizons. In the end, almost all people are sensitive to the growth performance of the aggregate economy, no matter where or in what sector they work.

Conclusion

We have outlined how macro markets can be beneficial to the average person interested in his or her long-term financial security. The introduction of such markets allows pension funds to offer a hedging instrument that can be used to reduce, or even eliminate, exposure to country-specific growth performance. We have found that the benefits of eliminating exposure to such country-specific risk are large. Over a period of thirty-five years, the per capita GDP of one industrialized country relative to that of another industrialized country could unexpectedly double. For a broader group of countries, the risks are much larger. While not documented in this paper, large gains are likely to be achieved by trading other forms of aggregate income claims, particularly those associated with occupational risks. We have also pointed out that existing financial markets are not a good substitute for macro markets that cash-settle on a measure of national income.

Given that macro markets can provide substantial improvements in long-term financial security—improvements that cannot be achieved in existing markets—it may seem peculiar that these markets have not yet developed. We offer several explanations for the absence of macro markets. Investors tend to be focused on short-term financial performance and may not consider the benefits of long-term financial security. Moreover, research has shown that for most people, friends and family represent the main source of financial advice. It is therefore unlikely that investors will consider the benefits of protecting themselves from country-specific risks until a broad consensus develops on the value of macro markets among financial advisors, writers, lawyers, the media, regulators, and lawmakers.

Before aggregate income contracts can be introduced, many practical hurdles must be overcome. Rules for settlement need to be developed, and decisions must be made about income measures, contract size, and margin requirements. Circuit breakers or other measures that deal with the possibility of sudden booms or crashes in the macro markets will be necessary. An array of regulatory and tax issues will need to be resolved. Perhaps most important, methods for evaluating the aggregate income risk exposure of individual households and businesses will need to be developed so that people will know how to use the markets. Given the costs of introducing such markets, it is also important to think about where the first markets should be created and whether initial markets should be for individual countries or for aggregates of countries.[16]

Some of the hurdles to a wide-scale use of macro markets could turn out to be too large. Margin requirements to enforce the contracts may be too big for many individuals. It may also be difficult to determine optimal exposure to aggregate income risk for individual people and to convince investors of the benefits of hedging this risk. Even if these markets are eventually introduced, they may be used more narrowly than has been suggested here. The presence of these obstacles, however, does not mean that we should avoid serious debate about the creation of aggregate income markets. Aggregate income growth uncertainty represents the largest macroeconomic risk incurred by households all over the world. The benefits from trading in macro markets are potentially very large. Factors that are essential to the start of such markets—including well-functioning financial exchanges, a sophisticated technology of trading, and the intellectual appreciation of the importance of risk management—are already in place. Eventually, portfolio managers and individuals could routinely hedge aggregate income risks in macro markets.

APPENDIX: TWO SETS OF COUNTRIES

We use two sets of countries in the regression analysis—a set of forty-nine countries and a smaller set of twenty-one OECD countries.

The forty-nine countries are Kenya, Mauritius, Uganda, Canada, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Trinidad and Tobago, the United States, Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela, India, Japan, Pakistan, the Philippines, Sri Lanka, Thailand, Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Turkey, the United Kingdom, Australia, and New Zealand.

The twenty-one OECD countries are Canada, the United States, Japan, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Turkey, the United Kingdom, Australia, and New Zealand.

ENDNOTES

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1. See Kang and Stulz (1997), French and Poterba (1991), and Tesar and Werner (1994, 1997).

2. See Shiller and Athanasoulis (1995) and Athanasoulis and Shiller (1997); for related work, see also Demange and Laroque (1995) and Allen and Gale (1994).

3. The country-specific growth uncertainty can also be transformed into a measure of welfare gains from international risk sharing. See Athanasoulis and van Wincoop (1999) and van Wincoop (1994, 1996, 1999).

4. See Athanasoulis and van Wincoop (1997) for details on the estimation procedure. For each horizon *s*, we use data for all non-overlapping intervals with that length, starting with the most recent interval ending in 1990.

5. See Barro and Sala-i-Martin (1995) and Levine and Renelt (1992).

6. We experimented with additional variables: political instability; terms of trade growth over the past five years; percentage of primary, secondary, and higher education attained; the most recent one-year and five-year growth rates of private consumption; and the investment rate averaged over the past five years. None of these variables improved predictive power substantially.

7. The residual risk is based on the three variables that have the most predictive power.

8. See *The Economist*, May 17-23, 1997, pp. 21-4, for a discussion of Ireland's recent growth.

9. The wage rate is the average real wage per employee using national data on employee compensation divided by the number of employees and the consumer price index.

10. Plenty of evidence suggests that technological convergence occurs across industrialized countries, leading to a common stochastic growth trend.

11. See Shiller (1997) for a discussion of public resistance to indexation.

12. Similar markets were reintroduced twice in the late 1980s. However, each time they were eventually shut down by the government.

13. This problem is not insurmountable. Initial public offerings face the same problem.

14. See Moss (1995).

15. See Tufano (1992).

16. Shiller and Athanasoulis (1995) find that a U.S.-Japan swap of national incomes may be the best single contract to recommend, with a U.S.-Europe swap being important as well. Athanasoulis and Shiller (1997) find that an important market to develop early would be a market for the entire world, a market that would trade claims on the aggregated incomes of all countries.

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