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Consumption Smoothing Across States and Time: International Insurance vs. Foreign Loans

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Abstract:

When countries, and macroeconomic models, open up to international capital markets, the welfare gains available through completion of financial markets for contingencies potentially are much greater than those available from access to noncontingent international borrowing. Intercasual insurance, reducing exposure to differences in contingent future cases, and not intertemporal smoothing between now and then is the big story in open economies although the two must be told together.

Keywords: Consumption Smoothing, International Economic Insurance, Arrow-Debreu Securities, Foreign Loans, International Risk Sharing

JEL-Classification: **F36, G22, E21**

Non Technical Summary

Welfare gains from international insurance receive far too little attention in theoretical open-economy macroeconomics compared with those attributed to international borrowing or lending that is non-contingent. A fully optimized model that attempts to capture long-term growth rate uncertainty is used to compare the different sources of welfare change numerically: Starting from financial autarky, the welfare gains available from insurance through the introduction of Arrow-Debreu securities in a country turn out to be over four times as great as those available from riskless international bonds alone under specified conditions.

In theory, Arrow-Debreu securities, which a country can sell for a guaranteed payoff in one future possible state and buy on another state, can achieve both intercasual and intertemporal consumption smoothing. They can do so to the extent countries' risks are diversifiable in relation to world income both over time and over different possible future outcomes for each. Hence, as Obstfeld and Rogoff have emphasized, in this sense insurance can do it all, and there is no need for having riskless bonds as such.

But insurance payments themselves may not be riskfree. Then the limits to insurability can be pushed out and insurance can be made more complete by use of noncontingent credit instruments (as escrow) in conjunction with insurance. Hence such credit is complementary with insurance in some respects -- quite as observed in financial markets -- even though it may be an inferior substitute in other respects. Integrating some of the key functions of an explicit and institutionally recognizable insurance sector into macroeconomic analysis to help assess its contribution to the completion of financial markets, stability, and growth thus appears an important task ahead.

Nicht technische Zusammenfassung

Verglichen mit den Wohlfahrtsgewinnen, die auf das internationale Kreditgeschäft zurückgeführt werden, wird Wohlfahrtsgewinnen aus internationalen Versicherungen in der makroökonomischen Theorie der offenen Volkswirtschaft viel zu wenig Aufmerksamkeit geschenkt. In dem Papier wird ein durchgängig optimiertes Modell, das die Unsicherheit hinsichtlich der langfristigen Wachstumsrate erfassen soll, verwendet, um die verschiedenen Ursachen für Wohlfahrtsveränderungen numerisch zu vergleichen: Wenn man zunächst die finanzielle Autarkie betrachtet, so sind die Wohlfahrtsgewinne aus Versicherungen durch die Einführung von Arrow-Debreu-Wertpapiere in einem Land unter bestimmten Bedingungen mehr als viermal so hoch wie die allein aus risikofreien internationalen Anleihen erzielten Gewinne.

In der Theorie können Arrow-Debreu-Wertpapiere sowohl eine interkausale als auch eine intertemporale Konsumglättung bewirken. Sie können dies in dem Ausmaß tun, wie die Risiken eines Landes, bezogen auf das Welteinkommen, sowohl im Zeitverlauf als auch mit Blick auf verschiedene mögliche Risikoergebnisse diversifizierbar sind. In diesem Sinne können Versicherungen folglich alle Aufgaben erfüllen, wie Obstfeld und Rogoff betont haben; risikofreie Anleihen als solche sind somit überflüssig.

Versicherungsleistungen selbst können jedoch mit Risiken behaftet sein. Die Grenzen der Versicherbarkeit können dann erweitert und die Versicherung mittels anderer, effektiver Kreditinstrumente (wie Treuhandgeschäfte - escrow) in Verbindung mit einer Versicherung ausgebaut werden. Solche Kredite sind also in gewisser Hinsicht eine Ergänzung zur Versicherung - wie an den Finanzmärkten zu beobachten ist - wenn sie auch in anderer Hinsicht ein minderwertiger Ersatz sein können. Die Aufnahme einiger wesentlicher Funktionen eines Versicherungssektors in die makroökonomische Analyse, mit dem Ziel, dessen Beitrag zur Vervollständigung der Finanzmärkte, zur Stabilität und zum Wachstum besser bewerten zu können, dürfte daher eine wichtige Aufgabe für die Zukunft sein.

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I. Introduction

The purpose of this paper is twofold. One is to help move open-economy macroeconomics away from its disproportionate emphasis on riskless international borrowing and lending as the primary benefit which opening-up to the international capital market can achieve. This paper thus will show that introducing noncontingent international debt contracts can deliver only a small fraction of the benefits available from the introduction of contingent payments and settlement, i.e., insurance. The reason is that riskless debt can contribute only to *intertemporal* consumption smoothing, defined as smoothing between present and expected future consumption. Insurance, on the other hand, can contribute to *intercasual* consumption smoothing as well. It does so by reducing the difference between the welfare results of good and bad cases, states, or outcomes in future periods.

The second purpose is to show that, in situations where a contract offering full insurance is not feasible because it is subject to default risk, financial intermediation with riskless government debt can make the insurance contracts that are feasible in the marketplace more complete. As long as there was no payment risk, insurance through Arrow-Debreu securities could achieve optimal degrees of both intertemporal and intercasual consumption smoothing quite without the benefit of any other financial instruments such as riskless bonds. However, there are other situations, modeled in this paper, in which introducing the latter may be helpful to providing more complete insurance. Even if it needs to be supplemented by other financial instruments, insurance remains central to the welfare benefits from financial development.

After summarizing diverse modeling assumptions used in this area in Section II, the advantage of insurance over noncontingent bond financing is demonstrated in

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Section III. This is done with modeling tools laid out in Obstfeld and Rogoff (1996, ch. 5) and with suitable parameter values assigned for obtaining concrete, numerical results. The greater the difference between the future states (income realizations) that have appreciable and stable probability and are thus insurable (see Courbage and Liedtke, 2002), the less the welfare gains that can be expected from advancing expected *intertemporal* smoothing alone. Furthermore, advancing intercasual smoothing may involve little or no sacrifice of intertemporal smoothing in the welfare sense, although the equilibrium level of the interest rate will change. Other novel insights are derived from a Taylor-series decomposition of the welfare gains involving changes in financial prices and quantities from "autarky" to the "riskless bonds only" and then to the "insurance" solution. For this decomposition, shadow financing prices had to be derived for complete identification of the sources of change.

Turning to a closed-economy microeconomic setting with idiosyncratic income risk, Section IV shows that while insurance is an important element of financial development, the credit market and its participation in financial intermediation may be needed also to raise the level of insurability internally. Specifically the section shows that the terms of insurance can be improved by use of riskless government bond financing to extend the limits to insurance derived in Obstfeld and Rogoff (1996, ch. 6). Thus riskless financial instruments can interact with insurance policies and raise the feasibility of contracts that make insurance more complete. But relying only on various money, bank-credit, bond, and stock-market indicators of financial development, as is the common practice,[1] leaves out the important contribution to financial development of the insurance sector.

Section V concludes by reflecting on possible implications of the results for policy analyses relating to the contribution of the (international) financial sector to economic stability, welfare, and growth.

[1] See Demirguc-Kunt and Levine (2001) for a comprehensive treatment, de Souza (2004) for further references, and Zhu, Ash and Pollin (2004) for a critical re-examination of some of the econometric evidence about stock market liquidity spurring economic growth.

II. An Overview of Diverse Modeling Assumptions Used in Past Results

In endowment economies without possibility of investment in inventories that can be carried over to next period, a country's representative agent can smooth personal consumption only through resource transfer between countries on credit. The determination of the current-account balances that are optimal for national consumption smoothing under various pre-specified conditions can then be evolved into optimal steady-state ratios of external debt, held or owed, to GDP.

Using different combinations of settings, specifications, and parameter assumptions for didactic purposes, *Foundations of International Macroeconomics* (Obstfeld and Rogoff, 1996) offers optimal riskless external-debt to national income ratios that range from 15 (p. 119) to as little as 0.12 (p. 384) in its first six chapters. Such results are, of course, not meant to be comparable as the first arises in an infinite-horizon model while the rate deduced from the result on p. 384 is a knife-edge solution showing the maximum quantity-constrained credit in relation to first-period income that is compatible with not choosing rationally to default. Nevertheless one general lesson that may be drawn for policy work from theoretical derivations of optimal variable levels that can differ by a factor of more than 100 is ultimately to choose the most informative models and parameters from a large menu of offerings to help focus on a much narrower range of results.[2]

Favorite problem settings on that menu are either the small open economy with perfect capital mobility that takes *the* world interest rate as given or an endogenously determined interest rate that is common to all countries. Unlike in Obstfeld and Rogoff (2000), there are no transportation costs and no differences in currency or in terms of trade on account of the assumption of a single and completely tradable good. The time horizon may be either infinite or limited to a two-period model of overlapping generations. Calibration of gross interest and time preference rates, such as 0.95 or 0.96

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[2] In policy applications, some of the authors mentioned above themselves certainly have no difficulty zooming in on the relevant part which lies near the low end of the above range. Thus Reinhart and Rogoff (2004, p. 14 of 15 unnumbered pages) have concluded that "prudent external debt thresholds may be much closer to 15 to 30 percent [i.e., 0.15 to 0.30 in relation to GDP] (the level seen in several of the emerging[-market-country] non defaulters) than the much higher levels today one sees in countries with a history of serial default, such as Turkey and Brazil."

as the discount factor applied to values realized in the second period,[3] curiously suggests that the time separating the two periods is more like a year than a generation. The specification most commonly chosen for consumer utility is the time-separable additive constant relative risk aversion (CRRA) function, starting with logarithmic utility implying CRRA of 1 or with a more suitable value.

National incomes of the representative agent are obtained either exogenously by endowment, available by endowment in the first period but produced in the second period, or needing to be produced in every period by technologies that may display either constant or diminishing returns to capital. Per capita incomes are trend-stationary except when labor-augmenting technological progress is assumed. Because the productive stock of capital is rarely assumed to depreciate at all though it may become part of personal consumption on account of its "putty-putty" character, the gross=net return on capital may be 10 percent or less per period.

When Obstfeld and Rogoff (1996, ch. 6) consider risk in international lending, they use the derivation to set an upper limit on the amount of debt that can be contracted with complete safety. Hence while there is a great variety of conceptual approaches and numerical results, the international financial product featured in the different models most often ends up being a bond or noncontingent liability that will surely be discharged or serviced as scheduled. This paper shows that the attention given to riskless international loans or their securitized equivalent, *riskless bonds*, in international macroeconomics is quite out of proportion to their ability to advance national welfare. The ability of international trade in insurance policies to do so is potentially much greater and deserving of much more study than hitherto accorded to it not just in the graduate macroeconomics curriculum but in economic research generally. New Open-Economy Macroeconomics, as appraised by Lane (1999) and Obstfeld (2001), could be well suited to support this research. For it emphasizes consumption smoothing and insurance and already gives some attention to the means by which international financial markets can be made more complete.

[3] Use of a value of β so close to 1 would seem to imply that the discount rate is annual rather than for successive generations. To avoid the problem of having to define the length of the discounting period which surely can not be thought of as just one year in the two-period model, we will simply assume that β is 1 in that model used in Section III, but not in the infinite-horizon model of Section IV.

As a practical matter, intertemporal smoothing can best be achieved by means of international riskless borrowing and lending when there are well-defined temporary deviations from firmly established growth trends, so that the borrowers and their lenders can be sure that the country soon will get back on track. Such conditions may be quite rare, and changes in trend rates of growth over the medium term can create difficulties. These difficulties are particularly acute if such changes appeared unlikely judging by past time-series processes or other forecasting methods used to represent expectations of future growth trends. Misplaced confidence may then facilitate international borrowing in good times that may well dry up and be regretted in bad times. Insuring against adverse future contingencies by paying now to be in a position to collect insurance settlements later is politically far less attractive than borrowing now and paying later. Perhaps for this reason, cycles of overborrowing or inefficient foreign borrowing (McKinnon and Pill, 1996; Tirole, 2003; Calvo, Izquierdo and Talvi, 2004; and Perry and Servén, 2004) followed by "sudden stops" and debt crises in emerging countries are common. They are so familiar in fact as to lend credence to Dornbusch and Park's (1987, pp. 432-433) caustic judgment that capital tends to rush to such countries "when it is unnecessary and leave when it is least convenient."

III. Welfare Gains from Riskless International Credit Compared with Insurance

While international capital flows may not in fact stabilize consumption or income over time in many emerging-market economies, what if these countries were free from political myopia and able to pursue economically optimal stabilization objectives through international credit and insurance channels? Table 1 then makes the point that the benefits of international borrowing alone would be rather limited under the best of circumstances represented by ex ante equilibrium. It shows that even if such borrowing is optimally deployed and the set of possible future outcomes is known with exact probability, non-contingent sovereign borrowing can achieve little to smooth consumption. Several times larger utility gains attach to the insurance available from a complete market in contingent claims between two countries. The introduction of insurance adds another financial-asset price to the interest rate and allows countries to buy insurance on one state and sell insurance on another so that the resulting gross international capital flows can be much larger than the net flows. By contrast, the only thing that matters about countries' borrowing or lending by use of the same homogeneous riskless bond instrument is the net flow and the resulting net lender or borrower position.

3.1 Technical Specifications

The three cases cases laid out in Table 1 involve financial markets that are increasingly complete from first to last. As fully specified in the appendix for convenience, the basic set-up chosen for concreteness is that there are only two countries, home and foreign (*), in the world (W) whose income (Y) at date 1 is equal such that $Y_1 = Y_1*$. Hence Y_1^W equals $2Y_1$. At date 2 there is a 50 percent chance that the income situation of date 1 will repeat itself exactly so that, in state s=1, $Y_2^W(1) = 2Y_1$ as before. Here states s=1,2 are identified in parentheses while dates are shown by subscript. However, there is an equal chance (so that probability $\pi(2) = \pi(1) = 0.50$) that $Y_2^W(2) = Y_2(2) + Y_2*(2) = Y_1 + 2Y_1 = 3Y_1$, i.e., that foreign (*) income will be twice as high as domestic income at date 2 in state 2. Thus one country may have significantly better prospects, allowing it to grow 2.8 percentage points faster annually than another, so that its relative income in state 2 could double over 25 years if this is how far the “date 1” and “date 2” periods are apart. Such differences in growth prospects could currently prevail, for instance, between some of the EU/EMU accession countries and some of the existing members. They have been observed between several pairs of countries in the past.[4] Hence the calibrations ands numerical simulations of this

[4] The ratio of Mainland China’s real national income per capita to Japan’s real GNP per capita and the ratio of Ireland’s real GDP per capita to Germany’s GNP per capita increased by one fifth and one fourth, respectively, over the 25-year period 1965-1990. In both instances, the average annual rates of per capita growth between the two countries related to each other differed by less that one percentage point. In the following 9 years, 1991-2000, however, using GDP volume indexes per capita that had by then become available, showed that these comparable per capita ratios had doubled in the first case and increased by almost two-thirds (62 percent) in the second. During this more recent period, China’s per capita growth exceeded that of Japan by more than 8 percentage points on annual average and Ireland’s per capita growth exceeded that of Germany by about 5-1/2 percentage point. The data used in these calculations are from IMF, *IFS Yearbook*, 1993; 2003. Particularly in the case of countries with relatively undiversified domestic production and exports, such as some oil-exporting countries, changes in the terms of trade may also be important in reshuffling their relative international positions. Hoffmann (2003) has considered the role of relative-price fluctuations in allocating consumption risk. Because of the assumption of a single homogeneous product with zero transfer costs, there is no role for relative product price changes, either by kind or market, in this paper. Introducing separate money`s and an exchange rate into the model would also be of no consequence, except perhaps for contract modalities, as the real exchange rate could not change. Artis and Hoffmann (2003) contribute

paper refer to long-term growth uncertainty - uncertainty about where countries will stand, say, 25 years from now relative to each other - and not to the type of shocks responsible for business cycles.

As pointed out by Obstfeld and Rogoff (1996, p. 331), Lucas'es (1987) estimate of the welfare gains from total elimination of consumption variability assumed that (U.S.) consumption fluctuates randomly around a fixed trend so that all consumption fluctuations are temporary. It is clear from the much longer horizons subsumed above, that such cyclical disturbances are not the subject here. Rather, uncertainty about long-term growth trends is most germane to the specification of the binary income process just before. Other choices are a personal discount factor, β, of 1 so that there is no net time preference in this (but not the next) section, and a constant relative risk aversion (CRRA) coefficient, ρ, of 2. The value of beta is at the upper end in view of recent evidence provided by Warner and Pleeter (2001), while $\rho=2$, the benchmark value also used by Lucas (1990, pp. 304-306) and Obstfeld and Rogoff (1996), is at the lower end of what commonly is accepted as arguably realistic in the Finance literature. Such a low value was chosen so as not to exaggerate the benefits derived from complete insurance. As already hinted, date 2 may be thought of as one generation after date 1. Thus the discount rate (r) in Table 1 is cumulative, not annual.

3.2 Riskless International Borrowing Only

In the riskless discount bonds (B, subscripted by maturity date) case portrayed in the middle column of Table 1, the optimal level of B_2 is negative, indicating a capital export from the home to the foreign country at date 1. Because of zero net time preference and equal incomes of 100 at both dates, the home country also has a shadow international interest rate of zero in the state of financial autarky. Hence it is willing to lend at any positive interest rate as soon as the international bond market opens up. Conversely, the foreign country whose desire to anticipate higher future incomes is restrained by a shadow interest rate of 60% under autarky in this consumption-loan model involving nonstorable goods will be willing to borrow at any interest rate less than 60% from the home country. Hence the international bond market clears at an

to an understanding and appreciation of global wealth effects linked to real exchange rate changes that may have an immediate effect on international consumption smoothing.

interest rate (r) between 0% and 60%, in fact, about midway between these rates, at r = 27.15%, in Table 1, with the home country lending $B_2/(1+r)$ to the foreign country at date 1, being repaid without fail at date 2.

Because payment of B_2 is noncontingent, the foreign country owes the fixed amount B_2 at date 2 irrespective of whether the bad state, s=1, or good state, s=2, materializes on that date. Hence it would end up worse off than without foreign borrowing in state 1-- something that surely has occurred quite often in the real world when countries came to regret past foreign borrowing. Not surprisingly, therefore, only rather small gains in utility are achieved from optimal international borrowing. The utility index increases by between 0.3 and 0.4 percent in each of the two countries from the level under autarky shown in Table 1. The difference between consumption in states 1 and 2 at date 2 is not modified, remaining 0 for the home country and 100% for the foreign country. Through trade in insurance, by contrast, both countries share the potential good fortune of the foreign country at date 2 so that consumption rise by the exact same percentage in each. That percentage is 50 from dates 1 to 2 in the good state (s=2) and 0 each otherwise (s=1). Also, unlike with insurance, with riskless bond financing only, each country's share of the expected discounted present value of world consumption -- 45.04 percent of 396.65 for the home and 54.96 percent for the foreign country -- is the same as its share of the corresponding expected value of world income, Y^W, where $Y^W = Y_1^W + 0.5[Y_2(1)^W + Y_2(2)^W]/(1+r)$. The reason is that no income redistribution effect can arise across countries from non-contingent borrowing at the compound rate r if that is the discount rate applied by both countries.

3.3 Complete Market for Contingent Claims on Uncertain Future Incomes

The home country, with an assured endowment of 100 at every date in every state has no need for insurance per se since it faces no endowment-income risk. However, it

Table 1. Utility Gains from International Credit and Insurance Compared

Internat. Financial Market:	Closed, Autarky	Riskless Bonds Only	Spanned by Insurance
Contingent Int. Fin. Claims:	None	None	Complete Market
Home Country			
(1) E_1U (expected utility[1])	-200	-199.28	-195.16
(2) C_1 (date 1 consumpt'n)	100	94.68	93.94
(3) $C_2(1)$ (C date 2, state 1)	100	106.76	93.94
(4) $C_2(2)$ (C date 2, state 2)	100	106.76	140.91
(5) r (real interest rate)	0%	27.15%	38.46%
Foreign Country (*)			
(6) $E_1{*}U$	-175	-174.45	-172.86
(7) $C{*}_1$	100	105.32	106.06
(8) $C_2{*}(1)$	100	93.24	106.06
(9) $C_2{*}(2)$	200	193.24	159.09
(10) r* (=r except in autarky)	60%	27.15%	38.46%
Financial Asset Trade			
(11) B_2 (riskless bond)[2]	-	-6.76	-
(12) $B_2(1)$ (pay B_2 in state 1)[3]	-	-	6.06
(13) p(1) (state 1 price)[4]	-	-	0.6923
(14) $B_2(2)$ (pay B_2 in state 2)[3]	-	-	-40.91
(15) p(2) (state 2 price)[4]	-	-	0.3077
Memorandum[5]			
(16) $p(1)B_2(1)/(1+r)$	-	-	3.03
(17) $p(2)B_2(2)/(1+r)$	-	-	-9.09

Notation: Subscripts indicate dates 1 or 2, while alternative states (s) at date 2 are identified by suffix (1) or (2). All quantity variables (upper case), except for U, are in percent of Y_1, with $Y_1 = Y_1{*} = Y_2(1) = Y_2{*}(1) = Y_2(2) = 100$, and $Y_2{*}(2) = 200$.

Source: Original problem solved in the appendix with the use of relations derived in Obstfeld and Rogoff (1996, ch. 5) for own parameter values and endowment income levels also specified in the appendix.

[1] The expected utility function with constant relative risk aversion is of the form $E_1U = 10{,}000(1-\rho)^{-1}[C_1^{1-\rho} + E_1(C_2^{1-\rho})]$, where $E_1(C_2^{1-\rho}) = \Sigma_{s=1,2}\ \pi(s)C_2(s)^{1-\rho} = 0.5[C_2(1)^{1-\rho} + C_2(2)^{1-\rho}]$, and the CRRA coefficient, ρ, is taken to be 2.

[2] Discount security issued for $B_2/(1+r)$ at date 1 by home (foreign) country, if B is positive (negative).

[3] Pay to foreign {home}country if $B_2(s)$ is positive {negative}, meaning that the home {foreign} country had sold {bought} insurance on that state (home-country capital import {export}) at date 1and the respective state occurs.

[4] The date 1 price of a payoff of one unit, conditional upon the occurrence of state s=1,2 at date 2, is p(s)/(1+r). The shadow prices of insurance on state 1 under "riskless bonds only", p(1) and p*(1), are 0.5 and 0.8112, respectively.

[5] The date 1 price of insurance contract paying the amount $B_2(s)$ at date 2 if state s=1,2 occurs. Selling international insurance implies taking on a liability (capital import, +), while buying insurance implies acquiring an insurance asset and state-contingent claim on the foreign country (capital export, -).

still desires to distribute consumption from the present to the future at any positive interest rate as before. Indeed, the equilibrium level of the world interest rate rises from 27.15 percent with "riskless bonds only" to 38.46 percent with insurance. This steep increase in the equilibrium rate of return on long-period saving compensates the home country for raising its saving through current-account surplus at date 1 out of an endowment income of 100 from 5.32 to 6.06 in spite of the fact that its expected income at time 2 is raised through the insurance trades, thereby further destabilizing its consumption intertemporally. It also finds that insurance on state 2, with world endowment income of 300, is cheap relative to insurance on state 1, with world endowment income of 200, given that both states are equally probable by assumption. Accordingly, it will want to buy insurance on state 2 and sell insurance on state 1, and spend more on the capital export [$B_2(2)<0$] than it receives from the capital import [$B_2(1)>0$]. At date 2 it then pays $B_2(1)$ to the foreign country if state 1 occurs while collecting $B_2(2)$ from that country in state 2.

With an international market for contingent claims that is complete when (unlike in the next section) there is no insurance-contract fulfillment risk,[5] much larger utility gains are registered than under riskless bond financing only, and they accrue disproportionately to the home country. When each country buys insurance on one state and sells insurance on another, the gains from these intertemporal trades, relative to the actuarial norm of insurance prices corresponding to probabilities, differ between them. The home country does not have any use for insurance except as a profitable business. Compared with the outcome under "riskless bonds only" in Table 1, its utility improves by 2 percent while rising only 1 percent in the foreign country. The reason for the disproportionate gain by the home country is that since its income prospects are stationary and certain, while the foreign country's prospects for date 2 are on balance more favorable but highly uncertain, the latter will have to accept insurance prices that are actuarially unfair and biased against it to clear the market for contingent claims. The appendix provides all the derivations. The result, that the consumption of one country must be destabilized for that of another to be made smoother intercasually, indicates that risk is not perfectly diversifiable between them. However, risk is being redistributed to the country best able to bear it as the home country's share in the intercasual risk of the foreign country is raised up for its disproportionate gain to the optimal margin of risk pooling.

Specifically, discounted at 38.46 percent, the present-value sum of domestic income endowments is 172.223 for the home country. This is 45.26 percent out of the corresponding expected world total of 380.558. However, with the values for p(s), $B_2(s)$, and r from the last column of Table 1, the home country gains (and the foreign country loses) a combined total of 6.5234 from (i) the needed overpricing [$p(1)>0.5$, $B_2(1)>0$] of the insurance it sells on state 1 yielding {$(p(1)–0.5)B_2(1)/(1+r) = 0.8416$} and (ii) the underpricing [$p(2)<0.5$, $B_2(2)<0$] of the insurance -- by the actuarial standard of equal probability of the two states -- it buys on state 2 yielding {$(p(2)–0.5)B_2(2)/(1+r) = 5.6818$}. As a result, its share of the expected present value of world consumption rises by almost 4 percent from 45.26 percent to 46.97 percent, while the foreign country's share declines by over 3 percent from 54.74 percent to 53.03 percent. Generalizing slightly, it is most advantageous for stable core countries[6] to sell insurance to countries with less certain prospects because they must be well rewarded to be willing to take on some of the instability of emerging-market countries.

Overall the theoretical demonstration of this section drawing on the results summarized in Table 1 creates a strong presumption that more complete financial markets for contingencies are a much more important welfare issue for the two countries than the institution of perfect capital mobility at the riskless interest rate between them. The economic welfare effects of insurance, for both buyer and seller of policies on the different states, can easily be several times greater than those available from noncontingent international borrowing alone.[7]

To represent the expected utility gains (dU for short, from lines (1) and (6) of Table 1) in terms of the equivalent additions to consumption, each country's

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5 The consequences of lifting this assumption, and how to mitigate them, are examined in Section IV.

6 As a general rule, over the period 1950-1990, large countries with highly developed financial markets had a much lower percentage standard deviation by Shiller's (1993, pp. 64-65) measure of volatility of return in the market for perpetual claims on GDP than small and emerging-market countries. Compare, for instance, the United Kingdom's annual percentage standard deviation of 1.14 with that of Spain, Greece and Portugal, all between 6 and 8 percent, and the corresponding measure for the United States, of 1.62 percent, with 6 percent for Mexico and between 9 and 10 percent for Argentina and Venezuela.

7 This conclusion may be compatible with the findings of Melitz and Zumer (1999) that credit plays a smaller role, relative to diversified claims on property with uncertain returns, in risk-sharing between countries.

consumption of 100 under autarky offers a convenient scalar. Since the form of the utility function is simply 10,000 times the negative inverse of consumption, this merely involves solving the equation dU = -10,000/x + 100 for x. Given that for the home country, dU=0.72 for bond financing compared with autarky and 4.84 for insurance compared with autarky, the equivalent one-time increases in first-period consumption are 0.73 percent and 5.09 percent. For the foreign country the corresponding increases are 0.55 percent and 2.19 percent, or about half as much in each case when rated over the two periods in the model. Hence the gains from complete insurance compared with autarky are 7 times as large as those of introducing riskless bond financing for the home country and four times as large for the foreign country. In addition, the equivalent consumption gains accrue disproportionately to the home country, most notably in the case of insurance.

Arrow-Debreu securities can be described in several equivalent ways. Thinking of the home country selling $B_2(1)$=6.06 units of a security called *state one* to the foreign country and buying $B_2(2)$=40.91 units of a security called *state two* from it at current prices of p(1)/(1+r)=0.5 and p(2)/(1+r)=0.22223, respectively, one could regard the acquisition of cross-holdings of foreign equity as each country buying a share of the other's contingent output along Shiller (1993) lines. At date 2, the price of one of the securities would then go to zero while the other would go to 1, depending on whether state 1 or 2 occurs. One could equivalently regard the home country as selling, at t=1, 6.06 percent of its contingent output (of 100) at t=2, conditional on state 1 occurring at that time, forward at a price of 3.03 while buying 20.46 percent of the foreign country's contingent output (of 200) in state 2 forward at a price of 9.09, with only one of the output shares delivered at t=2. Regardless of which financial paraphrase is preferred, the determination of the equilibrium prices and quantities remains clearest as shown.

Modest forms of international income insurance, such as through GDP-linked bonds, may be somewhat more practical,[8] but they can only be a partial substitute for

[8] Schiller (2003, pp. 124-125, 302) notes as "a path-breaking new development," a dollar bond issued by Bulgaria in 1994 with an interest rate tied to the growth rate of its economy. He lists a few additional innovations that have occurred since 1994 to partly insure some risks to economic growth, including the creation of the Economic Derivatives Market. Results for the U.S. economy 1950-79 summarized in Lucas (1987, p.44) show that the variability of real per capita consumption (0.6 percent) was only one-third as large as that of output (1.8 percent) in the United States with annual data. Most of the difference can be attributed to the effects of government tax-transfer program that make disposable

the Arrow-Debreu securities analyzed in this section. As introduced to the market so far, they merely reduce interest due and payable in the bad states but do not create a receivable (insurance settlement) for such states. Interestingly however, as proposed by Borensztein and Mauro (2004), they require contractual specification of a country's assumed trend rate of economic growth over the entire term to maturity so that deviations from that assumed rate can trigger adjustments in the interest rate that applies. The authors, and any investors in the instruments they propose, thus inevitably have to confront the kind of uncertainty about long-term growth rates with which this paper is concerned.

3.4 Decomposition of the Sources of Welfare Gains from Borrowing and Insurance

As already discussed, autarky implies a distinct shadow interest rate for each country at which that country would just be content not to borrow or lend internationally even if it could do so at that particular rate. By the same token, the riskless borrowing solution implies shadow insurance prices at which each country would want to either buy or sell equal amounts of insurance on each state thereby replicating the “riskless bonds only” solution as if the international insurance market were open to it on its particular terms. For selling (buying) $B_2(1)=B_2(2)=B_2$ amounts of insurance on each state is equivalent to borrowing (lending) $B_2/(1+r)$ at time 1 and repaying (receiving) B_2 with certainty at time 2.

But what would the shadow insurance prices $p(1)=1-p(2)$ and $p^*(1)=1-p^*(2)$ have to be in each country to make it willing to either borrow, or invest in, a combination of claims to be settled by an unconditional amount B_2? Determining these shadow prices for each country then helps identify the welfare effects from unifying them in the actual “insurance” market solution that follows. For the home country that shadow price must be the actuarially fair price $p(1)=p(2)=0.5$. The reason is that this country has no demand for insurance to promote intercasual smoothing since it continues to consume the same amount in both states in the “riskless bonds only” solution at date 2. Hence that country would be content to lend by buying equal settlement amounts of insurance

income less variable than output per capita though it is unclear to what extent “government smoothing” substitutes for “private smoothing” that would otherwise occur through financial-market channels.

on the two states at actuarially fair prices to replicate the solution for the riskless bond case where B_2 = -6.76 and r=27.15%.

The foreign country, by contrast, is looking forward to a plentiful state 2 (Y_2*(2) = 200) and a penurious state 1 (Y_2*(1) = 100). To keep it from reducing the difference through the sale of insurance on state 2 and the purchase of insurance paying off in state 1, p*(1) has to be much higher, and correspondingly p*(2) that much lower, than the actuarial norm. Substituting the consumption levels of the foreign country in the riskless bond case in the two states at time 2 into equation (6b) of the appendix, solving for the ratio p*(2)/p*(1) and then using p*(1)=1-p*(2) as before, yields p*(1)=0.8112 and hence p*(2)=0.1888. In other words, to (shadow-) price insurance out of the foreign country's market when prospective income in state 1 is only half as large as income in state 2 requires a huge price incentive to sell insurance with a settlement amount of B_2 on state 1 and not to sell any more than that on state 2 so as to replicate the "riskless bonds only" solution. Introducing complete insurance then causes these shadow prices for state 1, and correspondingly for state 2, to converge from p(1)=0.5 for the home country and p*(1)=0.8112 for the foreign country to the single market-clearing price of p(1)=p*(1)=0.6923 shown in Table 1.

The change in the remaining determinants that are needed to explain the change in the level of utility first from autarky to riskless bonds and then from there to insurance as shown in Table 2 can be obtained directly from Table 1. For instance, going to riskless bond financing from autarky, ΔB_2 = -6.76 for the home country and ΔB_2* = 6.76 for the foreign country since B_2 = -B_2* = 0 under autarky. Then going on to insurance, ΔB_2(1)=6.06-(-6.76)=12.82 (reducing C_2(1) by that amount relative to the riskless bonds solution) and ΔB_2(2)=-(40.91-6.76)=-34.15 (increasing C_2(2) by that amount). The results for the foreign country's changes in contractual position are the same with sign reversed because it is the counterparty to the home country. Both countries experience a rise in the equilibrium level of the interest rate from 27.15 percent for riskless bond financing to 38.46 percent with complete insurance. This result underscores Tobin's (1981) basic insight that, for given tastes and endowments, the interest rate or rates are determined by portfolio characteristics, in this case the richness and availability of different contingent and noncontingent financial products.

The largest benefits to both countries from proceeding from riskless bond financing to mutual insurance turn out to arise from the interaction of the equalization of insurance prices with the changes in $B_2(.)$ and hence $B_2^*(.)$ in states 1 and 2. These gains are shown on lines 14 and 15 of Table 2. Take, for instance, the gains shown on line 14 for the home country that sells insurance on state 1 on account of p(1) having risen from its shadow price of 0.5 to the common market price of 0.6923. Clearly all the three terms involved in obtaining the welfare effects of this interaction from the second-order Taylor-series expansion, $\partial^2U/[\partial p(1)\partial B_2(1)]$, $\Delta p(1)$, and $\Delta B_2(1)$, are positive for the home country. Changing p(1) can not affect utility evaluated at the starting level here given by "riskless bonds," because, when $B_2(1)=B_2(2)=B_2$, what is gained on one contract must be lost on the other given that $\Delta p(1)=-\Delta p(2)$. This changes, however, when the marginal effect of a rise in p(1) on the marginal utility of $B_2(1)$ is examined, because $B_2(1)>0$ implies that the home country then can sell insurance on marginally more favorable terms. The foreign country's cross-partial, $\partial^2U^*/ [\partial p^*(1)\partial B_2^*(1)]$, for selling the same insurance is of course likewise positive. So then is the product of all three terms in this second-order element of the Taylor-series expansion, because -- starting from $p^*(1)=0.8112$ and $B_2^* = 6.76$ -- the resulting changes, $\Delta p^*(1)$ and $\Delta B_2^*(1)$, are both negative. Hence both countries gain from the combination of the changes in variables implied in the transition from "riskless bonds only" to "insurance" shown on line 14.

3.5 Sensitivity Testing

There are more than a few instances, not just in East and Southeast Asia, where one country´s income has doubled relative to that of another over one generation (25 years) because one country´s per capita output growth slowed down while another's accelerated, largely unexpectedly. Yet it is certainly worth testing whether much more moderate prospective endpoint income-endowment disparities, such as 100 versus 120, rather than the 100 versus 200 that was assumed so far (with equal probability) for the foreign country in period 2, would still show that the welfare benefits brought by insurance through the introduction of Arrow-Debreu securities are several times as large

Table 2. The Utility Level (x 1million) of Home and Foreign Country under Autarky, with Noncontingent International Lending, and with Complete International Insurance

	HOME	FOREIGN
(1) Autarky, utility level	-20,000.00	-17,500.00
Utility gains due to bond		
(2) r b	183.58	86.78
(3) b b	-91.46	-43.58
(4) *Net gain - estimated*	*92.12 (67.11)*	*43.20 (52.79)*
(5) *- actual*	*71.67*	*54.87*
(6) Bond Fin., utility - est.	-19,907.88	-17,456.80
(7) - actual	-19,928.33	-17,445.13
Utility gains due to insur.		
(8) r	52.79	-42.67
(9) r r	-4.96	3.60
(10) b(1) b(1)	-97.52	-158.72
(11) b(2) b(2)	-691.52	-102.81
(12) r b(1)	-55.68	59.00
(13) r b(2)	148.27	-36.58
(14) p(1) b(1)	216.35	108.06
(15) p(1) b(2)	576.11	287.76
(16) b(1) b(2)	159.55	71.03
(17) Net Gain - estimated	303.39	188.67
(18) - actual	412.20	159.42
(19) Insurance, utility – est.	-19,624.94	-17,256.46
- actual	-19,516.13	-17,285.71

Notes: Using simplified notation, the utility gains shown are decomposed with a second-order Taylor series approximation, where r, p(1), b(1), and b(2) refer to term containing first derivatives with respect to the interest rate, the insurance premium [p(1)/(1+r)] per dollar of settlement in state (1) compounded to time 2, and the settlement amount of the insurance claim at time 2 in state 1 [b(1)] or state 2 [b(2)]. Arbitrage ensures that p(2)=1-p(1). Double letter codes, such as {r r} or{p(1) b(2)} refer to the terms formed with the respective second derivative or cross-derivative. In the case of riskless bonds only, where b(1)=b(2)= b, terms formed with r and b are zero and thus not shown. In the case of complete international insurance markets, terms formed with b(1), b(2), p(1), {p(1) p(1)}, and {r p(1)} contribute nothing in the expansion. Because the changes between financial regimes considered involve large changes in prices and quantities, the second-order Taylor-series approximation of the true welfare change is not very close. The total welfare gains estimated with the much closer third-order approximation are shown in parentheses on line (4) but showing the additional components would not be informative.

as those available through the introduction of riskless bonds only. The answer is strongly affirmative, as the home country still gains 3.6 times as much from insurance than it stands to gain from riskless bonds, while the foreign country gains 2.2 times as much. Hence the advantage of insurance over bonds, previously about 7 times for the home country and 4 times for the foreign country (see Table 1) , is only cut in half when the intercasual income-endowment outcome inequality, that can not be redressed by noncontingent borrowing and lending, is reduced by as much as 80 percent by assumption. Hence there is some generality to the claim that the welfare benefits from insurance are likely to be appreciably greater than those from riskless bonds in many actual situations. Appendix Table 1A provides all the numerical results obtained with Y_2*(1)=100, Y_2*(2)=120.

IV. Financial Synergies: Enhancing Insurance Opportunities through Credit

A second model from Obstfeld and Rogoff (1996, ch. 6) yields a new starting position that introduces premium payment risk into insurance when that premium is paid *ex eventu*. After outlining that model I will attempt to show how introducing government credit and additional financial intermediation can overcome all (with homogeneous time preferences) or almost all of this business risk exposure so as to make the market for contingent claims more complete. Rather than comparing what introducing insurance can do compared with just allowing riskless debt among countries, as in the previous section, my focus here is to show how much more insurance can do with judicious use of credit instruments within a single country.

The specification starts with per capita endowment income, Y, of each and every consumer and policyholder being equal to $\underline{Y}$ + ε where $\underline{Y}$ is the mean and ε is idiosyncratic income risk that is distributed symmetrically around the mean in a distribution that is known and constant, being rectangular from έ to -έ. The distribution of the individual realizations of ε is interpersonally independent so that there is no aggregate income risk and all the individual income risk is perfectly diversifiable domestically. The complete insurance contract therefore involves a flow of payments between insurer and individual insuree of P(ε) = ε+P_0, but with the unconditional fixed charge or deductible, P_0, zero in the ex ante optimal contract. Then P(ε) is always positive, requiring a premium payment in the good states (ε>0), and negative in the bad states (ε<0) when the insurance company has to pay. As a result, the insured's uncertain endowment income of $Y = \underline{Y} + \varepsilon$ always ends up generating a fixed disposable income and consumption of $Y = \underline{Y} + \varepsilon - P(\varepsilon) = \underline{Y}$ with complete insurance. Such insurance is characterized by $P_0 = 0$.

While the insurance company always lives up to its part of the contract, it cannot expect the insuree to do so here. Because the contract, when fully honored, achieves complete consumption smoothing for everyone at $\underline{Y}$, it is clearly the best solution that can be maintained ex ante. However, in some of the best states that may subsequently materialize, the insuree may refuse to pay more than can be extracted by means of sanctions, a fraction η of endowment income $\underline{Y} + \varepsilon$, so that the height of the sanctions line in Figure 1 is $\eta(\underline{Y} + \varepsilon)$. Indeed, if the insured lives for only two periods as in the Obstfeld-Rogoff version, one in which she contracts for insurance and the next in which she earns income with the specified amount of uncertainty, there is never a reason to pay more than what can be extracted by sanctions in the best states.

Hence it makes no sense for the insurance company ever to sell a contract that demands more in such high-ε states. This means that the first-best solution of $P(\varepsilon) = \varepsilon$ is not on offer in the market.[9] Rather, $P_0 > 0$, and the critical value of ε, e, from which on only the sanctions amount begins to be charged and collected, is reached when the insurance price is $P(e) = e + P_0 = \eta(\underline{Y} + e)$, so that:

$$e = (\eta\underline{Y} - P_0)/(1-\eta) \; . \qquad (1)$$

Beyond that value of $\varepsilon = e$, a premium of $P(\varepsilon) = \varepsilon + P_0$ would not be collected in full as $\varepsilon + P_0 > \eta(\underline{Y} + \varepsilon)$ for $\varepsilon > e$. The loss expected by the insurance company relative to obtaining $\varepsilon + P_0$ is $(1-\eta)(\acute{\varepsilon} - e)^2/4\acute{\varepsilon}$, where $(1-\eta)(\acute{\varepsilon} - e)/2$ is the expected amount of loss in this range and $(\acute{\varepsilon} - e)/2\acute{\varepsilon}$ the probability of being in that range of the distribution that is spread out uniformly over a total length of $2\acute{\varepsilon}$. The loss includes nonpayment of all or part of the fixed charge P_0 when $\varepsilon > e$. The competitive solution with zero economic profit, that

[9] Without government intermediation of the kind introduced later in this paper, this would be true even in the infinite horizon model subsequently adopted. For the insurance sector would be bound to operate at a loss if it started offering the first-best contract even if this contract were cancelled upon the first instance of default by a policyholder. This contract then would be replaced by the second-best break-even contract, but the one time loss due to partial default by any policyholder would never be recouped. The reason is that the second-best insurance contract is readily available under competitive conditions regardless of the experience with, or past behavior of, a policyholder since that contract is riskless for the insurer. Since the insurance sector's loss is the policyholder's gain, the latter would have an incentive to engage in opportunistic default when a sufficiently high value of ε materializes.

can be visualized with the help of the geometric presentation given in Figure 1, then implies that this gross loss is offset by setting the fixed charge at:

$$P_0 = (1-\eta)(\acute{\varepsilon}-e)^2/4\acute{\varepsilon}. \qquad (2)$$

Substituting $\eta\underline{Y}-(1-\eta)e$ for P_0 by use of equation (1) and solving the resulting quadratic for e yields a single root inside the range of ε of:

$$e = -\acute{\varepsilon} + 2[(\acute{\varepsilon}\eta\underline{Y}/(1-\eta)]^{1/2}. \qquad (3)$$

This, however, is not a general solution for e. Rather it applies only after the premium payment schedule has been modified by setting $P_0>0$ in return for requiring no more than the amount that could be extracted by sanctions in any state. Fulfillment of premium obligations on the altered contract terms thus is certain. Being riskless for the insurer, such a second-best contract will always be provided by a competitive insurance sector even to those who would have defaulted on the first-best contract. The resulting incompleteness of insurance is shown by consumption not being the same in all of the continuously distributed states. Rather, as the slashed line with a kink at e in Figure 1 shows, when $\varepsilon>e$, individual consumption is higher by $(1-\eta)(\varepsilon-e)$ than the level of $\underline{Y}-P_0$ that is maintained up to $\varepsilon=e$.

4.1 Discouraging Opportunistic Default

This is as far as Obstfeld and Rogoff (1996, ch. 6) have carried the matter. If there were a way to get back to the first-best solution with $P_0 = 0$ by making that solution sustainable, i.e., time-consistent, e would be given directly from equation (1) as $e_0 = \eta\underline{Y}/(1-\eta)$.[10] Achieving this is, of course, difficult since any premiums are due only after the insured outcome with a positive value of ε already has materialized because, in the model, premium-payment and claims-settlement periods coincide.[11] Hence the question

[10] In Figure 1, this solution is given by the value of ε that lies vertically below point I.

[11] The specification, that insurance premiums are outcome-contingent and payable together with a fixed charge of P_0, if any, after the outcome has materialized, may appear unusual. However, it is essential here to treat premiums on a par with insurance claims, minus any deductible of P_0, and to consider claims simply as negative premium payments from the point of view of the insured that are due at the same time. The reason is that the model does not provide for any endowment income, but only the choice of insurance contracts, prior to the insured outcome. Even if the model, as in Section III, did provide a certain endowment income, such as $\underline{Y}$, before the subsequent period of uncertain income, paying a premium in the former period in the expectation of a corresponding return on insurance in the latter would not allow disposable income, and hence consumption, to be stabilized over the two periods. The current model thus needs to rely on Arrow-Debreu securities for insurance.

that arises is whether insurance can be made more complete through additional financial intermediation by discouraging opportunistic default under favorable outcomes with $\varepsilon>e$. If so, P_0 can be whittled down to zero by the forces of competition represented by the zero-profit constraint.

While the expected amount of loss from opportunistic default, if it occurs, previously was given as $(1-\eta)(\acute{\varepsilon}-e)/2$, the maximum possible loss is twice as large, or $(1-\eta)(\acute{\varepsilon}-e)$. It occurs at the upper limit of endowment outcomes when $\varepsilon=\acute{\varepsilon}$. Since opportunistic default is possible only once before the fixed charge previously derived is imposed, the incentive for the insured to default is strongest in that limiting case or in its immediate vicinity.[12] I focus on that state for, no matter how small the vicinity of $\acute{\varepsilon}$ and hence its probability weight, an outcome falling into that arbitrarily small segment from the top part of the rectangular distribution is bound to come up eventually in an infinite-horizon model. Thus the pool of policyholders who have not fallen from grace by defaulting once on the above-sanctions part of the premium payment due under the $P(\varepsilon)=\varepsilon$ contract schedule would dwindle over time. Only the second-best contract form with $P_0 \neq 0$ would remain.

4.2 Insurance-Enhancing Financial Intermediation through Government Credit

To avert this prospect, which would prevent the first-best contract from being offered in the first place, incentives to default on the first-best contract, and hence the losses facing the insurance sector on that contract, must, as far as possible, be eliminated. One way to do this is through market-based financial innovation in which the government has a part. Let the government in effect give the insurance sector a

[12] If a policyholder inclined toward opportunistic default decided to default when $\varepsilon>e$ but appreciably less than $\acute{\varepsilon}$, rather than waiting for a higher value of ε to materialize, the entire escrow amount could still be lost. The part not applied to cover the insurance sector's losses would then have to be returned to the government and used to retire some part of the government debt. This, in turn, would affect the level of the lump-sum tax needed to pay the interest on the debt. Assuming default occurs only when ε is at least very close to $\acute{\varepsilon}$ avoids such untidy complications. In reality, however, policyholders would have to decide when a realization of ε is high enough to precipitate opportunistic default and forfeiture of the entire escrow balance that is available only once rather than waiting for a higher ε in the hope of exercising the one-time default option more profitably later on. For instance if ε is at the 98th percentile so that $\varepsilon=9.6$, it would take 34 periods (years) for the chance of a higher realization in the 9.6 to $\acute{\varepsilon}=10$ range at least once during this time to approach one-half. In discussing overprovisioning later in this section, any remainder is assumed to be transferred to the government though the scheme is designed to further discourage default that would leave such a remainder.

rolling guarantee[13] that the next premium will be paid in full by each individual, all of whom are assumed to be insuring. That guarantee would be given in return for the insurance sector offering "perfect" insurance by setting the insurance price at $P(\varepsilon) = \varepsilon$ so that $e_0 = \eta\underline{Y}/(1-\eta)$. It would be fully secured and funded by the government providing for the establishment of personal escrow accounts in the amount of $(1-\eta)(\acute{\varepsilon}-e) = (1-\eta)\acute{\varepsilon} - \eta\underline{Y}$ for the benefit of each client in the insurance sector in return for issuing a corresponding amount of its debt to that sector.[14] With this balance-sheet expansion as the first step, the insurance sector thus has acquired an asset, government debt, which matches the new liability, escrow accounts for clients. The government, in turn, has a continuous claim for tax payments on the household sector, consisting of the policyholders, to cover the interest on the debt issued.[15] The present value of this stream of tax receipts is equal to the amount of that debt. It is also the liability of the household sector that matches the sum of the escrow-account assets set up in the insurance sector for each individual or household receiving endowment income. Table 3 provides an overview of the notional accounting entries on the consolidated balance sheets of the three sectors involved in setting up the escrow accounts.

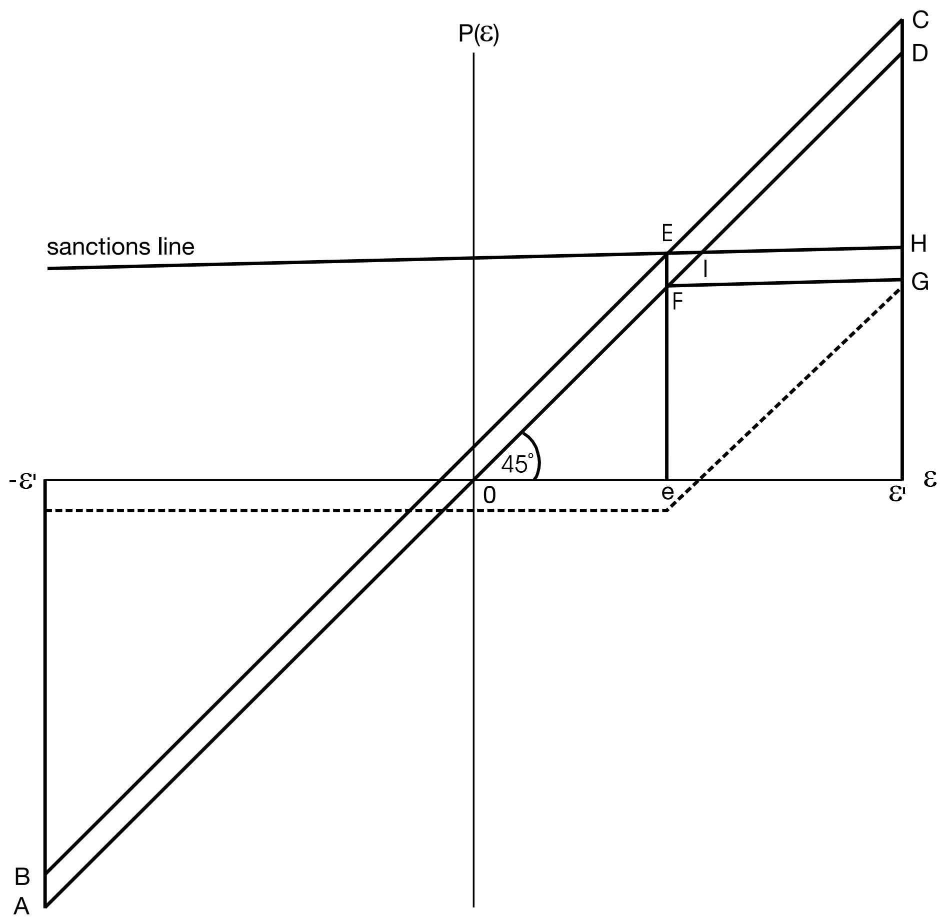
Turning from stocks to gross flows, the real interest rate, r per period, earned on the policyholders' escrow accounts is the same as the interest rate on government debt. The government imposes a lump-sum tax of $r[(1-\eta)\acute{\varepsilon} - \eta\underline{Y}]$ each period on all individuals to cover the interest on its debt. Hence individuals who have maintained

[13] Rolling guarantees, of the next one or two coupon payments, are familiar from Brady bonds, although their application here is different.

[14] The joint creation of notional interest-bearing assets and liabilities is familiar from interest-rate swaps. A more direct institutional antecedent for joint issuance of assets and liabilities bearing the same interest rate to the same party (here the insurance sector) is given by SDR allocations to member countries of the IMF on which interest is owed at the same rate as the rate of interest earned on (the resulting) SDR holdings.

[15] If the interest rate on government debt, and hence the escrow account, varies, the matching tax liability still is lump-sum from the point of view of the individual taxpayer even though it would have to adjusted from time to time to cover the interest on the government debt so as to maintain budget balance over a period of appropriate length.

Figure 1. The Terms of Incomplete Insurance



Explanation: Multiplying both sides of equation (2) by $2\acute{\varepsilon}$ shows that, to satisfy the zero-profit constraint, the fixed charge, P_0 = AB = EF = CD is to be chosen in such a way that $2\acute{\varepsilon}P_0$ is equal to area FDG. For given that the slope of the sanctions line is η, area FDG must be equal to $(1-\eta)(\acute{\varepsilon}-e)^2/2$. Figure 1 shows geometrically that the fixed charge yields added gross proceeds of $2\acute{\varepsilon}P_0$ (the parallelogram diagonally across the entire figure) of which ECDI can not be collected since it exceeds the amount that can be secured by sanctions. The area FDG, however, exceeds the net sum of IDH that needs to be compensated by ABEI by the same amount because, by construction, IHGF=ECDI. Hence $2\acute{\varepsilon}P_0$ = FDG, or $P_0 = (1-\eta)(\acute{\varepsilon}-e)^2/4\acute{\varepsilon}$, which is equation (2).

Table 3. Notional Accounting Entries Relating to the Escrow Accounts

Government

Present Value of Additional Taxes Receivable from Households	**Increase in Government Debt Outstanding**

Insurance Sector

Increase in Holdings of Government Debt	**Escrow Accounts Established for Household Clients**

Household Sector

Escrow Accounts Established with Insurance Sector	**Present Value of Additional Taxes Payable**

their escrow balance by not engaging in opportunistic default are able to stabilize their disposable income and consumption at $\underline{Y}=100$ under contract terms $P(\varepsilon) = \varepsilon$ because their interest receipts just cover the taxes due each period. Similarly, the insurance sector receives from the government, and pays to clients, equal amounts of interest. Although the application discussed here is domestic, the escrow scheme is viable even if foreign insurance companies and international insurance are involved provided the government that puts up the escrow is that of the insurance clients, because it then has taxing power over them. However, to avoid international capital flows, the foreign insurance sector would have to be required to invest the escrow amounts in home-government securities, and this could create conflicts with existing insurance regulations.

What about the situation of those who, perhaps on account of a preference shock making them very impatient (lowering β), want to default thereby forfeiting the balances held for them in escrow?[16] When they do so, each has a one-time gain in consumption[17] of $(1-r)[(1-\eta)\acute{\varepsilon} - \eta\underline{Y}]$. In this, reduction, by the fraction r, of the one-time default gain is due to the lump-sum tax of $r[(1-\eta)\acute{\varepsilon} - \eta\underline{Y}]$ no longer being offset by the interest earned on the policyholder's escrow balance. Upon default on the first-best contract, she will be subject to the less favorable second-best insurance contract. Its two-part tariff is $P(\varepsilon) = \eta(\underline{Y}+\varepsilon)$ when $\varepsilon>e$ and $P(\varepsilon) = \varepsilon + P_0$ when $\varepsilon\leq e$.[18]

Compared with a policyholder who never defaults (superscript n) and enjoys disposable income and consumption of $\underline{Y}$ in each period i, a defaulting (superscript d) policyholder will therefore have income and consumption (C) of:

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[16] If the preference shock affected a sufficiently large group, rather than isolated individuals, the increase in the aggregate demand for consumption would call for a temporary interest-rate increase that would induce those not subject to that preference shock and hence not defaulting to consume less than $\underline{Y}$ so that the others could consume more when the rash of opportunistic defaults occurs. The situation thereafter would be the reverse as consumption of the former group would increase above $\underline{Y}$ and that of latter group decline below it. Indeed, losses covered by balances held in escrow must always result in a sale of government debt by the insurance sector to nondefaulting policyholders. For it may be assumed that defaulting policyholders are liquidity constrained and, in effect, borrow by forfeiting their escrow balances and paying taxes equal to the interest on this "loan." Such issues of macroeconomic consistency in the event of default are set aside in this section because it focuses on how to set incentives to avoid such default even when a first-best contract is offered at the start to every policyholder.

[17] Default gains always are consumed in full in period 0 as modeled if any such gains saved, for instance by acquiring government debt which the insurance company is selling, are subject to seizure.

[18] For what follows, it may be helpful to note that the subscript in P_0 is not a time index but used to indicate the intercept of the insurance-price function.

$C^d_0 = [1-(1-r)\eta]\underline{Y} + (1-r)(1-\eta)\acute{\varepsilon}$, at i=0, and then for i>0 each year (4)

either the fixed amount $C^d_i = [1+r\eta]\underline{Y} - r(1-\eta)\acute{\varepsilon} - P_0$ if $\varepsilon \leq e$ or

the higher variable amount $C^d_i = (1-\eta)(\underline{Y}+\varepsilon) - r[(1-\eta)\acute{\varepsilon} - \eta\underline{Y}]$ if $\varepsilon > e$.

Unlike in the two-period model of the previous section, period i may now be taken to be simply annual, so that C_i refers to annual consumption in year i. The optimizing agent here has an infinite time horizon so that a single act of default has long-term consequences she cares about. Her escrow balance, once lost, will not be replenished by the government so that she will not qualify for getting a first-best contract from the insurance sector ever again.

4.3 Numerical Welfare Evaluation with Homogeneous Time Preferences

Calibration may again help decide whether there are likely to be any policyholders who will choose to default when ε approaches its upper limit of έ where the temptation to default is strongest. If so, the first-best contract, characterized by P(ε) = ε, would not be feasible. I now take $\eta = 0.05$ to be the percentage of an individual endowment income that can be seized by the insurance sector. That income itself is $\underline{Y}$=100 plus or minus up to έ =10 in symmetric rectangular distribution. Hence the largest premium that could be due under the first-best contract would be έ=10, of which only $\eta(Y+\acute{\varepsilon}) = 5.5$ could be secured through sanctions. In view of the insurance-premium payment risk, e equals 4.509525 from equation (3), and P_0 is 0.715951 from equation (1).

In the first-best solution, S1, that will continue to serve as the point of reference, C_i is constant at 100. Furthermore, with $\beta = (1+r)^{-1} = 0.96$ [and hence r=0.041667] and a CRRA utility function with ρ=2, the expected (operator E) level of utility at time i=0, discounting and summing over an infinite time horizon, is:

$$E_0(U^{S1}) = - \sum_{i=0,\infty} \beta^i [C^n_i]^{-1} = - 0.25. \quad (5)$$

Multiplied by 100,000 the utility level expected with complete insurance is –25,000.

The question at this point is whether there is a *shared* level of impatience at which starting out with complete insurance but then defaulting at the first realization of ε near έ would yield greater expected utility than continuing always to live up to obligations under P(ε)=ε. Substituting the chosen values of parameters and variable levels into equation (4) indicates that such policyholders obtain C^d_0 of 104.3125 in the year of default. This amount exceeds 100 by the amount of the individual's "gain" from default equal to $(1-\eta)(\acute{\varepsilon}-e_0)=4.5$ (where $e_0 = 5.2631579$ since $P_0 = 0$ at time i=0 but not thereafter) minus a tax amount equal to the interest of 0.0416667(4.5)=0.1875 on the government debt per head, where the interest rate, r, equals 4 -1/6%.

In any later year (i>0), C^d_i is either 99.096549 when $\varepsilon \leq 4.509525$ (=e), which it will be with probability of $(\acute{\varepsilon}+e)/\acute{\varepsilon} = 0.72547625$, or $[0.95(100+\varepsilon) - 0.1875]$ when $\acute{\varepsilon} \geq \varepsilon \geq e$. The latter amount ranges from 99.096549 when ε=e to 104.3125 when $\varepsilon=\acute{\varepsilon}$, yielding on average 101.7045245 with a probability weight of $(\acute{\varepsilon}-e)/2\acute{\varepsilon} = 0.27452375$. The individual's expected annual level of income after default in period 0 thus is, as it should be, 99.8125, which is less than 100 by the tax amount of 0.1875. From year i=1 on, the insurance is priced to break even on terms fully protected by enforceable sanctions so as to preclude opportunistic default on the changed terms. This rules out further insurance gains or losses but the tax remains to be paid each period to service the debt incurred by the government in effect borrowing on the policyholder's behalf. Disposable income is defined as endowment income net of any tax, and minus any premium payment (net of any gain from default) or plus any insurance settlement, and plus any interest earned on escrow balances (by non-defaulters). Utility is a negative inverse function[19] of consumption, that is equal to this concept of income.

There now are four welfare solutions (again presented after multiplying by 100,000) to compare. The "zero insurance" solution, S0, is for the state of nature. In it, individual endowment income and consumption varies randomly between 90 and 110 over the range of the rectangular distribution and there is no stabilization of any kind. By contrast, the first-best insurance contract S1, with $P(\varepsilon)=\varepsilon$, stabilizes each policyholder's income and consumption at 100. The second-best contract, S2, has the by now familiar two-part tariff from the very beginning. In it, $P(\varepsilon)$ is $\varepsilon + P_0$ or $\eta(\underline{Y}+\varepsilon)$, whichever is lower each period, and P_0=0.715951 as before. Under this form of contract disposable income is fixed at 99.284049 over the lower $(\acute{\varepsilon}+e)/2\acute{\varepsilon}$ = 72.547625 percent of the distribution of ε, but rising linearly with ε from that level of 99.284049 at

19 In the calibration, a CRRA coefficient of 2 is retained throughout because it represents the lowest respectable degree of risk aversion. This choice is appropriately conservative because it ensures that

ε=e=4.509525 to 104.5 at the upper end where ε=έ=10. Expected welfare gains over an infinite horizon for S1 and S2, relative to each other, are independent of the level of β since changing β affects both of these welfare levels by the same proportion. Furthermore r does not appear explicitly in either since, unlike in the last solution, S3, there is as yet no government or its borrowing and taxation.

The fourth welfare solution, S3, to recall, is based on an insurance contract that starts out with P(ε)=ε and government-assisted establishment of escrow accounts in the insurance sector for everybody. It then converts to the contract form with two-part tariff -- that in S2 was imposed from the very beginning -- for those policyholders who have forfeited their escrow accounts because they chose to default on paying the full amount of the premium due under the first-best contract. No punishment strategy or blacklisting is involved since no insurer would offer the first-best contract without (escrow) collateral but clients are free to regain eligibility for that contract by first restoring the escrow account balance with their own funds. Furthermore, any insurer would offer the second-best contract with the two-part tariff irrespective of the insuree's prior history of premium payments because that second-best contract never asks for any premiums in excess of the amount that is fully secured by sanctions. Welfare solutions S0, S2, and S3 require integration because consumption is given by the equation of a line that slopes upward with ε either over the entire range (in S0), or from e to έ (in S2 and S3).

At β=0.96, r=0.0416667 (β=0.95, r=0.0526316) [β=0.95, r=0.0416667], the utility levels to compare now are:

S0	-25,083.837	(-20,067.070)	[-20,067.070]
S1	-25,000.000	(-20,000.000)	[-20,000.000]
S2	-25,004.820	(-20,003.855)	[-20,003.855]
S3	-25,008.375	(-20,007.899)	[-19,998.025]

Comparing S0 and S1 within each of the columns shows that utility gains of slightly more than 3/10 of 1 percent are available from complete insurance compared with no insurance at all. The second-best insurance contract in which there never is a

the welfare gains from consumption smoothing are, if anything, understated, and so are the penalties for opportunistic default which has the opposite effect on consumption.

possibility of default results in utility level S2. It is able to capture over 94% of these maximum gains, while the contract with one-time default resulting in utility level S3 captures about 90% of them when β=0.96, less when β is lower. Hence in this example, S2 unambiguously dominates S3 so that policyholders otherwise inclined to opportunistic default for any reason would choose the second-best contract that precludes default. Both S2 and S3 dominate S0.[20] They are dominated by S1 whose commercial feasibility remains to be established.

At this point, the policyholder's knowledge, of having her insurance coverage reduced from first- to second-best in S3 if she should ever default on a premium due and then facing a tax liability that is no longer offset by the interest earned on escrow account, should discourage default under the assumed conditions and keep first-best contracts in force for all policyholders. This result is robust to matching variations in β and r as was shown (in parentheses above) by the welfare results for β=0.95. Indeed it holds for any solution with $\beta=(1+r)^{-1} <1$. For instance, if β=0.99 and hence r =0.010101, S1 still dominates both S2 and S3, and S3 is still a little worse than S2, as S0 = -100,335.348, S1 = -100,000, S2 = -100,019.276, and S3 = -100021.488.

4.4 Coping with Heterogeneity of Time Preferences

The previous requirement, that $\beta=(1+r)^{-1}$, even at the micro level, left no room for stratification of time preference rates by policyholders since r is a single market rate. Retaining β of 0.96 for the vast majority of policyholders and hence keeping r at the matching equilibrium level of 0.0416667 as before, a lower value of β, such that $\beta<(1+r)^{-1}$, now is assumed for a highly impatient small group of policyholders who want to shift consumption from the future to the present.[21] In contrast to the majority, these policyholders may welcome the borrowing opportunity which the government indirectly affords them, given that there is no direct personal borrowing in the model.

[20] This superiority, especially of the obviously viable insurance arrangement leading to utility level S2, shows that the model´s assumption, that each individual unit receiving endowment income also is a policyholder, is internally consistent. Hence the choice of whether to insure at all need not be analyzed in this paper.

[21] Because the distribution of income endowments is stationary, consumption tilting is not possible in the aggregate. Hence the endowment-weighted average value, β^*, must be equal to $(1+r)^{-1}$. This equality is compatible with β fluctuating at any one time symmetrically around β^* for subgroups of the population so that some temporarily consume more while others prefer to consume less than their current endowment.

The question now is how much their β could fall below $(1+r)^{-1}$=0.96 before it would jeopardize the feasibility of first-best insurance. The bracketed results in the last column of the list above show that β=0.95 would already be too low when r is decoupled from β. The reason is that the welfare level S3 of -19,998.025 is higher than the level S1 of –20,000, making one-time default attractive to this impatient group of policyholders. At a time preference discount factor of 0.952 however, its members would be indifferent between defaulting and always fulfilling the terms of the first-best contract as they would experience a welfare level S1=S3 of -20,833.

In this demonstration, raising the net rate of time preferences for the small minority from 0.0416667 when β is 0.96, as it remains for all others, to 0.0504202 when β=0.952, implies a 21 percent increase before reaching the point of indifference between S1 and S3. Hence, if sufficient heterogeneity of time preferences is allowed, such that the net rate of time preference can be more than 21 percent higher than the mean for a small, but not negligible, number of policyholders, there is a difficulty: The first-best contract may not be commercially feasible even with the support of the government's intermediation and its regular taxing power.

A modest amount of overprovisioning would afford a simple way out of this predicament. If the escrow balance, and hence the tax amount not covered by interest on the escrow account in the event of its forfeiture through default, were raised by 6 percent, even those who apply a discount factor as low as β = 0.95 or a net time preference rate of 0.0526316, would be indifferent between S1and S3.[22] Strengthening disincentives to default in this way would enhance the feasibility of the first-best contract leading to the welfare maximum S1.

[22] The assumptions made in this paragraph imply that, in year i=0, default boosts consumption by 4.5 minus the tax due which is now equal to the interest payable on 4.77, rather than 4.5. As a result, C^d_0 now equals 104.30125, rather than 104.3125 before. All other consumption levels also fall by the difference between tax amounts 0.19875 and 0.1875 when r remains at 4-1/6%.

V. Conclusions and Policy Extensions

International macroeconomics by and large continues to be wedded to models of international credit represented as riskless by invoking either the transversality condition or the availability of strong sanctions. As Obstfeld and Rogoff (1996, p. 272) have pointed out, issuing such riskless debt is equivalent to the constraint that equal settlement amounts of insurance must be purchased by the capital-exporting country and hence sold by the capital importing country on all possible future states. Buying or selling *equal* coverage for all contingencies makes the financial outcome noncontingent. It thus can achieve a fixed transfer of resources intertemporally but no insurance at all. When insurance functions are served by buying and/or selling *different* settlement amounts of insurance on the different future states, there are both intertemporal and intercausal effects on consumption smoothing.

A fully optimized numerical demonstration was chosen to identify and compare the different sources of welfare change numerically. Starting from autarky, it showed the welfare (and first-period consumption) gains available from insurance through the introduction of Arrow-Debreu securities in a country to be 4 to 7 times as great as the welfare gains available from riskless international borrowing or lending alone. The introduction of insurance contributed so much more than that of bonds in spite of the adoption of the lowest acceptable level of relative risk aversion, which, following the Finance literature, was taken to be 2. Limited sensitivity testing indicated that the qualitative result of an appreciably greater welfare effect from insurance than riskless bonds may apply even to a broad range of actual situations of long-term growth uncertainty in which intercasual risk is not nearly as pronounced as in the basic demonstration.

In this simulation, insurance could "do it all" and a credit market as such was not needed except perhaps as an anchor for capital-asset pricing demonstrations (see Obstfeld and Rogoff, 1996, pp. 308-309). Such a conclusion would be too strong, as we observe a useful co-existence of many different types of financial instruments, contingent and noncontingent, in financial markets. A second demonstration, again taking off from Obstfeld and Rogoff (1996) but then heading in a different direction with a domestic infinite-horizon model, thus aimed to model a situation where riskless bonds may support more complete insurance because fulfillment of the insurance contract has become an issue. Because complete consumption insurance would be available only through the contribution to insurability made by government financial intermediation and its taxing power, “riskless bonds,” as separate instruments, now appear helpful to insurance, rather than superfluous with it. Hence when risks that threaten to reduce insurability enter, a greater variety of financial contracts may be needed to maintain full coverage.[23]

5.1 Extensions

In spite of the importance of contingent claims in economics and finance in both theory and practice, the insurance sector is rarely modeled concretely or featured in empirical macroeconomic work. The list of references provided in one of the few exceptions, Ward and Zurbruegg (2000), is correspondingly short. Even monetary and financial development frequently has been discussed, and measured by indicators, with no reference to insurance. Indeed, the most common measure of financial development used in recent years has been “the sum of Domestic Credit and Market Capitalization to GDP,” (Fisman and Love, 2004, p. 21; see also Demirguc-Kunt and Levine, eds., 2001)), in which the insurance sector appears, if at all, only as financial investor in any debt and equity securities included in that sum.

In fact, however, insurance may provide inputs that are strategically important for the process of transformation to higher levels of development. Deeper monetary and financial integration such as would result from accession to EU/EMU could afford a much higher degree of production and consumption insurance through a variety of formal and informal insurance channels than would be available without acceding to economic and monetary union.[24] For instance, insurance reserves would become investable in a major international currency and financial market without exchange risk or risk of currency mismatches and with low inflation risk attaching to the intertemporal transport of purchasing power. Furthermore, opportunities for risk pooling, both within

[23] The challenging task of considering the completion of domestic insurance in the presence of heterogeneous agents jointly with international insurance for the representative national agents has not been tackled here. Obstfeld and Rogoff (1996, p. 331) have commented on a similar lack in Shiller (1993) although Shiller (2003) attempts to make such a link.

and across lines of the insurance business, would be enhanced. Economic and monetary unions thus may increase the diversifiability of risks that are not fully diversifiable within smaller units. Integrating some of the key functions of an explicit and institutionally recognizable insurance sector into macroeconomic analysis to help assess its actual and potential contributions to the completion of financial markets, stability, and growth thus appears an important task ahead.

[24] The process appears, however, to be quite gradual. For instance, Berger, DeYoung and Udell (2001), OECD (2000, p. 65), and Prati and Schinasi (1999) have pointed out issues of residual market segmentation in the financial sector that remain to be resolved in the euro area.

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Appendix. Consumption Insurance Across States and Time: International Insurance vs. Foreign Loans

Glossary

ß	Gross time-preference discount factor
B_2	Time t=2 maturity value of riskless bond issued as discount bond, $B_2/(1+r)$, at t=1, with B_2 signed positive if representing a capital import by home country i
$B_2(s)$	Insurance sold at a fractional price of p(s)/(1+r) at t=1 per unit payoff in state s=1,2 at t=2, with the amount of the contingent payoff or settlement value, $B_2(s)$, signed positive if the insurance contract is sold by country i to foreign country j
C_1	Consumption in period t=1; numeric subscripts refer to time throughout
$C_2(s)$	Consumption in period t=2 in state s=1,2
$\pi(s)$	Probability of state s=1,2 occurring at time t=2 so that $\pi(1) + \pi(2) = 1$
p(s)	Implied t=2 price per unit of insurance on state s=1,2 sold at t=1, see $B_2(s)$
ρ	Constant relative risk aversion (CRRA) coefficient
r	Riskless annual real interest rate or compounded net interest return
Y	Endowment income for each of the different periods and states
u	Utility of consumption in the given period and state as in $u(C_1)$ and $u(C_2(s))$
U	Expected utility function, with utility that is time-additive
w	Subscript on variables when they refer to "world," the sum of i and j
W	Wealth defined as the sum of current (Y_1) and contingent future income valued at its current insurance sales price, $p(s)Y_2(s)/(1+r)$.

Exogenous variable levels and parameter values used in Section III

$\beta = 1$; $\pi(1) = \pi(2) = 0.5$; $\rho = 2$; $Y_{1i} = 100$, $Y_{1j} = 100$, $Y_{1w} = 200$; $Y_{2i}(1) = 100$, $Y_{2j}(1) = 100$, $Y_{2w}(1)= 200$; $Y_{2i}(2) = 100$, $Y_{2j}(2) = 200$, $Y_{2w}(2)= 300$.

Representative-Agent Model for a Closed Country and Two Open Countries

I. Expected Utility Function

(1) $U = u(C_1) + \pi(1)\beta u(C_2(1)) + \pi(2)\beta u(C_2(2))$

Where u has the specific (s) CRRA form :

(1s) $u = C^{1-\rho}/(1-\rho)$

II. Budget Constraints for Individual Countries

II.A Case a: Riskless International Bond with Maturity Value B_2 Only

(2a) $Y_1 = C_1 - B_2/(1+r)$

(3a) $C_2(s) = Y_2(s) - B_2$, s=1,2

II.B Case b: Complete Markets for Contingent Claims on Uncertain t=2 Income

(2b) $Y_1 = C_1 - p(1)B_2(1)/(1+r) - p(2)B_2(2)/(1+r)$

(3b) $C_2(s) = Y_2(s) - B_2(s)$, s=1,2

Note: (2a) could be modeled as a constrained solution of the more general model (2b) where the constraint added to (2b) is $B_2(1) - B_2(2) = 0$ with a shadow price that indicates the utility cost of this constraint when, as in the case of riskless bond financing, it is tight. Because investing in equal settlement amounts in each of the two states assures a certain payoff with present value of $B_2/(1+r)$, $p(1) + p(2) = 1$ follows immediately.

III. Expected Utility Function Incorporating the Resp. Budget Constraints

(1a) $U = u[Y_1 + B_2/(1+r)] + \pi(1)\beta u[Y_2(1) - B_2] + \pi(2)\beta u[Y_2(2) - B_2]$

(1b) $U = u[Y_1 + p(1)B_2(1)/(1+r) + p(2)B_2(2)/(1+r)] +$

$\pi(1)\beta u[Y_2(1) - B_2(1)] + \pi(2)\beta u[Y_2(2) - B_2(2)]$

IV. FOCs w.r.t. B_2 and Solutions Under Autarky and Bond Financing

(4) $u'(C_1)/(1+r) = \beta[\pi(1)u'(C_2(1)) + \pi(2)u'(C_2(2))]$,

With u of form (1s), $\beta = 1$, $\pi(1) = \pi(2) = 0.5$, and $\rho = 2$, the numerical form of the first-order condition (4), for each of the two countries is :

(4s) $C_{1k}^{-2}/(1+r_k) = 0.5[C_{2k}(1)^{-2} + C_{2k}(2)^{-2}]$, k = i,j, or, in case a:

(4as$_i$) $[Y_{1i} + B_2/(1+r_i)]^{-2}/(1+r_i) = 0.5[(Y_{2i}(1) - B_2)^{-2} + (Y_{2i}(2) - B_2)^{-2}]$

(4as$_j$) $[Y_{1j} - B_2/(1+r_j)]^{-2}/(1+r_j) = 0.5[(Y_{2j}(1) + B_2)^{-2} + (Y_{2j}(2) + B_2)^{-2}]$

Specific Solution under Autarky ($B_2 = 0$)

In autarky $C_{1k} = Y_{1k}$ and $C_{2k}(s) = Y_{2k}(s)$ where real endowment incomes are pregiven and nonstorable in each of the two countries, i and j. Hence substituting the matching values of Y for C in (4s) solves for the real interest rate r_k in the first column of Table 1.

Specific Solution under Riskless Bond Financing Only ($B_{2i} = -B_{2j}$, $r_i = r_j = r$)

The specific first-order conditions for the two countries ($4as_i$) and ($4as_j$) are solved for the two unkowns in those equations, r and B_2. As shown in the second column of Table 2, $B_2 = -6.76$ and r = 27.15% compounded over the length of the multiyear periods t = 1,2. Hence the home country (i) lends $B_2/(1+r) = 5.32$ at t=1 to the foreign country (j) after the integration of the capital market between them.

V. FOCs with Complete Markets for Contingent Claims

Differentiating equation (1b) w.r.t. $B_2(1)$ and $B_2(2)$ for each of the two countries and solving the resulting four first-order conditions for the respective value of $C_{2k}(s)$ yields :

(4b) $C_{2k}(s) = [\pi(s)\beta(1+r)/p(s)]^{1/\rho}C_{1k}$, s = 1,2; k =i,j

The nonstorability constraint implies that world income and output, $Y_{1w} = Y_{1i} + Y_{1j}$ and $Y_{2w}(s) = Y_{2i}(s) + Y_{2j}(s)$, must be equal to the corresponding world consumption, C_{1w} and $C_{2w}(s)$, at each date t = 1,2 and state s=1,2. Hence adding the two equations obtained from (4b) for i and j, given s, yields:

(5b) $Y_{2w}(s) = [\pi(s)\beta(1+r)/p(s)]^{1/\rho}Y_{1w}$, s = 1,2

Dividing the two equations obtained from (4b) for s = 1,2, given k, yields:

(6b) $C_{2k}(1)/C_{2k}(2) = \{[p(2)/p(1)][\pi(1)/\pi(2)]\}^{1/\rho}$, k = i,j

Equation (6b) holds equally for country i and j, so that the ratio of consumption in t=2 states 1 and 2 is the same in each. Hence, for global consistency, that common consumption ratio must also equal the ratio of world incomes in the two states. Hence the logical implication of the pair of equations (6b), and the direct mathematical implication of dividing the two equations obtained from (5b) for s=1,2, is:

(7b) $Y_{2w}(1)/Y_{2w}(2) = \{[p(2)/p(1)][\pi(1)/\pi(2)]\}^{1/\rho}$

VI. Solutions for Countries i and j with Complete Insurance Markets

Equation (7b) shows that market-clearing insurance prices would be actuarially fair, so that $p(2)/p(1) = \pi(2)/\pi(1)$, only if the ratio of world incomes in the two states were unity. Furthermore, the ratio of insurance prices on the two states, $p(2)/p(1)$, also determines their individual levels, $p(1)$ and $p(2)$, since the following arbitrage condition holds in efficient markets:

(8b) $p(1)/(1+r) + p(2)/(1+r) = 1/(1+r)$

The reason is that buying a unit of insurance on every state at price $p(s)/(1+r)$ this period, in t=1, must yield with certainty (assuming no uncertainty about insurers honoring claims against them) a unit payoff next period, in t=2, whose present value is $1/(1+r)$. Now with $\pi(1) = \pi(2) = 0.5$ and $\rho = 2$ and with $Y_{2w}(1)/Y_{2w}(2) = 200/300$, as before, equation (7b) yields $p(2)/p(1) = (2/3)^2 = 2.25^{-1}$. Hence $p(1) = 1/[1 + p(2)/p(1)] = 0.6923$ and $p(2) = 0.3077$ using equation (8b). We can now select either s=1 or s=2 to solve for r from equation (5b). This in turn allows the two possible consumption levels at t=2 to be determined for each of the two countries once the consumption level at t=1, C_{1k}, has been obtained for each of them. This is the final task laid out separately below. Once it has been solved, substituting the consumption levels $C_{2i}(s)$ for $C_2(s)$ in constraint (3b) yields $B_2(s)$, s = 1,2 with the desired sign for the home country.

Finding C_{1k} from the Wealth (W) Equation for Country k

As explained in the glossary at the beginning of this appendix, wealth is defined as the present value of current and state-contingent future income valued at the current market prices for a unit of insurance. Having already found r and p(s), it is determined for given values of Y from the equation:

(9b) $W_k = Y_{1k} + p(1)Y_{2k}(1)/(1+r) + p(2)Y_{2k}(2)/(1+r)$, k = i,j

Substituting for the different values of Y using equations (2b) and (3b) yields:

(10b) $W_k = C_{1k} + p(1)C_{2k}(1)/(1+r) + p(2)C_{2k}(2)/(1+r)$, k = i,j

Using equation (4b) to substitute further for $C_{2k}(1)$ and $C_{2k}(2)$ yields:

(11b) $C_{1k} = \{1 + [p(1)/(1+r)][\pi(1)\beta(1+r)/p(1)]^{1/\rho} + [p(2)/(1+r)][\pi(2)\beta(1+r)/p(2)]^{1/\rho}\}^{-1} W_k, \ k = i,j$

The last column of Table 1 shows the results.

Acknowledgment: Adapted from Chapter 5 in Obstfeld and Rogoff (1996) to fit the case presented. Their notation has been kept except that B_2 and $B_2(s)$ are signed positive if representing a t=1 capital import (from international borrowing or sale of insurance) by the home country i.

Appendix Table A-1: Utility Gains from International Credit and Insurance Compared when Y_2*(2) is lowered from 200 to 120

Internat. Financial Market:	Closed, Autarky	Riskless Bonds Only	Spanned by Insurance
Contingent Int. Fin. Claims:	None	None	Complete Market
Home Country			
(1) E_1U (expected utility[1])	-200	-199.91	-199.68
(2) C_1 (date 1 consumpt'n)	100	97.98	97.89
(3) $C_2(1)$ (C date 2, state 1)	100	102.20	97.89
(4) $C_2(2)$ (C date 2, state 2)	100	102.20	107.67
(5) r (real interest rate)	0%	8.80%	9.50%
Foreign Country (*)			
(6) E_1*U	-191.67	-191.59	-191.41
(7) C^*_1	100	102.02	102.11
(8) $C_2^*(1)$	100	97.80	102.11
(9) $C_2^*(2)$	120	117.80	112.33
(10) r* (=r except in autarky)	18.03%	8.80%	9.50%
Financial Asset Trade			
(11) B_2 (riskless bond)[2]	-	-2.20	-
(12) $B_2(1)$ (pay B_2 in state 1)[3]	-	-	2.11
(13) p(1) (state 1 price)[4]	-	-	0.5475
(14) $B_2(2)$ (pay B_2 in state 2)[3]	-	-	-7.67
(15) p(2) (state 2 price)[4]	-	-	0.4525
Memorandum[5]			
(16) $p(1)B_2(1)/(1+r)$	-	-	1.06
(17) $p(2)B_2(2)/(1+r)$	-	-	-3.17

Notation: Subscripts indicate dates 1 or 2, while alternative states (s) at date 2 are identified by suffix (1) or (2). All quantity variables (upper case), except for U, are in percent of Y_1, with $Y_1 = Y_1^* = Y_2(1) = Y_2^*(1) = Y_2(2) = 100$, and $Y_2^*(2) = 120$.

[1] The expected utility function with constant relative risk aversion is of the form $E_1U = 10{,}000(1-\rho)^{-1}[C_1^{1-\rho} + E_1(C_2^{1-\rho})]$, where $E_1(C_2^{1-\rho}) = \Sigma_{s=1,2}\ \pi(s)C_2(s)^{1-\rho} = 0.5[C_2(1)^{1-\rho} + C_2(2)^{1-\rho}]$, and the CRRA coefficient, ρ, is taken to be 2.

[2] Discount security issued for $B_2/(1+r)$ at date 1 by home (foreign) country, if B is positive (negative).

[3] Pay to foreign {home}country if $B_2(s)$ is positive {negative}, meaning that the home {foreign} country had sold {bought} insurance on that state (home-country capital import {export}) at date 1and the respective state occurs.

[4] The date 1 price of a pay-off of one unit, conditional upon the occurrence of state s=1,2 at date 2, is p(s)/(1+r). The shadow prices of insurance on state 1 under "riskless bonds only", p(1) and p*(1), are 0.5 and 0.5920, respectively.

[5] The date 1 price of insurance contract paying the amount $B_2(s)$ at date 2 if state s=1,2 occurs. Selling international insurance implies taking on a liability (capital import, +), while buying insurance implies acquiring an insurance asset and state-contingent claim on the foreign country (capital export, -).

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