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WHAT CAN EXPLAIN THE APPARENT LACK OF INTERNATIONAL CONSUMPTION RISK SHARING?

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ABSTRACT

Recent research in international business cycles based upon complete markets has found that international consumption correlations are lower than predicted by the standard risk-sharing implications of these models. In this paper, I use regression tests to ask whether two different types of explanations can help explain this result. First, I consider whether non-separabilities between tradeables and non-tradeable leisure or goods can explain the puzzle. Surprisingly, non-separabilities explain only a tiny fraction of the variation in tradeables consumption across countries. Furthermore, risk-sharing in tradeables is rejected. Second, I examine the effects of capital market restrictions on aggregate consumption risk-sharing by countries. While rejections of risk-sharing are stronger for countries facing more severe capital market restrictions, risk-sharing is still rejected for the unrestricted group of countries. Therefore, risk-sharing does not appear to be resolved by either explanation alone. However, when I allow for both non-separabilities and certain market restrictions, risk-sharing among unrestricted countries is not rejected. This evidence suggests that a combination of these two effects may be necessary to explain consumption risk-sharing across countries.

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International business cycle models with complete markets generally imply that consumption growth rates should be highly correlated with eachother and more highly correlated than output growth rates. However, recent research has found the opposite result.[1] For this reason, researchers have studied departures from standard assumptions in at least two general ways. First, if variables in the utility function that are internationally tradeable are not separable from those that are non-tradeable, then the correlation of aggregate consumption growth rates need not be high.[2] Second, international capital markets may not be complete. This second line of research has also shown that the asset market structure provides an important role in connecting business cycles across countries.[3]

This paper addresses the question: based upon international consumption data, to what extent do these considerations explain the apparently low degree of risk sharing? I answer this question along the two dimensions above.

First, I ask whether the puzzle can be explained under complete markets by allowing for non-separabilities in utility. While this possibility has been proposed by others, I use formal regression tests to provide confidence intervals on the magnitudes explained by non-separabilities. These regressions show how much of the variation in cross-country consumption growth rates can be explained by potential non-separabilities of tradeables with leisure, non-traded goods, and

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[1]The implications of risk-sharing for consumption growth rates across countries was first described in Scheinkman (1984) and Leme (1984). Backus, Kehoe, and Kydland (1992) showed that consumption correlations were too low to be explained by a model incorporating non-separable leisure in the utility function. Devereux, Gregory, and Smith (1992) use a different model assuming separable leisure that generates consumption correlations more consistent with those in the data.

[2]Tesar (1993) makes this point. Stockman and Tesar (forthcoming) simulate a two country general equilibrium model with traded and non-traded goods. In earlier work, Stulz (1981, 1987) analyzed the effects of non-traded goods on international portfolio allocation. Backus, Kehoe and Kydland (1992) examined the effects of non-separabilities with respect to labor. Scheinkman (1984) gives an example in which taste shocks play the same role as these non-separabilities.

[3]For example, Conze, Lasry and Scheinkman (1993) and Baxter and Crucini (1991) show that the transmission of shocks across countries are very different depending upon whether countries face restrictions in capital markets relative to complete markets.

durable goods. For these tests, I use two panel data sets: (1) aggregate consumption, output, and employment of 72 countries measured annually from 1950 to 1992; and (2) consumption disaggregated into groups of tradeables and non-tradeables, durables and non-durables, along with tradeables output for 48 countries measured at five year intervals from 1970 to 1985.

Interestingly, I find that non-separabilities do not appear to explain the puzzle. Leisure explains less than 0.1% of the cross-country variation in consumption, although these results are based upon unemployment data and should be viewed cautiously.[4] More surprisingly, non-durable non-tradeable goods also explain a tiny fraction of the variation at 0.1%. Furthermore, when accounting for these non-separabilities, tradeables consumption continues to be correlated with idiosyncratic variations in tradeables output, in contrast to the predictions of complete markets models. While other studies combine durable and non-durable tradeables in risk-sharing tests, I examine the importance of non-separabilities between these two components. I find that non-separabilities among all the components of consumption can account for up to about 13% of the cross-country variation in consumption, although risk-sharing is still rejected. These results suggest that complete markets do not explain the international co-movements of consumption, even after allowing for non-separable utility.

Given this result, the second way I ask the question in the title is: if countries are restricted from acquiring claims on foreign output, how would this affect the international co-movements in consumption? This question is also important for understanding the connection of business cycles across countries in the presence of market frictions.

I show that restrictions on ownership of foreign assets that take the form of taxes on repatriated earnings will induce domestic consumption growth to have a higher covariation with domestic output. I then test whether countries with capital market restrictions have a higher covariation with domestic consumption growth by combining proxies for capital market restrictions together with the regression tests.

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[4]Unemployment data are difficult to compare across countries due to differences in unemployment insurance and other labor market institutions. See Atkinson and Micklewright (1991) and Burdett and Wright (1989).

I consider two ways in which the restrictions can resolve the risk-sharing puzzle. First, I ask whether capital market restrictions alone can explain the puzzle ignoring non-separabilities. While the covariation between idiosyncratic consumption and output is indeed significantly higher for restricted countries than unrestricted countries, I find that risk-sharing is rejected for both groups. Thus, capital market restrictions do not explain the puzzle if non-separabilities are ignored.

Second, I ask whether a combination of capital market restrictions and non-separabilities can explain the puzzle. Strikingly, I find that non-separabilities are important. For both measures of capital market restrictions considered, the relationship between components of utility for restricted countries are significantly different from unrestricted countries. For one measure, risk-sharing in tradeables among unrestricted countries is not rejected, even though risk-sharing is rejected for restricted countries.

This evidence suggests that both non-separabilities and capital market frictions are necessary to explain the behavior of international comovements in consumption. Non-separabilities alone do not appear sufficient. Nor do capital market restrictions if non-separabilities are ignored.

The structure of the paper is as follows. Section 1 examines whether non-separabilities can explain the lack of consumption co-movements. Section 2 considers the effects of international market restrictions. Concluding remarks follow.

Section 1: Can Non-Separabilities Under Complete Markets Explain It?

I begin by asking to what extent non-separabilities in utility between traded and non-traded leisure and goods can explain the lack of international risk-sharing. To test for risk-sharing, I will use a modified version of the regression tests based on household data by Cochrane (1991) and Mace (1991). The modification I introduce into these tests is to allow for non-separabilities in utility.

These regression tests provide at least two useful features relative for this analysis. First, they directly provide confidence intervals that suggest the range of, say, covariations between consumption and output. Second, since measurement error in the data and taste shocks are likely to affect the estimates, the evidence can be used to ask what these errors would have to look like in order to explain all of the rejections of risk-sharing.

(1.1) The Framework

To see the framework for these tests, consider the social planner's problem of maximizing utility over J countries with representative agents having utility functions, $u(T^j(s^t)), N^j(s^t), L^j(s^t))$, where j indexes the countries, j = 1, ..., J. T^j, N^j, and L^j are, respectively, tradeable consumption, non-tradeable consumption and leisure in country *j*, and s^t is the state of the economy at time t. Labor is immobile internationally and therefore functions as a non-traded good. Tradeables and non-tradeables are both non-durable and I begin by treating durables as separable in utility from the above function, u(), although I will consider the importance of durables below.

Given these assumptions, the social planner maximizes:

$$\text{Max} \quad \Sigma_{j=1}^{J} \lambda^j \Sigma_{t=1}^{\infty} \rho^t \Sigma_{s^t} \pi(s^t)\, u(T^j(s^t),N^j(s^t),L^j(s^t)) \qquad (1)$$
$$\{T^j(s^t)\}_{j=1}^{J}, \forall\, s^t$$

$$\text{s.t.} \quad \Sigma_{j=1}^{J} T^j(s^t) \le \Sigma_{j=1}^{J} \eta^{j,T}(s^t) \;\forall\, s^t$$
$$N^j(s^t)) \le \eta^{j,N}(s^t)$$
$$L^j(s^t) \le \eta^{j,L}(s^t)$$

where λ^j is the social planner's weight on country *j* utility, ρ is the discount rate, and $\pi(s^t)$ is the probability of state s^t.[5] Furthermore, $\eta^{j,T}(s^t)$, $\eta^{j,N}(s^t)$, and $\eta^{j,L}(s^t)$ are, respectively, country *j*'s output levels of tradeables, non-tradeables and country *j*'s leisure in state s at time t. While the η^j may be viewed as endowments, this view is not necessary since in a production economy a social planner would maximize output over time and the resulting output levels would have to satisfy the constraints in equation (1).

The first-order conditions with respect to tradeables are:

$$\rho^t \lambda^j u_T(T^j(s^t),N^j(s^t),L^j(s^t)) = \mu(s^t) \qquad (2)$$

where u_T is the marginal utility with respect to tradeables and $\mu(s^t)$ is the Lagrangian on the tradeables constraint in (1) over the probability of the state. Taking the ratio of first-order

[5]In a previous version, I allowed for different discount rates, ρ^j, across countries. This modification introduced a fixed country effect in the panel estimation, but did not alter the main conclusions of the empirical evidence.

conditions with respect to tradeables at time t relative to those at $t-1$ gives,

$$\frac{\rho\, u_T(T^j(s^t),N^j(s^t),L^j(s^t))}{u_T(T^j(s^{t-1}),N^j(s^{t-1}),L^j(s^{t-1}))} = \frac{\mu(s^t)}{\mu(s^{t-1})} \tag{3}$$

To simplify notation below, I will adopt the notation that for any variable y, $y_t \equiv y(s^t)$, i.e., the value for variable y realized in state s at time t.

To put this relationship into a testable form requires specifying a utility function. I will follow Baxter and Jermann (1994) and treat the utility function as:

$$u(T_t^j, N_t^j, L_t^j) = b_t^j\, \psi(T_t^j, N_t^j)^{(1-\gamma)}\, \upsilon(L_t^j)/(1-\gamma) \tag{4}$$

where $\psi(T,N)$ is a linearly homogeneous aggregator function. To the utility function in Baxter and Jermann (1994), I have included a country specific shock to preferences, b_t^j, that is insurable at time 0. Relating this utility function to the ratio of marginal utilities in equation (3) requires taking the derivative of (4) with respect to tradeables:

$$u_T(T_t^j, N_t^j, L_t^j) = \psi(T_t^j, N_t^j)^{\gamma}\, \psi_T(T_t^j, N_t^j)\, \upsilon(L_t^j). \tag{5}$$

To put this relationship into testable form, substitute (5) into (3) above, take the logarithm, and use the approximations from Baxter and Jermann (1994). Specifically, since ψ is linearly homogeneous,

$$\Delta\ln(\psi(T_t^j, N_t^j)^{\gamma}) = -\gamma\, (x_T\, \Delta\ln(T_t^j) + (1-x_T)\, \Delta\ln(N_t^j)) \tag{6}$$

where $\Delta y_t \equiv y_t - y_{t-1}$ for any variable y, and x_T is the expenditure share on tradeables. Also, by linear homogeneity,

$$\Delta\ln(\psi_T(T_t^j, N_t^j)) = -(1-x_T)\, (\Delta\ln(T_t^j) - \Delta\ln(N_t^j))/\zeta_{TN} \tag{7}$$

where ζ_{TN} is the elasticity of substitution between tradeables and nontradeables. Finally,

$$\Delta\ln(\upsilon(L_t^j)) = \delta_{\psi L}\, \Delta\ln(L_t^j), \tag{8}$$

where $\delta_{\psi L}$ is the elasticity of the marginal utility of the consumption aggregate with respect to leisure. With these approximations and defining measurement error as $u_t^{j'}$, the ratio in (3) becomes:

$$\Delta\ln(T_t^j) = -c\, \Delta\ln(\mu_t) + c\, \ln(\rho) - c\, (1-x_T)\, (\gamma - \delta_{TN}^{-1})\, \Delta\ln(N_t^j) + c\, \delta_L\, \Delta\ln(L_t^j) + u_t^j \tag{9}$$

where $c \equiv (\gamma\, x_T + (1-x_T)/\delta_{TN})^{-1}$ and $u_t^j = c\, \ln(b_t^j/b_{t-1}^j) + u_t^{j'}$. The last term, u_t^j, is comprised of the insured taste shocks and the measurement error.

According to the first-order conditions, the relationship between the growth rate of tradeables and non-tradeables is governed by the interaction between the inverse of the elasticity of substitution between tradeables and non-tradeables, ζ_{TN}^{-1}, and the parameter of relative risk aversion, γ. Baxter, Jermann, and King (1994) show how the relationship between ζ_{TN}^{-1} and γ determines whether domestic residents will bias their portfolio holdings toward domestic equities.

I will use the basic form of equation (9) to test for risk-sharing using cross-sectional and panel regressions. If not rejected, these regressions can also be used to recover estimates of the elasticity of substitution, ζ_{NT}, given estimates of the parameter of relative risk aversion, γ. To see the basic form of the regression tests, I will rewrite equation (9) in terms of observables. Defining X_t^j as any country j specific variable at time t, this equation can be written:

$$\Delta\ln(T_t^j) = \theta_o(t) + \theta_1 \Delta\ln(N_t^j) + \theta_2 \Delta\ln(L_t^j) + \beta X_t^j + u_t^j \qquad (10)$$

where $\theta_o(t)$ is a constant at time t, $\theta_1 = (\zeta_{TN}^{-1} - \gamma)/(\zeta_{TN}^{-1} + (\gamma x_T/1-x_T))$, $\theta_2 = c\,\delta_L$. The term u_t^j is an error term that includes the measurement error, $u_t^{j'}$, and the percentage change in the taste shocks, b_t^j. Since movements in X_t^j are ensurable, we should find that $\beta = 0$ when countries are risk-sharing. Note that the measurement errors will include both error in measuring the variables and the approximation errors from equations (6) to (8). Since this error is potentially important, one way of interpreting the results below is to ask if measurement error can explain all of the results. I will return to this interpretation below.

Given equation (10), I can test for risk-sharing by running the equation as a regression and asking whether $\beta = 0$. These estimates can also be used to calculate the amount of the variation in tradeables consumption explained by each component on the right-hand side. I will use this type of regression to test for risk-sharing using two different types of data below.

(1.2) Tests Based upon Aggregate Consumption

I begin by testing for risk-sharing using aggregate consumption data for the left-hand side of equation (10), thereby treating aggregate consumption as non-durable and tradeable. Treating consumption in this way is clearly incorrect since durables and non-tradeables are also components in the aggregate. I nevertheless start with tests on aggregate consumption for three reasons. First, the results can be directly compared with other studies in the literature on international

consumption risk-sharing that have used the same aggregate data. Second, aggregate data are available for more countries at a higher frequency than the disaggregate data to be examined below. Therefore, the aggregate data are less likely to suffer from problems of low power or small sample bias. These results provide a useful benchmark for comparison with the disaggregate results. Third, the aggregate data allow me to ask whether disaggregation is necessary at all if market restrictions are used to explain the cross-country consumption co-movements. I will come back to this third issue in section 2.

(1.2.1) Modifications When Aggregate Consumption is Assumed Tradeable

A number of recent studies have used aggregate consumption data to test for risk-sharing in time series data or to calculate the welfare costs of not risk sharing.[6] Clearly, the implicit assumption in these studies is that all goods are tradeable and non-durable, i.e., $\psi(T,N) \equiv T$. This special case corresponds to a model in which all countries consume the same tradeable good. Substituting T for ψ in the social planner's problem (1), implies that the variables in equation (10) reduce to: $\theta_o(t) = -(1/\gamma)\ln(\mu_{t+1}/\mu_t) + (1/\gamma)\ln(\rho)$, $\theta_1 = 0$ since non-tradeables do not exist, and $\theta_2 = (\delta_{\psi L}/\gamma)$. As before, risk-sharing implies that $\beta = 0$. In other words, after controlling for the non-separability due to idiosyncratic leisure, consumption should vary with the common component of international consumption growth captured by the fixed time effect and should be independent of any other country specific disturbances.

Therefore, equation (10) may be written as:

$$\Delta\ln(T_t^j) = \theta_o(t) + \theta_2 \Delta\ln(L_t^j) + \beta X_t^j + u_t^j \qquad (11)$$

where $\theta_o(t)$ is the fixed time effect that captures the aggregate effects of consumption, leisure and X at time t, θ_1 and β are parameters, and u^j_t is the residual including the measurement error and possible taste shocks given in (9). Below, I will generically call these composite errors, u^j_t, "measurement error" although it should be kept in mind that they may include taste shocks.

(1.2.2) The Aggregate Data

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[6]Obstfeld (1989, 1992) and Canova and Ravn (1993) test whether aggregate consumption depends upon country-specific variables in time series data. Among others, Obstfeld (1994), Tesar (forthcoming), and Lewis (1994) use aggregate data to calculate welfare costs of not risk-sharing.

To consider a broad cross-section of countries, I use the Penn World Tables data set version 5.6. An earlier version is described in Summers and Heston (1991). Following Obstfeld (1992, 1994), I exclude the countries with data quality rated C- and below. The panel data set provides annual observations for the remaining 72 countries over 43 years from 1950 to 1992.[7] The Summers and Heston (1991) data set provides a set of comparable quantity data series across countries and over time. The consumption and output data series used in the analysis below is the per capita real variables measured in terms of a 1985 composite index.[8]

In addition to consumption, a data series must be selected for candidate measures of a country-specific variable denoted X_t^j above. For this purpose, I use domestic output growth demeaned by the aggregate of world output in each period. A problem with this variable is that measurement error in domestic output is likely to be correlated with measurement error in domestic consumption. I focus upon idiosyncratic output variations despite this problem for three reasons. First, a finding that the hypothesis $\beta = 0$ cannot be rejected may simply result from low power, particularly if X_t^j is a noisy measure of country-specific risk. Using a measure such as output with measurement error that is likely to be correlated with measurement error in consumption implies that when I cannot reject that $\beta = 0$, this result is fairly strong evidence in favor of risk-sharing. At the same time, a finding that $\beta \neq 0$ can be evaluated under the alternative view that all of the rejection is due to measurement error.

The international business cycle literature provides a second reason for considering output. Backus, Kehoe and Kydland (1992) and others have found that output growth rates are more highly correlated internationally than are consumption growth rates. Thus, using output growth rates as measures of idiosyncratic shocks focuses the risk-sharing puzzle upon this corollary puzzle in the co-movements with output as well.

Third, the deviation of domestic output from world output relates directly to the capital

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[7]A number of countries have years with missing observations, particularly over the early years. The treatment of missing values is discussed in the data appendix.

[8]This series corresponds to the 1985 international dollars consumption and output in the Summers-Heston data set.

market restrictions tests to be examined below in Section 2. The results in this section therefore provide a benchmark for those tests.

(1.2.3) The Evidence

Panel A of Table 1 provides summary statistics of these data in annualized percentage growth rates. The mean annual consumption growth rate over the period has been about 2.9% with a standard deviation of about 6.1%. Output has a somewhat higher growth rate but lower variability. The table also shows the mean growth rates and standard deviations of leisure as measured by unemployment. In contrast to the other variables, this variable has a standard deviation less than 1%. It is well-known that employment can be difficult to compare across countries. For example, Burdett and Wright (1989) find that the variation in total employment due to the number of workers is much higher in the US and Canda than for most European countries where the variation largely comes from variation in hours worked. Given these data problems, the following results may be used to consider whether hours worked are sufficiently different from unemployment to overturn the basic conclusions below.

Panel B of Table 1 reports the results of estimating equation (11) with a pooled time-series cross-section regression correcting the standard errors for conditional heteroskedasticity.[9] The first row reports the results of estimating the equation assuming that consumption and leisure are separable so that $\delta_{\psi L} = 0$. The column labeled β reports the estimate of the coefficient. The point estimate of β is close to one at .975 and significantly different from zero at the 95% confidence level. Furthermore, idiosyncratic variations in output explain about 57% of the variation in idiosyncratic consumption movements.

The second row of Panel B relaxes the assumption that $\delta_{\psi L} = 0$. However, the estimate of

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[9]The standard errors for the parameter vector ϕ for the general form of the equation: $Y = \phi Z + e$ were estimated according to: $(Z'Z)^{-1}\ \Omega\ (Z'Z)^{-1}$, where Z is the stacked matrix of right-hand side variables, and $\Omega \equiv \sum_{t=1}^{\tau} Z_t' e_t e_t' Z_t$ where e_t and Z_t are the vector of errors and right-hand side variables, respectively, at time t, and where τ is the number of observations. In an earlier version of this paper, the time-series data for each country were examined for serial correlation by testing for moving average coefficients in the error term. Using the test in Cumby and Huizinga (1992), the hypothesis of moving average components equal to zero was rejected in less than 5% of the countries. Therefore, the errors were assumed to follow white noise processes.

θ_2 and, hence, $\delta_{\psi L}$, is insignificantly different from zero. Furthermore, the percent of cross-sectional consumption variation that is explained by leisure is tiny, less than one tenth of one percent. Although these data are based upon unemployment and should therefore be considered with caution, they suggest that non-separability between consumption and leisure are unlikely to explain the consumption correlation puzzle. This basic conclusion is consistent with the findings of Backus, Kehoe, and Kydland (1991) using US data alone.

The evidence based upon aggregate data suggests a strong rejection of the risk-sharing hypothesis if measurement error is small. On the other hand, if measurement error alone explains these results, the measurement error in output must explain almost 60% of the variation in consumption.

The tests reported above combined time series with cross-sectional evidence. These results could potentially mask a particular outlier in a certain year, causing the over-all rejection. To consider this possibility, equation (11) assuming $\delta_{\psi L} = 0$ was estimated for each year of the available data. Figure 1 depicts the estimate of β as the solid line with 95% confidence bands above and below these estimates. As the figure shows, the hypothesis that $\beta = 1$ is rejected in every year except for 1960. Thus, the evidence against risk-sharing based upon the benchmark case is robust over time.

(1.3) Using Disaggregated Data

The evidence using aggregate consumption suggests that the degree of risk-sharing as predicted by complete markets is rejected. However, the components of consumption may behave quite differently across countries than the aggregates, particularly if the consumption or service flows of some goods are non-tradeable. In this case, the tests above might reject risk-sharing even if markets are complete simply because of the idiosyncratic effects of non-tradeables. In this section, I consider whether a decomposition of consumption is capable of explaining the results by estimating equation (10) directly.

(1.3.1) The Data

The disaggregated consumption data were constructed from the benchmark studies that underlie the construction of the Summers and Heston (1991) data set. The studies were undertaken

for various countries at five year intervals beginning in 1970.[10] These studies involved collecting data on consumption components in a consistent manner across the countries within the study for a given year. The data were collected for four separate years.[11] In 1985, the study included 64 countries with 113 consumption categories. The 1980 study involved 60 countries and 125 consumption categories. The 1975 data were based upon 34 countries and 108 categories. In 1970, the data were collected for only 16 countries but 110 consumption categories. Kravis, Heston, and Summers (1982) describes the methods used in these studies.

From these components, I constructed measures of non-durable tradeables, non-tradeables, and durables and then transformed the series into per capita units.[12] The risk-sharing tests require an observation for a country's consumption in two adjacent five year intervals. Countries that were in the sample only for one of the four years were eliminated from the sample for purposes of estimation. For the country specific measure X^j, I use the domestic output of tradeables since the growth rate of tradeables goods should be uncorrelated with domestic output of tradeables. The appendix describes the data in more detail.

(1.3.2) The Evidence

To test for risk-sharing using disaggregated data, I will use a modification of equation (10):

$$\Delta_5 \ln(T_t^j) = \theta_0(t) + \theta_1 \Delta_5 \ln(N_t^j) + \beta X_t^j + u_t^j \qquad (12)$$

where $\Delta_5 y_t \equiv y_t - y_{t-5}$ for any variable y. Equation (12) has been written in five year growth rates. Also, leisure is treated as separable by setting θ_2 in equation (10) equal to zero.[13]

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[10]I thank Alan Heston for supplying the original data to me.

[11]The 1990 study did not use the same pricing benchmark across countries within the year as did the previous years. Since this series was not directly comparable, they were not used.

[12]In an earlier version of the paper, I also disaggregated consumption by a fourth group, semi-durables which included items such as shoes, tires, and clothing. Since these commodities are likely to be non-durable over the five year periods I examine, I have incorporated this series into the non-durable tradeables series. However, none of the main results below are affected by either treating them as durables on the right-hand side or excluding them from the analysis altogether.

[13]The estimates of θ_2 were never significantly different from zero and the variability of leisure was only a tiny fraction of the consumption variation, as found with the aggregate data in Table 1. Since the estimates on the other coefficients were not affected by excluding leisure, I exclude the

Panel A of Table 2 provides summary statistics on the disaggregated data. Noticeably, the standard deviations are substantially larger than those in Table 1, in part because the observations are only for four periods and cover a smaller subset of countries.

Panel B reports the results of estimating equation (12).[14] The first row assumes that tradeables and non-tradeables are separable so that non-tradeables have a coefficient of zero. As reported, the evidence of risk-sharing is similar to the case of consumption aggregates. Non-durable tradeable consumption is significantly related to the domestic output of tradeables. Furthermore, at 71.5%, the percent of variation in consumption explained by output is even higher than that of the consumption aggregates.

The second row reports the same estimates allowing for non-tradeables. Given the recent interest in non-tradeables as an explanation of the consumption correlation puzzle, it is perhaps surprising that non-separabilities between tradeables and non-tradeables are not significant. The coefficient θ_1 is insignificantly different from zero and the variation in non-tradeables explains only 0.1% of the variation in tradeables.

Under risk-sharing, the estimate of θ_1 is a function of the elasticity of substitution, ζ_{TN}, the parameter of relative risk aversion, γ, and the ratio of non-tradeables consumption share to tradeables, $(x_T/1\text{-}x_T)$. Therefore, with estimates of γ and the shares, the estimate for the elasticity of substitution can be backed out. Since the expenditure share of non-durable tradeables is 0.593, the inverse of the elasticity of substitution for $\gamma = 2$ has a point estimate of 2.1 in a confidence range of 1.48 to 2.88. This range is consistent with point estimates in the literature as described by Baxter, Jermann, and King (1994).

On the other hand, since tradeables consumption growth is significantly correlated with domestic output growth, the evidence rejects risk-sharing and therefore equation (12). One possible

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leisure effects in the results below in order to focus upon the non-separabilities arising from consumption components.

[14]I also conducted the risk-sharing tests using aggregate data over these same periods to make sure that differences do not arise from differences in five year relative to one year horizons. Since the evidence is similar to those in Table 1, I report only the disaggregated results in Table 2 to conserve space.

explanation is that durables and non-durables may not be separable, an assumption that has been maintained to this point.

(1.3.3) Incorporating Durables

Durables may affect the results above since the correlation of domestic non-durable tradeables may pick up the effects of durable tradeable services that are not separable in the utility function. In other words, instead of the utility function above, suppose that the aggregator of consumption included durable services:

$$u(T_t^j, N_t^j) = b_t^j \psi(T_t^j, N_t^j, D_t^j)^{(1-\gamma)}/(1-\gamma) \qquad (13)$$

where D^j is services on durable goods. While durable goods are certainly tradeable, the services on these goods are likely not to be. For example, the rental markets in cars, household appliances, and furniture in most cases do not cross national boundaries, although exceptions can be found. Since previous studies have combined durables and non-durables into measures of tradeables, these studies treat the expenditures as equivalent to services and both measures as tradeables. If some part of services on durables are non-separable in utility, however, then the coefficient on output in (12) may differ from zero because of omitted variables bias.

By calculating the marginal utility with respect to tradeables in (13), equation (12) can be rewritten:

$$\Delta\ln(T_t^j) = \theta_o(t) + \theta_1 \Delta\ln(N_t^j) + \theta_2 \Delta\ln(D_t^j) + \beta X_t^j + u_t^j \qquad (14)$$

where now θ_2 would reflect the elasticities of substitution of durables if these variables were used in the test. Since durables services are not observable, however, I use the expenditures on durables as proxies for the underlying variation in durables services. Since these can be poor measures of services, the estimates of θ_i cannot be interpreted in terms of parameters in the utility function.

Row 3 of Panel B reports the estimates assuming separability between non-durable tradeables and non-tradeables so that $\theta_1 = 0$. In this case, durables are significantly correlated with non-durable tradeables and represent a higher proportion of variation in non-durable tradeables than do conventional non-tradeables at 10.3%. However, risk-sharing is rejected.

Row 4 reports the estimates including both non-tradeables and durables to allow for potential omitted variables bias in the non-tradeables regressions. As these estimates show, the

combined components of consumption explain 12.8% of the variation of tradeables consumption and a lower proportion is explained by output at 32%.[15] Risk-sharing continues to be rejected.

(1.2.4) Conclusions About Non-Separabilities

The evidence to this point shows that risk-sharing tests are rejected. Under the view that measurement error is the reason for this rejection, the evidence shows how this error must behave. In Table 2, the error should be relatively uncorrelated with non-tradeables, but should be significantly correlated with durables and tradeables output. Furthermore, it must explain at least 32% of the variation of tradeables consumption, or greater than the other components of consumption combined.

Alternatively, under the view that measurement error is not the sole source of the rejection, Tables 1 and 2 suggest that non-separabilities in utility cannot explain the low cross-country correlation in consumption on their own. Including measures of leisure, non-tradeables, and durables services help to explain the puzzle, by accounting for up to about an eighth of the variation in consumption growth rates. However, even after incorporating all of these non-separabilities, non-durables tradeables consumption is significantly related to output. Therefore, while non-separabilities help to explain the puzzle, they do not appear to be enough.

Section 2: Can Capital Market Restrictions Explain It?

The non-separabilities story is based upon the presumption that all countries have equal access to international capital markets, a presumption clearly at odds with casual empirical observation. Recent research on the individual household level has emphasized the importance of restrictions such as transactions costs, liquidity contraints, and short-sales constraints.[16] These market frictions are likely to be even more important in the international market where governments impose taxes and restrictions on the holdings of foreign assets by domestic residents. Furthermore, residents of countries may be restricted from borrowing in international markets due

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[15]When consumption is decomposed into semi-durables and these goods are controlled for on the right-hand side, then non-separabilities explain up to about 36% of tradeables variation although risk-sharing is rejected.

[16]See, for example, Zeldes (1989), Telmer (1993), and Heaton and Lucas (1992,forthcoming).

to past defaults on loans by their government or other domestic residents. Therefore, I now ask whether international capital market frictions can help explain the low degree of risk sharing.

(2.1) Based Upon a Single Tradeable Good

I will begin the investigation of the effects on market restrictions by assuming that there is a single tradeable good to provide straightforward implications for the aggregate regression tests examined above. I will then examine the effects of incorporating non-separabilities between tradeables and non-tradeables in section (2.2) below.

To examine the effects of restrictions on the risk-sharing rejections, consider the regression tests in Table 1 using aggregate consumption so that $\psi(T,N) \equiv T$ and assume that $\theta_1 = 0$. In this case, the regression reduces to:

$$\Delta \ln(T_t^j) = \theta_o(t) + \beta X_t^j + u_t^j. \qquad (15)$$

By OLS, $\beta = \text{Cov}(\Delta \ln(T_t^j), X_t^j)/\text{Var}(X_t^j)$. In other words, the sign of β is determined by the covariance between the growth rate of the consumption good and domestic output both relative to the world.

Recent studies of incomplete markets at the individual level suggest that various types of restrictions will increase the covariance between consumption and idiosyncratic income. Cuoco and Cvitanic' (1994) show theoretically for the case of log utility (i.e., $\gamma = 1$) that general types of restrictions on risky assets will bias holdings of these assets toward zero and hence increase the covariance of consumption and idiosyncratic income relative to complete markets. With iso-elastic utility, Heaton and Lucas (1992) find in simulation results that the covariance between consumption and idiosyncratic income increases relative to complete markets as various types of market frictions are imposed including transactions costs and borrowing constraints.

A higher covariance between consumption and idiosyncratic disturbances implies that for countries facing market frictions, the coefficient on output in the regression (15) should be positive. Thus, defining β^u as the coefficient on unrestricted countries and β^r as the counterpart for restricted countries, we are likely to find that $\beta^r > \beta^u$. Furthermore, for risk-sharing among the unrestricted countries, we should find that $\beta^u = 0$.

With this simple intuition, I will re-examine the aggregate results in Table 1 to ask whether

market restrictions can explain the evidence. Focusing on aggregated consumption can address whether examining non-separabilities are necessary, as well. Before doing so, I will provide another motivation for the test that $\beta^r > \beta^u = 0$ assuming that restricted countries are small and therefore take the world price of equities as given.

(2.1.1) Theoretical Framework

One way to think about international market restrictions is that they impose a tax on holdings of foreign equities relative to the complete markets equilibrium. Although I will treat the restrictions this way, the basic effect of this restriction is to introduce a cost on holdings of foreign equities so that transactions costs or other types of market frictions can be captured by this "tax."

To think about the decentralized country-specific equilibria behind equation (1), suppose that production is given by endowments that accrue to residents of each country. Suppose first that residents of all countries derive utility from a single tradeable good. On the other hand, wealth is held in the form of domestic and foreign equities that pay out dividends in the realizations of endowments of this good in the respective countries. For now, I will assume that domestic residents can borrow and lend at the world interest rate, although I will relax this assumption below.

Residents in each individual country j maximize an intertemporal utility function:

$$E_t\{\sum_{r=1}^{\infty} \rho^r u(T^j_{t+r})\}$$

$$\text{s.t.} \quad T^j_t + p_t b^j_t + \chi^j_t q_t + \chi^{*j}_t q^*_t \leq b_{t-1}{}^j + \chi_{t-1}{}^j (q_t + \eta_t) + \chi^*_{t-1}{}^j (q^*_t + \eta^*_t)(1 - \kappa) \qquad (16)$$

where b_t is domestic holdings of an internationally traded pure discount bond that pays out one unit of the consumption good at time $t+1$, p_t is its price, χ^j_t is domestic holdings of the domestic equity that pays out the output stream η^j_t, q_t is its price, χ^{*j}_t is domestic holdings of the foreign equity that pays out the composite foreign output stream, $\eta^*_t = \Sigma^J_{i=1} \eta^i_t - \eta^j_t$.

In (16), κ represents the proportional direct or indirect tax placed upon domestic residents who want to hold foreign equity. It is well known that when $\kappa = 0$, for iso-elastic utility, all countries will hold the same portfolios of a world mutual fund and, hence, share the same

consumption growth rates as implied by (1).[17] On the other hand, when domestic residents face the tax in (16), they will bias their holdings toward more domestic equities and, hence, towards domestic output. To see this, note that the first order condition with respect to χ^* in (16) implies:

$$u_T(T_t^j)\, q^*_t = \rho\, E_t[u_T(T_t^j)\, (q^*_{t+1} + \eta^*_{t+1})(1 - \kappa)] \qquad (17)$$

Defining $Q_t \equiv \rho\, E_t\, u_T(T_t^j)/u_T(T_{t-1}^j)$, the intertemporal marginal rate of substitution of consumption, and $R^*_t \equiv (q^*_t + \eta^*_t)/q^*_{t-1}$, the foreign equity return, and rearranging (17) gives:

$$Cov_t(Q_{t+1}, R^*_{t+1}) = (1/1-\kappa) - E_t(Q_{t+1})\, E_t(R^*_{t+1}). \qquad (18)$$

Recall that this country is small in world markets so that the return on the foreign mutual fund, R^*, and the price of the bond, p_b, are given. Since the first-order condition with respect to the bond price implies that $E_tQ_{t+1} = p_b$, both E_tQ_{t+1} and $E_tR^*_{t+1}$ are unaffected by the tax. Clearly, then, as the proportional tax increases towards 1, the covariance between the intertemporal marginal rate of substitution and the foreign return increases. This is because, in equilibrium, residents will be willing to hold the foreign stock with the higher tax rate only when it provides a better hedge against consumption risk at the margin.[18]

Now consider the effects of restrictions on borrowing.[19] Zeldes (1989) shows that in states of the world in which individuals are constrained from borrowing, their expected intertemporal marginal rate of substitution in consumption is lower than implied by the risk free rate. This is because liquidity constrained individuals would like to borrow and consume more today relative to the future, thereby pushing up the current relative to future marginal utility of consumption. By equation (18), for states in which a country is borrowing constrained so that E_tQ_{t+1} is lower than its alternative under unrestricted borrowing, the covariance of Q with the foreign equity return will

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[17]For example, Ingersoll (1987)) describes a mutual fund theorem in which all investors with the same isoelastic utility would hold the same portfolio shares. Lewis (1995) describes the implications of this theorem in the international context.

[18]Note that in equilibrium, consumption, T^j, depends upon the domestic and foreign equity returns, R and R^*, so that the covariance of the intertemporal marginal rate of substitution, Q, and foreign equities can be changed by increasing holdings of domestic relative to foreign equities even though the expected movement in Q is determined by world bond markets.

[19]Conze, Lasry, and Scheinkman (1993) show how borrowing constraints can help explain the comovements in consumption, production, and output disturbances internationally.

also be higher than under no restriction.[20]

The increase in this covariance relative to complete markets can be related to the regression tests as in equation (15). Note that in the steady state, the foreign return R^*_{t+1} pays out the sum of total world outputs relative to domestic output. Since the country-specific variable in the regression tests, X^j, is the logarithm of the deviation of domestic output from the aggregate world economy, the foreign return depends inversely on X. In other words, in steady state, $\ln(R^*_{t+1}) \approx -X^j_t$ so that in the regression test, $\beta = \text{Cov}(\Delta\ln(T^j_t), X^j_t)/\text{Var}(X^j_t) \approx -\text{Cov}(\Delta\ln(T^j_t), \ln(R^*_{t+1})/\text{Var}(\ln(R^*_{t+1}))$.

I can therefore ask what happens to β, the coefficient on X, as restrictions on foreign equities increase relative to complete markets assuming conditional joint log normality between Q and R^*. In this case, the increase in the covariance between the intertemporal marginal utility and the foreign return found in (18) implies that $\text{Cov}_t(\ln Q_{t+1}, \ln R^*_{t+1}) = -\gamma\, \text{Cov}_t(\ln(T^j_{t+1}/T^j_t), \ln R^*_{t+1})$ also increases.[21] Therefore, β increases with the restriction.

(2.1.2) An Empirical Test

If investors have access to unrestricted assets, then restrictions such as transactions costs or, in the present case, taxes on other assets may not be important.[22] In the current context, investors may substitute into other non-restricted foreign assets or self-insure with domestic assets so that international market restrictions may not matter. The relationship found above that the covariance between consumption and output for restricted countries should be positive suggests a test for the importance of these restrictions.

For this purpose, I define an indicator variable,

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[20]It should be noted that borrowing constraints will also increase the covariance of Q with domestic equity. However, as long as borrowing constrained countries also find it more costly to invest in foreign equities than domestic equities, i.e., $\kappa > 0$, then the following implications described in the text hold.

[21]By joint log normality, $\text{Cov}(Q,R^*) = E(Q)\, E(R^*) \exp[\text{Cov}(\ln(Q),\ln(R^*)) - 1] = E(Q)\, E(R^*) \exp[-\gamma\, \text{Cov}(\Delta\ln(T), \ln(R^*)]$. Since the covariance between Q and the foreign equity return R^* increases with κ, the covariance between log consumption growth and the foreign equity decreases.

[22]This point has been made by Telmer (1993) and Heaton and Lucas (1992), among others.

$$D(j,t) = 1 \text{ when } \kappa > \underline{\kappa} \text{ for country j at time t} \quad (19)$$
$$= 0 \text{ when } \kappa = \underline{\kappa} \text{ for country j at time t}$$

where $\underline{\kappa}$ is a lower bound of costs on foreign equity and is equal to zero for unrestricted countries.

Then, the relationship in the regression in (15) can be written:

$$\Delta \ln(T_t^j) = \theta_o(t) + \beta^r D(j,t) X_t^j + \beta^u (1 - D(j,t)) X_t^j + u_t^j \quad (20)$$

where β^u is the coefficient on unrestricted countries and β^r is the coefficent on restricted countries. The discussion above implies the hypothesis that $\beta^r > \beta^u$. Also, if $\underline{\kappa} = 0$ so that a country has no restrictions, then we should find that $\beta^u = 0$. I will test these restrictions below.

(2.1.3) The evidence

I now re-examine the previous results to see whether restrictions to capital markets help explain the low degree of risk sharing. For this purpose, I need measures of indicator variables for the presence of restrictions. These data were compiled from the International Monetary Fund's *Annual Report on Exchange Restrictions and Exchange Arrangements*.[23] The annual report summarizes types of restrictions into broad categories that unfortunately do not allow a precise definition of the restriction for each country. Two of these measures are related to capital market movements.[24] A third measure corresponds to countries that are likely to face borrowing constraints. Panel A of Table 3 provides summary information about each of these measures and further details are provided in the data appendix.

The first column reports information about the measure "Restrictions on Capital Transactions" over the period 1966 to 1992.[25] This series incorporates all countries that impose quantity or tax restrictions on acquisitions or holdings of foreign assets. As such, these restrictions vary from mild to severe. The column shows the average proportion of years in which one of the

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[23]I thank Andy Rose for giving me most of this data set.

[24]The report also contains information about goods market restrictions that are not considered in this paper.

[25]The series begins in 1966 so that this is the first year of data availability. As the year-by-year results in Figure 1 and the Table 2 results based upon 1970 to 1985 indicate, the basic findings in Table 1 are not sensitive to beginning the sample in 1950.

members of different country groups had a restriction on capital transactions. This proportion ranges from .39 on the low side for the Group of Seven to .98 on the high side for Africa. Clearly, capital restrictions of some form have been prevalent over the period. Figure 2 shows how the proportion of restricted countries has varied over time.

One problem with this measure is that it treats restrictions of different degrees equally. Some examples of countries categorized as restricted by this measure are provided in the appendix. Since so much of the world faces restrictions of this sort, it is useful to examine restrictions that are less general. Therefore, the second measure of restrictions I consider is a less direct measure intended to capture difficulties with payments arrangements. Some countries have currencies that are not heavily tradeable in international markets and therefore find it advantageous to develop so-called "Bilateral Payments Arrangements" with certain countries. Under these arrangements, payments for goods can be made with other goods in lieu of currency payments. Residents in countries who find it necessary to enter into this type of arrangement rather than using international currency payments may face higher costs in transacting in world capital markets as well.

The second column of Panel A reports the proportion of these countries across the world. This proportion ranges from 0 and near 0 for Oceania (New Zealand and Australia) and the Group of Seven, respectively, to .43 for Asia. Clearly, this measure captures a smaller subset of countries and, perhaps, more severe restrictions than does the other capital market restrictions measure. Figure 2 shows that the proportion of restricted countries by this proxy has decreased over time.

A third measure of capital market restrictions in Panel A is a series of countries that are in interest arrears. Countries that are not current on interest payments are likely to be constrained from borrowing and potentially from other types of international capital market transactions as well. Reporting of this data began only in 1986 so that this series has a shorter sample period than the other two capital market restrictions series. Panel A reports the composition of countries in interest arrears by group and Figure 2 shows how the overall proportion of countries in interest arrears has changed over time. As the table shows, the highest concentration of countries in interest arrears has been in South and Central America, with African countries coming in close behind.[26]

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[26]Neither the US nor Canada have been in interest arrears over this period.

Panel B reports the results of the test posed above. Interestingly, using all three measures of restrictions the estimates suggest that $\beta^r > \beta^u$ and the constraint that $\beta^r = \beta^u$ is strongly rejected at marginal significance levels less than 5%. On the other hand, the coefficient on the unrestricted countries, β^u, are significantly different than zero. Therefore, restrictions seem to be important even for countries with relatively low restrictions.

In summary, Table 3 provides evidence that consumption growth rates in countries facing capital market restrictions covary more strongly with domestic output variations relative to the world than do unrestricted countries. This relationship is precisely what a simple model of capital market restrictions on foreign equity holdings would imply. However, risk-sharing tests among countries with relatively unrestricted countries is also rejected. Therefore, these restrictions do not independently explain the lack of risk-sharing.

(2.2) Using Disaggregated Data

One possible explanation for the rejection of risk sharing among unrestricted countries is that aggregate consumption includes non-tradeables. In Section 1, I found that non-separabilities in utility between non-durable tradeables and other components of consumption explained a significant proportion of the cross-country covariation in consumption growth rates. If these non-separabilities are important and if some countries find it costly to hold foreign assets that would allow them to risk-share, then the tests above may confound both issues. For this reason, I will now consider whether the allocation of tradeables consumption allowing for non-separabilities can explain the puzzle.

(2.2.1) Theoretical Framework

When allowing for non-separabilities between tradeables and non-tradeables, the individual portfolio decisions become more complicated than for the single good risk-sharing example in equation (16). Baxter, Jermann, and King (1994) examine this portfolio allocation decision under complete markets for investors who can hold domestic and foreign equities in tradeables and non-tradeables industries. They show that investors hold the same proportion of the world equity market in tradeables, similar to the single good case above. They also hold domestic non-tradeables equities depending upon the elasticity of substitution between tradeables and non-tradeables. In

this way, the marginal utility of tradeables must be independent of domestic output variation, as found in the social planner's problem.

If domestic residents are restricted from holding foreign tradeables equities, however, then tradeables risk may not be diversified away internationally so that tradeables consumption may be correlated with tradeables output, as found in Table 2. If restrictions are important, then the coefficients in the regressions of unrestricted countries should differ significantly from those of restricted countries. Furthermore, if countries with low restrictions are sufficiently diversified, then tradeables consumption should be uncorrelated with tradeables output for these countries.

A test of this relationship relative to the risk-sharing regressions in (10) is provided by:

$$\Delta_5 \ln(T_t^j) = \theta^r_0(t)\, D(j,t) + \theta^u_0(t)\,(1 - D(j,t)) + D(j,t) \sum_{i=1}^{k} \theta_i^r\, \Delta_5 \ln(Z_t^{ij}) + (1 - D(j,t)) \sum_{i=1}^{k} \theta_i^u\, \Delta_5 \ln(Z_t^{ij}) + D(j,t)\, \beta^r\, X_t^j + (1 - D(j,t))\, \beta^u\, X_t^j + u_t^j \qquad (21)$$

where $(Z_t^{1j}, Z_t^{2j}) \equiv (N_t^j, D_t^j)$ and for separable durables k = 1 while for non-separable durables, k = 2. If market restrictions are unimportant, then we should find no difference between the two groups so that $\beta^r = \beta^u$ and $\theta_i^r = \theta_i^u$. On the other hand, if market restrictions are important, then we should find $\beta^r \neq \beta^u$ and $\theta_i^r \neq \theta_i^u$. If unrestricted countries are risk-sharing in tradeables, then we should find that $\beta^u = 0$, while if restricted countries are not, we may find that $\beta^r \neq 0$. Note that since β is a multiple regression coefficient in (21), its sign and magnitude do not have natural interpretations in terms of restrictions as in the aggregate consumption case.

(2.2.2) The Empirical Evidence

Table 4 reports the results of the regression tests in (21) using the disaggregated data from Table 2 and the market restrictions series described in Table 3, Panel A. Since the interest arrears series begins after the disaggregated series, this measure of restrictions could not be studied.

Panel A of Table 4 gives the tests based upon the "Restrictions on Capital Transactions" measure. The first row shows the estimates assuming separability. Consistent with the evidence in Table 2, tradeables consumption is significantly related to tradeables output and this result does not depend upon whether the country has high or low restrictions. However, allowing for non-separabilities with respect to non-tradeables as in the second row, significantly alters the results. The hypothesis that restricted countries and unrestricted countries share the same coefficients is

strongly rejected. The final entry allows for non-separabilities in durables. The hypothesis that the coefficients on the non-tradeables arguments in utility are the same is rejected.

The evidence based upon "Capital Transactions Restrictions" provides mixed evidence in terms of risk-sharing. The relationship between tradeables and non-tradeables is significantly different across the two groups of countries as would be suggested if the restrictions were binding. On the other hand, risk-sharing is rejected in all cases since tradeables consumption depends significantly upon tradeables output.

An important problem with this measure of restrictions is that it combines many different levels of restrictions into one measure. As illustrated by Figure 2, the unrestricted countries comprise a small part of the world. A degree of risk-sharing may take place among unrestricted countries and countries with mild restrictions as measured by the capital market restriction measure in Panel A. By segmenting the two groups, risk-sharing among the unrestricted countries may be rejected simply because countries with mild restrictions were not included in their group.

For this reason, Panel B shows the results of these same tests on a more specific proxy of capital market restrictions, the "Bilateral Payments Arrangements" measure. As Figure 2 shows, countries that find it necessary to maintain these types of arrangements comprise significantly less than 50% of the countries in the world and this percentage has fallen over time.

As in Panel A, when utility is assumed to be separable, risk-sharing is rejected and the coefficients on tradeables output are insignificantly different from eachother. However, once non-separabilities in nontradeables are allowed, the effects are striking --- risk-sharing is not rejected. This result suggests that countries with payments arrangements may provide risk-sharing among eachother, although it may also result from low power due to the small number of these countries.

Since the relationship between non-durable tradeables and non-tradeables may be affected by omitting durables, row 3 of panel B includes this variable. Again, the relationship among the components of consumption are significantly different. Interestingly, risk-sharing is rejected for the restricted countries but is not rejected for the unrestricted countries.

This result suggests that, first, non-separabilities in utility between non-durable tradeables and other components are important in explaining the differences across restricted and unrestricted

countries, and, second, countries that are unrestricted appear to be risk-sharing in terms of tradeables. While these results may be due to low power, they suggest an interesting resolution to risk-sharing. Incorrect rejection of risk-sharing may result from ignoring non-separabilities and the importance of market restrictions.

3. Conclusions

This paper has asked whether either non-separabilities or market restrictions can explain the lack of international consumption risk-sharing observed in the data. Interestingly, the evidence suggests that neither explanation can resolve the risk-sharing puzzle alone. When considering non-separabilities and ignoring market restrictions, non-tradeable goods and leisure explain only a tiny fraction of the cross-country variance in tradeables consumption. Further, tradeable consumption is significantly correlated with country-specific movements in output. On the other hand, when considering market restrictions based upon aggregate consumption, risk-sharing tests suggest that although rejections are stronger for the restricted countries, both sets of countries reject risk-sharing.

Instead of these two individual explanations, the evidence points to a combination of both to explain risk-sharing. The relationship between tradeables and other components of utility appears to be significantly different for restricted and unrestricted countries. Strikingly, risk-sharing in tradeables is not rejected for unrestricted countries measured by the less general of two market restrictions measures. While this result could be due to low power and should be studied further, it suggests that both non-separabilities and market restrictions are important for explaining international consumption risk-sharing.

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Data Appendix

1. Annual Data

The annual data of consumption, output and leisure were taken from the Penn World Tables data set described in Summers and Heston (1991). Output is the series RGDPCH "Real GDP per capital in constant dollars" using 1985 as the base year. Consumption is series C, the share of GDP times income. The growth rate of leisure is treated as minus the growth rate in employment. Employment is calculated as number of workers per equivalent adult, series RGDPEA divided by RGDPW. Countries with missing values for a given year are dropped from estimation, including calculation of the fixed time effects.

2. Disaggregated Consumption

Disaggregated consumption by commodity for years 1970, 1975, 1980, and 1985 were used from the United Nations International Comparison Program (ICP) described in Summers and Heston (1991). Each year had between 110 and 150 consumption goods categories. These series were also real goods in base year 1985. The categories of goods are described in more detail in Kravis, Heston, and Summers (1982), especially beginning on page 69.

For each year, the consumption categories were aggregated across the individual commodities. A general description of each category follows.

Non-Durable Tradeables: Includes goods such as basic food items, tobacco products, gasoline and fuels (used in residences), house cleaning supplies, drugs, non-durable recreation, toilet articles, and personal accessories. Tradeable goods that are typically associated with semi-durables were incorporated into the series since the data are observed only every five years. The semi-durables include goods such as clothing, footwear, glass and tableware, tires and automobile accessories, radios, photographic equipment, books and newspapers. The tests in Table 2 and 4 were conducted both including and excluding semi-durables without affecting the main results.

Durables: Includes goods such as furniture, floor coverings, refrigerators, washing appliances, and passenger vehicles.

Nontradeables: Includes services such as repair and maintenance of clothing and footwear, rents on housing, repairs on home and glass and tableware, domestic services, services of physicians,

dentists, nurses, maintenance and repair on automobiles, personal transportation services, local taxi rides, theater and sports, hairdresser and barber services, restaurants and cafes, hotels and lodging, and financial services.

A few goods categories were difficult to categorize or showed up in only one year. As a result, these were thrown out of the analysis. Here are the main offenders. Hospital care (only in 1970 and 1975); long distance air fare; net purchases abroad by tourists.

The raw data are measured in terms of the "current international US prices" as defined in Summers and Heston. They were converted into per capita 1985 units by deflating with population and the US consumption price index in 1985 relative to those of the other years in the sample.

Based upon the aggregated components of consumption above, the five year growth rates were formed. Countries without adjacent five year observations, such as countries in the study for only one year, were excluded. The number of countries remaining in the study are 48 and the number of observations including the pooled time series cross-section is 71.

3. Capital Market Restrictions Data

The data on capital market restrictions are from the summary tables at the end of *The Annual Report on Exchange Arrangements and Exchange Restrictions* (1967 through 1993). These data equal one if there was a restriction during the year, and a zero otherwise. Some countries have missing values, and these are treated as in the other cases.

The "Restrictions on Capital Transactions" measure is defined as "Official actions directly affecting the availability or cost of exchange or involving undue delay" (footnote 5 of the table.) These restrictions cover many different types of restrictions. For example, the 1990 issue of the annual report gives the following descriptions of capital restrictions. Countries that are "restricted" include Algeria for which the treatment of "Capital" is described as: "Residents are obliged to repatriate and surrender capital assets (or the sale proceeds thereof) held or acquired outside of Algeria. Capital transfers to any destination abroad are subject to individual license; residents are not normally permitted to acquire capital assets outside of Algeria. All borrowing abroad or from nonresidents must be approved in advance by the Minister of Economy or the Central Bank" (page 9.) Clearly, this constitutes a rather restricted economy.

A less restricted country but one that is considered restricted by the data set is Greece. For Greece, the report says: "Direct investments in Greece by non-EC residents are subject to prior approval, and the repatriation of capital and capital gains is permitted after three years following the realization of the investment.... Greek firms are allowed to borrow in foreign exchange without prior approval, provided that the maturity of the loans is at least six months."

On the other extreme, Hong Kong is listed as having no capital restriction in the data set. The discussion of "Capital" for Hong Kong says: "No exchange control requirements are imposed on capital receipts or payments by residents or non-residents" (p. 206).

The second measure, "Bilateral Payments Arrangements," indicates whether countries have arrangements with other countries for the purpose of paying for goods or capital. For example, in the 1990 report Hungary is listed as having a bilateral payment arrangement. The report says: "Hungary had bilateral payments aggreements with Albania, Brazil, the People's Republic of China, Columbia, Ecuador, Democratic Kampuchea, the Democratic People's Republic of Korea, and the Lao People's Democratic Republic. Hungary also had trade agreements with bilateral features for certain commodities with Afghanistan, Bangladesh, and Pakistan" (p. 209).

Pakistan is also listed in the same year as having a bilateral payments agreement. "Trade transactions under 'barter' agreements are settled through special accounts in nonconvertible currencies. Trade in specified commodities with Bulgaria, the People's Republic of China, Czechoslovakia, Hungary, the Democratic People's Republic of Korea, Poland, Sweden, and the USSR is settled through special nonconvertible accounts" (p. 362). Similar discussions can be found for the other countries.

Table 1

Risk Sharing Tests with Aggregate Consumption

A. Summary Statistics
(Annualized Percentage Growth Rates)

	Mean	Standard Deviation
Consumption	2.916	6.091
Output	3.833	4.824
Leisure	0.004	0.642

B. Panel Regressions

$$\ln[T_t^j/T_{t-1}^j] = \theta_0(t) + \theta_2 \ln[\ell_t^j/\ell_{t-1}^j] + \beta X_t^j + u_t$$

Model	θ_2	Percent Consumption Variance Explained by Leisure[a]	β	Percent Consumption Variance Explained by Output[b]
Separable Leisure	—	—	0.975[c] (0.042)	59.6%
Non-Separable Leisure	−0.045 (0.139)	< 0.1%	0.975[c] (0.042)	59.7%

Notes: Data are from the Penn World Tables Version 5.6 for employment and per capita consumption and output in 1985 dollars. The sample period is 1950 to 1992 for 72 countries (see the data appendix). All equations are estimated allowing for conditional heteroskedasticity across countries.

[a]Calculated as $\mathrm{Var}\big(\theta_2 \ln(\ell_{t+1}/\ell_t)\big)/\mathrm{Var}\big(\ln(T_{t+1}/T_t) - \theta_0(t)\big)$.

[b]Calculated as $\mathrm{Var}(\beta X_{t+1})/\mathrm{Var}\big(\ln(T_{t+1}/T_t) - \theta_0(t)\big)$.

[c]Significantly different from zero at the 95% confidence level.

Table 2

Risk Sharing Tests with Disaggregate Consumption

A. Summary Statistics
(Annualized Percentage Growth Rates)

Summary Statistic	Consumption Components			Tradeable Output
	Non-Durable Tradeables	Durable Tradeables	Non Tradeables	
Mean	5.67	7.86	3.00	4.94
Standard Deviation	16.17	31.09	31.68	23.98
Expenditure Shares	0.593	0.064	0.343	—

B. Panel Regressions

$$\ln(T_t^j/T_{t-5}^j) = \theta_0(t) + \sum_{i=1}^{k} \theta_i \ln[Z_t^i/Z_{t-5}^i] + \beta X_t^j + u_t^j$$

Z^j	θ_i	Percent Consumption Variance Explained by Z [a]	β	Percent Consumption Variance Explained by Output[a]
1. None (Separable Utility)	—	—	0.587[b] (0.084)	71.5%
2. Non-Tradeables	0.017 (0.057)	0.1%	0.550[b] (0.071)	66.9%
3. Durables	0.169[b] (0.033)	10.3%	0.412[b] (0.052)	37.4%
4. All				
Non-Tradeables	0.029 (0.052)			
Durables	0.170[b] (0.041)	12.8%	0.380[b] (0.077)	31.9%

Notes: Data are from the five year benchmark studies used in the Penn World Tables for disaggregated consumption expenditures in current international dollars. The data are converted into 1985 dollars using the US current dollar consumption to the US 1985 dollar consumption in the Penn World Tables. The sample years are 1970, 1975, 1980, and 1985 for 48 countries (not all countries have data in each year, as described in the data appendix). All equations are estimated allowing for conditional heteroskedasticity.

[a]Calculated as $\text{Var}(bY)/\text{Var}\big(\ln(T_t/T_{t-5}) - \theta_0(t)\big)$ where b is the coefficient and Y is the righthand side variable.

[b]Significantly different from zero at the 95% confidence level.

[c]Calculated as $\text{Var}\left(\sum_{i=1}^{3} \theta_i \ln[Z_t^i/Z_{t-5}^i]\right)/\text{Var}\big(\ln(T_t/T_{t-5}) - \theta_0(t)\big)$.

Table 3

Tests of Market Restrictions on Risk Sharing Using Aggregate Consumption

A. Average Restrictions
(as proportion of one)

Group	Restriction Measure		
	On Capital Transactions[a]	Bilateral Payment Arrangements[a]	Interest Arrears[b]
Group of Seven	0.392	0.005	0.000
Continents:			
Africa	0.984	0.178	0.414
North and Central Americas	0.596	0.074	0.500
South America	0.641	0.344	0.529
Asia	0.736	0.432	0.076
Europe	0.752	0.268	0.043
Oceania	0.667	0.000	0.000

B. Panel Regressions

$$\ln[T_t^j/T_{t-1}^j] = \theta_0(t) + \beta^r D(j,t) X_t^j + \beta^u \big(1 - D(j,t)\big) X_t^j + u_t^j$$

Restriction Measure $(D(j,t))$	β^r	β^u	M.S.L. H_0: $\beta^r = \beta^u$
On Capital Transactions	1.01[c] (0.02)	0.92[c] (0.04)	0.037
Bilateral Payment Arrangements	1.09[c] (0.04)	0.96[c] (0.02)	0.003
Interest Arrears	0.95[c] (0.07)	0.67[c] (0.06)	0.004

Notes: Consumption and output data are the same as in Table 1 over the period 1966 to 1992 coinciding with the restrictions data. The restrictions data are from the International Monetary Fund *Annual Report on Exchange Arrangements and Exchange Restrictions.*

[a]For period 1966 to 1992.

[b]For period of data availability, 1986 to 1992.

[c]Significantly different from zero at the 95% confidence level.

Table 4

Tests of Market Restrictions on Risk Sharing Using Disaggregate Consumption

$$\ln[T_t^j/T_{t-5}^j] = \theta_0^r(t)\,D(j,t) + \theta_0^u(t)\big(1-D(j,t)\big) + D(j,t)\sum_{i=1}^{k}\theta_i^r \ln(Z_t^i/Z_{t-5}^i)$$
$$+ \big(1-D(j,t)\big)\sum_{i=1}^{k}\theta_i^u \ln(Z_t^i/Z_{t-5}^i) + \beta^r\,D(j,t)\,X_t^j + \beta^u\big(1-D(j,t)\big)X_t^j + u_t^j$$

A. Capital Transactions Restrictions

Z^j	θ_i^r	θ_i^u	M.S.L. H_0: $\theta^r = \theta^u$	β^r	β^u	M.S.L. H_0: $\beta^r = \beta^u$
1. None (Separable Utility)	—	—	—	0.800[a] (0.059)	0.810[a] (0.068)	0.704
2. Non-Tradeables	0.613[a] (0.051)	0.244[a] (0.083)	<.001	0.208[a] (0.065)	0.428[a] (0.090)	<.001
3. All						
Non-Tradeables	0.061 (0.086)	0.035 (0.067)				
Durables	0.123[a] (0.049)	0.650[a] (0.052)	<.001	0.236[a] (0.081)	0.394[a] (0.107)	0.362

B. Bilateral Payments Arrangements

Z^j	θ_i^r	θ_i^u	M.S.L. H_0: $\theta^r = \theta^u$	β^r	β^u	M.S.L. H_0: $\beta^r = \beta^u$
1. None (Separable Utility)	—	—	—	0.751[a] (0.091)	0.721[a] (0.097)	0.481
2. Non-Tradeables	0.660[a] (0.219)	0.596[a] (0.112)	0.762	0.104 (0.181)	0.078 (0.145)	0.852
3. All						
Non-Tradeables	−0.182 (0.287)	0.030 (0.104)				
Durables	0.184 (0.141)	0.768[a] (0.237)	0.037	0.622[a] (0.115)	−0.007 (0.190)	0.028

Notes: The data are the same as in Table 2 for consumption and output and Table 3 for capital market restrictions.

[a]Significantly different from zero at the 95% confidence level.

[b]Significantly different from zero at the 90% confidence level.

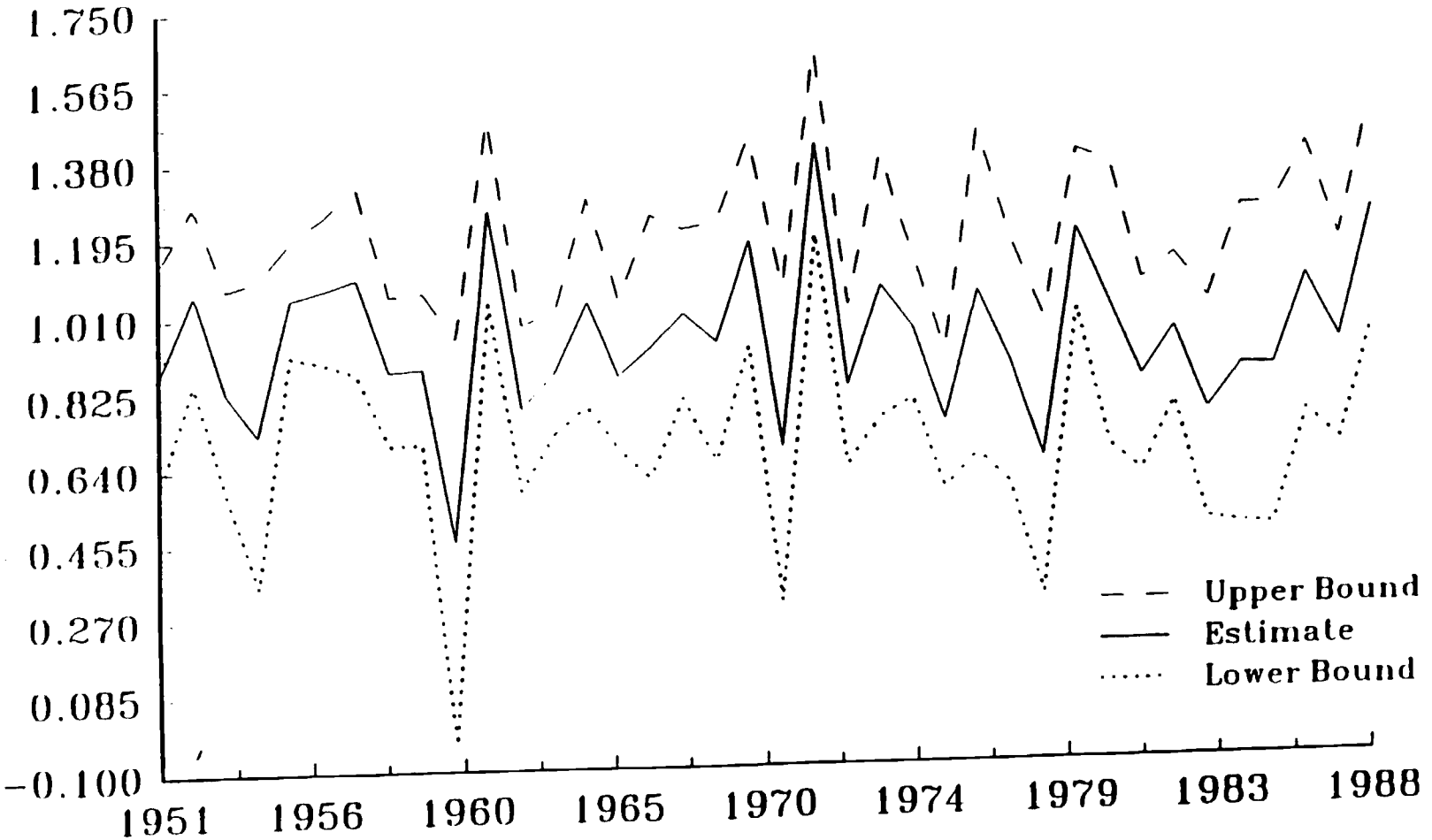

Figure 1: Coefficient on Income Growth

Figure 2: Proportion of Countries with International Capital Market Restrictions