Volume Title: Capital Flows and the Emerging Economies: Theory, Evidence, and Controversies

Volume Author/Editor: Sebastian Edwards, editor

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-18470-6

Volume URL: http://www.nber.org/books/edwa00-1

Conference Date: February 20-21, 1998

Publication Date: January 2000

Chapter Title: Contagion, Globalization, and the Volatility of Capital Flows

Chapter Authors: Guillermo A. Calvo, Enrique G. Mendoza

Chapter URL: http://www.nber.org/chapters/c6163

Chapter pages in book: (p. 15 - 41)

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Contagion, Globalization, and the Volatility of Capital Flows

Guillermo A. Calvo and Enrique G. Mendoza

The "contagion effect" . . . was thought to be a very common occurrence by almost all the market participants interviewed. It was attributed by many either to demonstration effects arising from the reassessment of the value of the totality of emerging market paper in light of the information highlighted by the particular characteristics of the crisis in one country, or to technicalities of the portfolio management methods used by many investors or fund managers.
—Group of Ten (1996, 33)

1.1 Introduction

One of the most puzzling features of the recent balance-of-payments crises has been the simultaneous collapse of securities markets at regional and global levels. In the case of Mexico's 1994 crash this phenomenon was named the *tequila effect:* As the crisis in Mexico surged, investors reduced their exposure both in markets of vulnerable countries like Argentina and Brazil, and in countries widely believed to be more stable, like Chile or Singapore. All of these countries had few, if any, economic linkages with Mexico. Similarly, the Russian default and the collapse of the ruble in October 1988 had major ramifications for equity markets worldwide, including a major "run for quality" in the U.S. stock market, despite the small share of world output that Russia accounts for and its very limited economic linkages with the United States. This behavior seems indicative of contagion by global investors: Equity positions and prices displayed major shifts that were not related to market "fundamentals."[1]

The recent crises have led observers and some policy makers to conclude that along with the efficiency gains resulting from the unprecedented globalization that securities markets have attained also came a high degree

Guillermo A. Calvo is distinguished university professor and director of the Center for International Economics at the University of Maryland, College Park. Enrique G. Mendoza is associate professor of economics at Duke University.

The authors thank V. V. Chari, David Bowman, Rudi Dornbusch, Jon Faust, David Howard, Sebastian Edwards, and Matt Pritsker for helpful comments and suggestions.

1. Calvo and Mendoza (1996) review factual evidence of herding by holders of Mexican securities. Calvo and Reinhart (1995) provide statistical evidence of contagion effects in emerging markets.

of volatility of private capital flows. In light of this increased volatility, countries have resorted in some instances to the introduction of controversial capital controls, taxes, and other barriers to asset trading (see, e.g., Chile's taxes and timing restrictions on short-term capital flows, and the more drastic controls introduced in Malaysia in 1997). All these barriers were judged traditionally as major policy flaws, but they are gaining increasing popularity in the wake of the recent crises. This need to respond quickly to a critical situation, however, contrasts sharply with our very limited understanding of the mechanisms that may drive contagion, of the quantitative significance of this phenomenon, and of the kind of policies that can be effective to prevent it.

The urgent question at hand is this: Is there a tendency for larger, or globalized, securities markets to become more volatile, or more susceptible to contagion, as globalization progresses? More precisely, are there mechanisms that lead investors to be influenced by contagion that grow stronger with globalization? This paper aims to answer these questions by showing that contagion is an outcome of optimal portfolio diversification that can become more pervasive as securities markets grow. We define contagion as a situation in which investors optimally choose to react to a rumor regarding a country's asset return characteristics, or to mimic the perceived optimal portfolio share assigned to a particular country by an arbitrary "market" portfolio.

Our analysis illustrates how two characteristics of imperfect information produce equilibria in which mean-variance portfolio optimizers are more likely to exhibit contagion as capital markets grow.[2] First, if there is a fixed cost of gathering and processing country-specific information, the expected utility gain made by paying this cost generally falls as the number of countries where wealth can be invested grows. Portfolios also become more sensitive to changes in perceived asset returns as markets grow, and thus contagion is more likely to prevail and to produce larger capital flows in globalized markets. Second, if investors (or fund managers) bear variable costs that depend on the performance of their portfolios—in particular, if the marginal cost of producing a mean return lower than the market exceeds the marginal gain of beating the market—there is a "contagion range" within which investors rationally choose to mimic arbitrary "market" portfolios. Globalization works to widen this contagion range.

Information frictions have been widely used in the extensive literature

2. The model does not differentiate global markets from domestic markets. We believe, however, that information frictions are more pervasive in global markets. This assumption is supported by some empirical regularities documented later in the paper and is also in line with the elaborate warnings that mutual funds give investors to highlight the special risks of global investing (see, e.g., Franklin Partners Funds, *Prospectus,* 1 May 1996, p. 13), particularly, sudden currency collapses, differing legal and accounting practices, and unanticipated large policy changes.

on contagion and herding in financial markets. To date, however, the interaction between the distortions generated by information frictions and the size of financial markets has remain largely unexplored. Thus, we begin by exploring analytically what conditions are required for the growth of securities markets to have the perverse effect of enlarging the information frictions that induce contagion. In addition, since the magnitude of the actual shifts in portfolio allocations that contagion may induce is also largely unknown, we examine the model's quantitative implications by conducting some basic numerical simulations.

Our quantitative analysis is based on a version of the model calibrated to capture key stylized facts of historical data from equity markets and country credit ratings (CCRs). Equity-market measures of the mean and variance of country asset returns are viewed as free information, while the information embodied in CCRs is assumed to be costly. These CCRs are very stable for industrialized and least-developed countries, while the ratings of emerging economies are very volatile, suggesting that historical equity-market data are significantly less useful for predicting future asset returns in emerging economies than in industrialized countries.

The numerical exploration suggests that the model can generate large capital flows driven by contagion. If the block of emerging economies is viewed as a segmented market, we found that investors will not assess the veracity of country-specific rumors if fixed information costs exceed one-sixth of the mean portfolio return prior to the emergence of a rumor. The full adverse effect of globalization on information gains is transmitted with about a dozen countries. The contagion range predicted by a rough parameterization of variable costs that depend on portfolio performance measures about 2.5 percentage points, even for small total costs. Simulations applied to Mexican data suggest that the model can rationalize capital outflows in excess of $15 billion triggered by contagion.

Keynes's (1936) classic analysis of speculation, which he defined as "the activity of forecasting the psychology of the market," anticipated our work in predicting that speculation can be more pervasive in larger or better organized markets. He also proposed other mechanisms that could drive speculation—sudden changes of opinion driven by mass psychology, perverse incentives of professional investors induced by information or reputational costs,[3] and changes in the confidence of lenders that finance speculators. These mechanisms have been the focus of the modern literature on herd behavior, which has made notable progress in providing the microfoundations of contagion and in justifying the information and reputational costs that we take for granted in this paper (see, e.g., Scharfstein

3. Keynes (1936, 157) wrote: "Investment based on genuine long-term expectation is so difficult to-day as to be scarcely practicable. He who attempts it must surely lead much more laborious days and run greater risks than he who tries to guess better than the crowd how the crowd will behave. . . ."

and Stein 1990; Bikhchandani, Hirshleifer, and Welch 1992; Banerjee 1992; and Morris and Shing 1995).

The rest of the paper is organized as follows. Section 1.2 analyzes the relationship between herd behavior and the globalization of securities markets. Section 1.3 examines the quantitative implications of the analysis. Section 1.4 concludes with a discussion of normative issues.

1.2 Optimal Global Portfolio Diversification with Contagion

The presentation that follows is a less technical version of that found in Calvo and Mendoza (2000a). We have omitted proofs and focused instead on developing the intuition. Consider a globalized securities market consisting of J countries, for $2 \leq J \leq \infty$, and a large number of identical investors. Wealth is normalized to 1 for simplicity. The representative investor must choose a portfolio to be divided between a "world fund" of $J - 1$ identical countries and a single country (country i). Each of the $J - 1$ countries in the world fund pays an independent and identical normally distributed stochastic return with mean ρ and variance σ_J^2. The return of country i also follows a normal distribution, but with mean r^* and variance σ_i^2, that will generally differ from those of the world fund, and with a correlation with the world fund determined by the correlation coefficient η. Since all $J - 1$ countries in the world fund are identical, in equilibrium the share of the portfolio invested in each of these countries is identical. Hence, the relevant choice is between the fraction of the investor's wealth allocated to the world fund, defined as θ, and the fraction allocated to country i, $1 - \theta$.

The investor sets θ so as to maximize the following indirect expected utility function:

$$(1)\quad EU(\theta) = \mu(\theta) - \frac{\gamma}{2}\sigma(\theta)^2 - \kappa - \lambda[\mu(\Theta) - \mu(\theta)], \qquad \gamma,\kappa > 0,$$

where γ is the coefficient of absolute risk aversion; μ and σ are the mean and standard deviation of the return for a particular portfolio θ. The model's information frictions are introduced by the costs reflected in κ and λ: κ is a fixed cost of acquiring country-specific information and λ is a variable cost (benefit) resulting from obtaining a mean return lower (higher) than that of an arbitrary "market" portfolio Θ. This variable cost can be interpreted as a reputational cost or as an incentive scheme for fund managers. We show below that these information frictions strengthen incentives for contagion as the global market grows (i.e., as J rises).

1.2.1 Contagion with Fixed Information Costs

The investor can acquire and process country-specific information at the fixed cost κ to update the estimates of the mean and variance of country i's returns he obtained using free information. If the investor chooses not to pay the information cost, the portfolio choice involves the world fund, with asset return moments ρ and σ^2, and country i, with mean return r^*, variance σ_i^2, and correlation with the world fund η. On the other hand, if he pays the information cost, the characteristics of asset returns in the $J - 1$ countries are unchanged, but the mean and variance of country i returns are updated.

We simplify significantly the model so as to characterize the nature of costly information in a manner that enables us to derive clear analytical results, leaving to section 1.3 the numerical analysis of the more general setting. In particular, costly information lets investors learn the "true" return of country i with full certainty. Thus, investors who pay κ learn a rate of return r^I with zero variance. Before paying κ, however, the potential update of the return is a random variable drawn from a known probability distribution function (pdf). Clearly, the investor will pay the information cost only if the expected utility obtained by gathering information, EU^I, exceeds that of remaining uninformed, EU^U (i.e., the gain from information searching $S \equiv EU^I - EU^U$ must be positive).

Consider an initial equilibrium in which country i is identical to the rest (i.e., $r^* = \rho$ and $\sigma_i = \sigma_J = \sigma$) and asset returns are uncorrelated ($\eta = 0$). It is trivial to show that in this initial equilibrium the share of the portfolio invested in each country is $1/J$ and the mean and variance of the portfolio return are ρ and σ^2/J, respectively. We offer two motivations for investors to have incentives to acquire costly information. First, investors may be willing to pay for eliminating the uncertainty of investing in country i. Second, investors may use information to assess the veracity of an exogenous and "reliable" rumor that country i's mean return is r, $r \leq \rho$, while the variance is still σ^2.[4]

Let θ^U and θ^I be the portfolio shares chosen by the investor if he decides to be uninformed or informed respectively. Ignoring variable costs, θ^U is set so as to maximize expected utility:

$$(2) \qquad EU^U = \theta^U\rho + (1 - \theta^U)r - \frac{\gamma}{2}\left[\frac{(\theta^U)^2}{J - 1} + (1 - \theta^U)^2\right]\sigma^2.$$

The solution for the optimal portfolio is

$$(3) \qquad \theta^U = \left(\frac{J - 1}{J}\right)\left(1 + \frac{\rho - r}{\gamma\sigma^2}\right).$$

4. Note that in the first case we must impose the consistency condition $E(r^I|\kappa) = r^*$, since r^* is an expectation based on free information and the distribution of r^I is also known at no cost, while in the second case this condition is not required because investors are trying to assess the veracity of an exogenous rumor that they regard as credible.

Short positions are ruled out by assumption. Thus, $\theta^U = 1$ for $r \leq r^{\min}$, where $r^{\min} = \rho - [\gamma\sigma^2/(J-1)]$, and $\theta^U = 0$ for $r \geq r^{\max}$, where $r^{\max} = \rho + \gamma\sigma^2$. Notice that as J goes to ∞, the interval of returns that supports internal solutions shrinks to $r^{\max} - r^{\min} = \gamma\sigma^2$.

For rumors within the interval $r^{\min} < r < r^{\max}$, expected utility valued at the maximum is

$$(4) \qquad EU^U = \left\{ r - \frac{\gamma}{2}\frac{\sigma^2}{J} + \frac{(\rho - r)}{2}\frac{J-1}{J}\left[2 + \frac{(\rho - r)}{\gamma\sigma^2}\right]\right\}.$$

Alternatively, if $r \leq r^{\min}$, $EU^U = \rho - [\gamma\sigma^2/2(J-1)]$, and if $r \geq r^{\max}$, $EU^U = r - \gamma\sigma^2/2$.

Next we study the portfolio problem if the investor pays for country i information. An investor that paid κ and learned r^I will maximize the following state-contingent utility function:

$$(5) \qquad U^I(r^I) = \theta^I\rho + (1 - \theta^I)r^I - \frac{\gamma}{2}\left[\frac{(\theta^I)^2}{J-1}\right]\sigma^2 - \kappa.$$

The optimal, state-contingent portfolio is

$$(6) \qquad \theta^I(r^I) = (J - 1)\left(\frac{\rho - r^I}{\gamma\sigma^2}\right).$$

Short positions are again ruled out, so $\theta^I(r^I) = 0$ if $r^I \geq \rho$, and $\theta^I(r^I) = 1$ if $r^I \leq r^I_{\min}$ where $r^I_{\min}$ is

$$(7) \qquad r^I_{\min} = \rho - \frac{\gamma\sigma^2}{J-1}.$$

Note that $r^I_{\min}$ rises with J, and converges to ρ as J grows without bound. Thus, the interval that allows the portfolio of an informed agent not to be specialized shrinks to almost zero as the market grows infinitely large.

The solution in equation (6) is only for the realization r^I. Expected utility in the scenario in which the investor chooses to acquire information is determined by

$$(8) \quad EU^I = \int_{-\infty}^{\infty}\left(\theta^I(r^I)\rho + [1 - \theta^I(r^I)]r^I - \frac{\gamma}{2}\left\{\frac{[\theta^I(r^I)]^2}{J-1}\right\}\sigma^2\right)f(r^I)dr^I - \kappa,$$

where $f(r^I)$ is the pdf of r^I, and the corresponding cumulative distribution function (cdf) is defined as $F(r^I)$.

Obviously, the fixed cost can be set large enough so that S is negative, and hence agents would choose not to be informed. Less obvious is the fact that, under fairly general conditions, S is a decreasing function of J for any given κ, as the following proposition argues.

PROPOSITION 1. *For any "pessimistic" rumor such that* $r^{min} < r < r^{max}$ *and* $r \leq \rho$, *and assuming that both F and f are continuously differentiable, the gain of acquiring country-specific information S is a decreasing function of J (i.e.,* $dS/dJ < 0$*) if the number of countries in the market is at least* $J < 1/[1 - F(\rho)^{1/2}]$.

The proof of this proposition is provided in Calvo and Mendoza (2000a). Here we simplify the exposition by adopting that result for dS/dJ in the case in which short positions are ruled out:

$$(9) \qquad \frac{dS}{dJ} = \frac{\gamma}{2}\frac{\sigma^2}{(J-1)^2}F(r^I_{\min}) + \int_{r^I_{\min}}^{\rho}\frac{1}{2}\frac{(\rho - r^I)^2}{\gamma\sigma^2}dF(r^I)$$
$$- \frac{\gamma}{2}\frac{\sigma^2}{J^2} - \frac{(\rho - r)}{2J^2}\left[2 + \frac{(\rho - r)}{\gamma\sigma^2}\right].$$

Setting $r^I = r^I_{\min}$ in equation (9), we obtain

$$(10) \qquad \frac{dS}{dJ} \leq \frac{\gamma}{2}\frac{\sigma^2}{(J-1)^2}\left[F(\rho) - \left(\frac{J-1}{J}\right)^2\right] - \frac{(\rho - r)}{2J^2}\left(2 + \frac{(\rho - r)}{\gamma\sigma^2}\right).$$

Since $r^{min} < r \leq \rho$, it follows that $J > 1/[1 - F(\rho)^{1/2}]$ is sufficient for $dS/dJ < 0$.

A simple interpretation of this result is the following. Consider a case in which there is no rumor (i.e., $r = \rho$), so that costly information eliminates the variance of country i returns (i.e., the last terms in equations [9] and [10] vanish). It follows from equation (10) that as J increases, both the expected utility of being informed and of being uninformed increase to the extent that a higher J makes the world fund a less risky asset. Proposition 1 establishes a sufficiency condition for the utility gain of being uninformed to be larger than that for being informed, so S falls as J rises. What lies behind this condition is the fact that in those "bad" states of nature in which costly information reveals that agents should short country i, the "second best" choice *if these positions are ruled out* is to allocate the entire portfolio to the world fund. State-contingent utility for those states of nature increases as J rises but at a rate that (1) declines as J rises and (2) declines faster than the rate at which the utility gain of being uninformed falls as J rises. As a result, eventually the utility of being uninformed increases by more than that of being informed as J rises, and S falls.

The above scenario (in which there is no rumor and costly information eliminates the variance of one asset in the investor's portfolio) is comparable to the standard analysis of the value of information to individual investors in the finance literature (see Pritsker 1994). However, our findings are strikingly different because of the assumption ruling out short positions. If there were no restrictions on short positions, as in the standard case in the value-of-information literature, dS/dJ eventually becomes *increasing* in J as J rises, instead of decreasing. This is because with unlimited short positions the utility of being informed rises as J rises at a rate that does not depend on J, while that of being uninformed still increases at a rate that is declining in J.

While absolutely ruling out short positions seems unrealistic, some form of short-selling constraints can be easily justified in the conventional way, by arguing that they will emerge naturally because of the risk of bankruptcy. Consider a case in which J has grown so large as to make the world fund virtually risk free. There could be states of nature in which the earnings of the riskless asset are not sufficient to cover the losses of the risky asset. In our framework with information frictions, one can argue in addition that short-selling constraints make sense because otherwise as J rises informed agents would take infinitely large positions in the world fund—as predicted by equation (6). It is difficult to argue that information would remain costly to gather in an environment like this. Moreover, in exploring the implications of allowing limited short selling in the model presented above, we found that the key results described here are robust to this modification (Calvo and Mendoza 2000a).

Equations (9) and (10) show that there are two key determinants of the critical market size after which S becomes a negative function of J: The first is the position of the mean return of the world portfolio (i.e., ρ) in the distribution of country i returns that agents learn if they pay the fixed cost. For example, if f is symmetric and $E(r^I) = \rho$, $F(\rho) = 0.5$ and dS/dJ is negative with as few as four countries. If $F(\rho)$ is smaller (larger) than one-half, which implies that $E(r^I)$ is larger (smaller) than ρ, the critical value of J falls (rises). The intuition is that, if investors are "bullish" on country i in the sense that $E(r^I) > \rho$, the incentives to gather information begin to decrease with J for a smaller market than when investors are "bearish" on country i. When costly information is *expected* to produce good news, incentives for acquiring it are weak. The second determinant is the size of the rumor. If the rumor is very optimistic, in the sense that $r \geq r^{max}$, one can show that dS/dJ is always positive. At the other extreme, for very pessimistic rumors $r \leq r^{min}$, one can show that dS/dJ is always nonpositive. Pessimistic rumors inside the interval relevant for proposition 1 play a similar role. Consider again the case in which f is symmetric. A pessimistic rumor such that $r^{min} < r < \rho$ implies that dS/dJ may be negative even if $F(\rho)$ is somewhat larger than one-half (i.e., with $r < \rho$, the critical value of J falls for any given $F(\rho)$). Thus, a bad rumor reduces the benefits of gathering information on country i as the market expands even if investors are bearish about country i (i.e., $E(r^I) < \rho$).

Two final remarks. First, as the market grows infinitely large the gain of gathering country-specific information becomes independent of the size of the global market. This is because in the limit, as $J \rightarrow \infty$, both r^{min} and

$r^J_{\min}$ converge to ρ, as a very large global market offers a risk-free asset at the rate of return ρ.[5] Second, as J rises, not only are the incentives to gather information diminishing as J goes to infinity, but the impact of rumors on the allocation of investment funds to a single country by uninformed investors, relative to the initial allocations $1/J$, grows without bound. This is because $-d\theta^U/dr$ converges to $1/\gamma\sigma^2$ in the limit as $J \to \infty$.

1.2.2 Variable Performance Costs

Consider now the effects of variable costs linked to the performance of portfolio managers, and set $\kappa = 0$. Variable costs allow the model to produce contagion as a result of multiple equilibria in optimal portfolio shares, and this has the advantage of making the response to rumors identified above more persistent. This is useful because otherwise contagion could be ruled out by arguing that whenever investors react to a rumor there is a sell-off in the affected country's stock market, and the ensuing "price correction" drives expected returns high enough to undo the effect of the rumor. The persistence of contagion could also be justified by self-fulfilling crises related to policy imbalances (as in Calvo 1998).

We consider identical mutual fund managers that pay a variable cost, or collect a benefit, when the mean return of the portfolio they manage deviates from the mean return of an arbitrary market portfolio. These costs and gains are given by the function $\lambda(\mu(\Theta) - \mu(\theta))$, which satisfies the following properties:[6]

$$\text{(11)} \qquad \lambda > 0 \text{ if } \mu(\theta) < \mu(\Theta), \quad \lambda \leq 0 \text{ if } \mu(\theta) > \mu(\Theta), \quad \lambda(0) = 0,$$
$$\lambda' \geq 0 \text{ with } \lambda'(x) > \lambda'(-x) \text{ for all } x = \mu(\Theta) - \mu(\theta) > 0,$$
$$\lambda'' \leq 0.$$

Hence, there is a cost (benefit) when the mean return of the investor's portfolio is smaller (larger) than that of the market portfolio and the marginal cost exceeds the marginal gain.

Fund managers choose θ, given some Θ, so as to maximize

$$\text{(12)} \quad EU(\theta) = \theta\rho + (1 - \theta)r - \lambda(\mu(\Theta) - \mu(\theta)) - \frac{\gamma}{2}\left\{\frac{(\theta\sigma_J)^2}{J-1} + [(1-\theta)\sigma_i]^2 + 2\sigma_J\sigma_i\theta(1-\theta)\eta\right\}.$$

The variances of investing in country i (σ_i^2) and in all J countries except i (σ_J^2) differ, and asset returns are correlated according to the correlation

5. Note that this also implies that the result that S declines as J rises cannot be obtained if the portfolio included a riskless asset even for small J. However, the focus of our study is on the composition of portfolios of country-specific risky assets, not on the choice between risky and riskless assets.

6. It is also assumed that $\lambda'(0)$ does not exist to capture the notion of fixed costs.

coefficient η. This portfolio optimization problem displays contagion in the sense that, for rumors within a certain *contagion range* of values of Θ, choosing $\theta = \Theta$ is optimal for all investors in the global market. Within this range, a rumor calling for a different Θ results in a panic that induces all investors to reoptimize their portfolios and choose that new Θ.

The above result is not all that surprising since the assumption that poor performance is punished relatively more than good performance is rewarded provides an incentive to mimic market portfolios. We are more interested in a second result showing that in the presence of performance-related costs or benefits it is again the case that globalization strengthens incentives for contagion (i.e., the contagion range widens as the global market grows for a given cost function). These results are established in propositions 2 and 3.

PROPOSITION 2. *If in the neighborhood of the optimal portfolio* θ^* *corresponding to an investor free of information frictions, the marginal performance cost (gain) of deviating from the mean return of the market portfolio* $\mu(\Theta)$ *is sufficiently large (small), there exists a contagion range of individual portfolio allocations* θ, *such that investors optimally choose* $\theta = \Theta$.

The proof is provided in Calvo and Mendoza (2000a). Here we provide a graphical example showing that, as long as near θ^* the marginal performance cost exceeds the marginal gain, there is a range of values of Θ for which setting $\theta = \Theta$ is optimal.

Consider the first-order condition for maximization of equation (12) with respect to θ:

$$E\hat{U}'(\theta) - \lambda'(\cdot)(r - \rho) = 0, \tag{13}$$

where

$$E\hat{U}'(\theta) \equiv \rho - r - \gamma\{\theta\sigma_J^2/(J - 1) - (1 - \theta)\sigma_i^2 + \eta\sigma_J\sigma_i[(1 - \theta) - \theta]\}$$

is the marginal utility of θ for an investor that does not face information frictions, so $E\hat{U}'(\theta^*) = 0$ at the optimum θ^*. Note that the second-order condition $E\hat{U}''(\theta) < 0$ requires $\sigma_J^2/(J - 1) + \sigma_i^2 > 2\eta\sigma_J\sigma_i$. Clearly, it follows from equation (13) that if $r = \rho$ the solution θ^* is the unique solution of the model, and there is no contagion. Thus, contagion in this model requires that r and ρ differ.

A particular case of equation (13) is illustrated in figure 1.1, which assumes that $r > \rho$, that the marginal gain for beating the market is zero, and that there is a constant marginal cost paid for producing below-market returns (i.e., a linear function for the performance incentives). Any value of Θ within the indicated contagion range implies that it is optimal to set $\theta = \Theta$. To see why, first consider what would happen if the investor

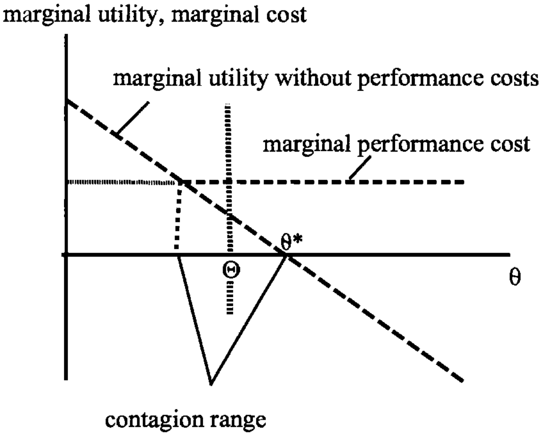

Fig. 1.1 Multiple optimal portfolios in the presence of performance costs

tried $\theta < \Theta$. He would be beating the market—this can be easily confirmed because the difference between individual and market returns can be expressed as $(\Theta - \theta)(\rho - r)$. Given a zero marginal gain for beating the market and the fact that $E\hat{U}'(\theta)$ is positive for $\theta < \Theta \leq \theta^*$, the marginal utility of portfolio reoptimization is positive. If, on the other hand, the investor tried $\theta > \Theta$, he would now produce a mean return lower than the market and pay the constant marginal cost. Within the contagion range this marginal cost exceeds the marginal utility of an investor not subject to information frictions, as shown in figure 1.1, and hence the net marginal utility of setting a portfolio $\theta > \Theta$ is negative. Thus, $\theta = \Theta$ is the optimal choice. Moreover, it is easy to see that contagion equilibria cannot exist in figure 1.1 for any $\Theta \geq \theta^*$. A similar argument can be constructed to show that, for $r < \rho$, there is a contagion range for some values of Θ in the region $\Theta \geq \theta^*$, and that in this case there are no contagion equilibria for $\Theta \leq \theta^*$.

PROPOSITION 3. *The contagion range, defined by the values of* Θ *in the interval* $\theta^{low} < \Theta < \theta^{up}$ *for which proposition 2 holds, widens as the global market grows (i.e.,* $\theta^{up} - \theta^{low}$ *is increasing in* J*).*

The proof is again in Calvo and Mendoza (2000a), where we show that, for a linear marginal cost function as the one in figure 1.1, the total differential of equation (13) and the second-order condition stated earlier imply that $d\theta/dJ$ is positive and *increasing* in θ. Thus, as J rises both θ^{up} and θ^{low} rise, but, since $\theta^{up} > \theta^{low}$, θ^{up} rises more than θ^{low} and hence the contagion range widens. In graphical terms, the downward sloping line that represents $E\hat{U}'(\theta)$ in figure 1.1 shifts counterclockwise around its vertical intercept as J rises.

The intuition for this result is simple. Given a marginal reputational cost invariant to J or θ, the growth of the global market can only affect the expected marginal utility of optimal portfolios in two ways. First, as J rises, the effective variance of the world fund ($\sigma_J^2/(J-1)^2$) falls, and thus the marginal utility of θ rises. This effect is proportional to the portfolio share invested in the world fund. Second, the reduced variance of the world fund makes this asset more attractive relative to country i, providing an incentive to increase θ, which in turn reduces marginal utility. The magnitude of this second effect is independent of θ because the rate at which marginal utility falls as θ rises is invariant to portfolio shares with a linear marginal utility (as in fig. 1.1). Hence, the portfolio shift induced by market growth is larger the larger the initial θ. We also prove (Calvo and Mendoza 2000a), however, that $d\theta/dJ$ is decreasing in J and converges to 0 as J goes to infinity because in a large market the world fund becomes riskless.

Since the portfolio θ^* of the investor free of information frictions is Pareto-efficient, all portfolios within the contagion range are suboptimal. This is because θ^* maximizes $E\hat{U}(\theta)$, and $EU(\theta) = E\hat{U}(\theta)$ whenever $\theta = \Theta$ since $\lambda(0) = 0$. Moreover, the existence of multiple optimal portfolios for a given pair of mean returns r and ρ implies that there can be capital outflows from country i even in the absence of rumors about country asset returns. This also implies that a price correction following a rumor about r may not prevent persistent contagion.

1.2.3 A Comparison with Models of Costly Information, Contagion, and Herd Behavior

The fixed cost of acquiring information featured in our model is reminiscent of the information costs driving the models of informational efficiency in the tradition of Grossman and Stiglitz (1976, 1980). Our focus, however, is on the implications of market size for the profitability of gathering costly information in a partial equilibrium setting where asset prices are exogenous. In contrast, the classic finding of Grossman and Stiglitz that incentives to gather costly information are reduced by the fact that prices can partially or totally reveal that information emphasizes the general equilibrium determination of prices. The Grossman-Stiglitz argument suggests that if our model is examined in general equilibrium it may yield even smaller expected utility gains of gathering costly country-specific information, for any given J, because endogenous changes in asset returns would reveal some or all of the information at no cost. Through this channel, therefore, we would expect a general equilibrium analysis to strengthen our results rather than weaken them.

Our framework also considers a global market consisting of a large number of identical investors formulating simultaneous decisions. This differs from the sequential decisionmaking setup typical of game-theoretic models of herd behavior.[7] These models show that when information is incomplete and the signals that transmit it are noisy, agents *waiting in line* to make a decision may imitate agents ahead of them rather than use their own information (a situation referred to as an "informational cascade").

Our framework can easily be incorporated into a sequential decision-making setting. Consider the case with variable performance incentives, viewed as the "sharing-the-blame" reputational effects that induce herding externalities in Scharfstein and Stein (1990). Assume N investors waiting in line to choose their portfolios observe the portfolios chosen by investors ahead of them, with the first one facing an arbitrary Θ. Each investor draws a piece of news at random that acts as a shift parameter in λ', so marginal costs are indexed by h for $h = 1, \ldots, N$. The λ_h's are like the signals introduced in Banerjee (1992) or Bikhchandani, Hirshleifer, and Welch (1992), with the distribution of λ' defined to have positive (negative) support for $\theta > \Theta$ ($\theta < \Theta$). Under these conditions, there can be informational cascades in which the agents first in line may draw λ_h's such that they choose Θ, thereby increasing the incentives for followers to also choose Θ. In some of these cascades everybody chooses Θ, and herd behavior dominates. Since for any λ_h the contagion range widens as J rises, a set of signals that supported an equilibrium without herding in a small market can produce an informational cascade with herding in a large market.

The contagion models examined by Shiller (1995) also have an interesting connection with our model. Contagion by word of mouth provides microfoundations for the determination of Θ or r, and for the process leading from one value of Θ to another within the range of herding equilibria. Survey data collected by Shiller and Pound (1986, 1987) provide further evidence of word-of-mouth contagion among institutional investors in the United States.

1.3 Quantitative Implications of the Model

We proceed next to explore the model's quantitative implications. In order to conduct numerical simulations, we calibrate a benchmark version of the model to reflect basic statistical properties of international asset returns and portfolio holdings. We do not test the model's ability to explain actual investment behavior, since it is well known that the mean-variance

7. Our analysis adopts some assumptions similar to those used in game-theoretic models. In Banerjee (1992) payoffs are discontinuous at the "true value" of asset returns, resembling the discontinuity of λ' at $\theta = \Theta$. Banerjee (1992) and Bikhchandani, Hirshleifer, and Welch (1992) require two sources of uncertainty (about outcomes and about signals), while in our model investors considering whether to pay the fixed information cost face uncertainty about asset return "fundamentals" and about potential updates of mean and variances of assets returns.

model cannot explain actual portfolio allocations, particularly the "home" bias of international portfolios (see Tesar and Werner 1995a). Our intent is simply to quantify how large contagion effects can be because of the information frictions we proposed.

1.3.1 Calibration

The benchmark calibration requires a value for the preference parameter γ, estimates of the mean and variance of country asset returns, and a framework for characterizing the nature of costly information and for how this information maps into updates of the mean and variance of country asset returns. The value of the coefficient of absolute risk aversion, γ, is set to make the model consistent with existing estimates of the mean and variance-covariance structure of asset returns, and data on net holdings of foreign equity by global investors, assuming a conventional mean-variance setup without information or reputational costs. The equation that relates γ to θ and the statistical moments of asset returns is derived by solving equation (13) for γ setting $\lambda'(\cdot) = 0$. Using various data sets that exist in the home bias literature (see, e.g., Bohn and Tesar 1994; Lewis 1995; and Tesar and Werner 1995b), we found that plausible values of γ range between near 0 and $1/2$. We chose the middle point $1/4$ for the benchmark calibration. Note, however, that there are also several data combinations that produce negative values of γ, highlighting the weaknesses of the mean-variance model.

The best available measure of costly country-specific information is embodied in the CCRs constructed by investment banks, and compiled and published every six months, in March and September, by *Institutional Investor.* Figure 1.2 plots the time-series average of each country's CCR against the corresponding standard deviation, using all available data, which in most cases covers the period September 1979–March 1996. Figure 1.3 is a similar plot that includes only member countries of the Organization for Economic Cooperation and Development (OECD) and Latin American countries.

Figures 1.2 and 1.3 show that credit ratings are significantly more variable in emerging markets than they are in either industrialized or least-developed economies. Emerging markets are defined here as those with credit ratings between 20 and 80—high-risk countries have ratings lower than 20 and industrialized countries have ratings higher than 80. This evidence suggests that when asset trading restrictions among industrial countries were lifted in the 1980s, the newly created global market consisted of countries of roughly similar risk quality. The globalization of the 1990s expanded to emerging markets where asset returns are intrinsically more risky, and where information gathered on economic, social, and political issues results in much larger innovations to credit ratings than in OECD countries. Under these conditions, it may in principle be valuable to ac-

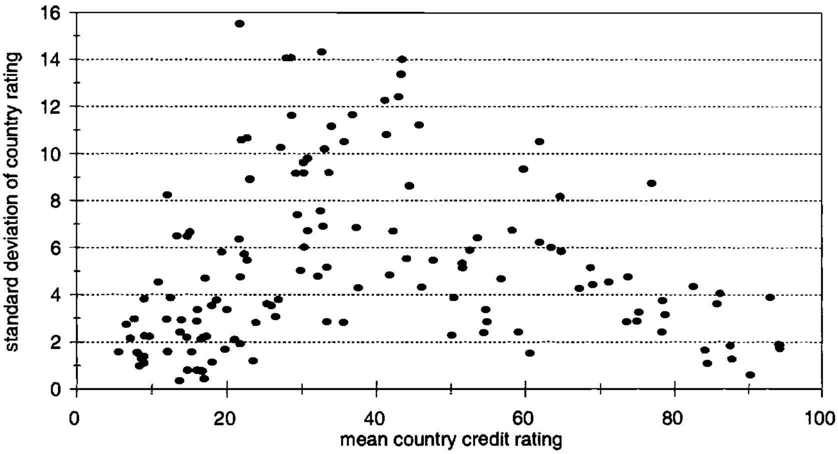

Fig. 1.2 Variability of country credit ratings

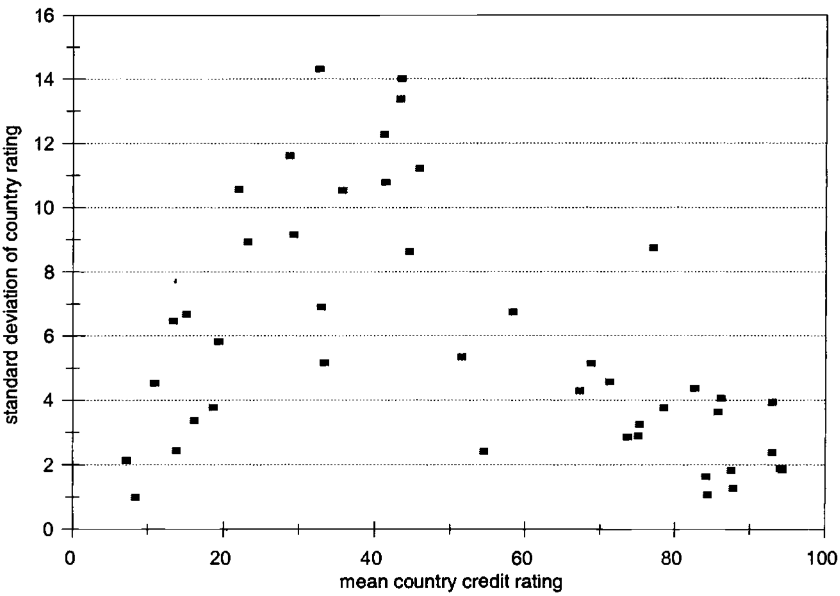

Fig. 1.3 Variability of country credit ratings in Latin America and the OECD

quire costly country-specific information. We must still determine, however, whether a globalized market provides enough incentives for investors to pay for this information.

The calibration is completed by specifying a framework for mapping the costly information of the CCRs into probability distributions from which updates of means and variances of asset returns are drawn.[8] We adopt a framework created by Erb, Harvey, and Viskanta (1996) to forecast the mean and variance of asset returns in eighty countries for which CCRs exist but equity markets do not. These authors estimated log-linear panel regressions of the mean and variance of returns on the information innovations measured by CCRs for countries with equity markets, and used them to forecast means and variances of returns in countries *without* equity markets. In particular, they estimated panel regressions of the form $x_{ht+1} = \alpha^x + \beta^x \ln(CCR_{ht}) + u^x_{ht}+1$, where x = the mean (μ) or standard deviation (sd) of asset returns in country h. This exercise assumes normal distributions for the one-step-ahead mean and variance of returns, which are defined by

$$E[r^I] = \alpha^{\mu} + \beta^{\mu} E[\ln(CCR_h)],$$

$$E[\sigma^I_h] = \alpha^{sd} + \beta^{sd} E[\ln(CCR_h)],$$

$$\sigma^I_r = (\beta^{\mu})^2 \text{VAR}[\ln(CCR_h)] + (\sigma^{\mu}_u)^2,$$

and

$$\sigma^I_{\sigma} = (\beta^{sd})^2 \text{VAR}[\ln(CCR_h)] + (\sigma^{sd}_u)^2.$$

Assuming that the regressions are homogenous across countries, the regression coefficients and the data on CCRs can be combined to compute these four moments for the 144 countries with credit ratings data. A table listing these moments for each country is available from the authors on request.

For countries with equity markets, the predicted moments based on the regressions created by Erb, Harvey, and Viskanta can be compared to the estimates of the mean and standard deviation of returns produced using historical equity-market data, as shown in figure 1.4. This chart plots updates of the mean and standard deviations of returns based on the September 1996 CCRs against each country's CCR. Updates are measured as a difference relative to the corresponding statistical moment based on historical equity-market data. Figure 1.4 shows that costly information generally results in positive updates of mean returns and reduced estimates of the variability of asset returns. Moreover, emerging markets yield relatively large upward adjustments in expected returns and large downward revisions in standard deviations of returns, while updates of the mean and variance of returns for OECD countries are generally small.

8. Note that although *Institutional Investor* provides CCRs at a trivial cost, the published ratings are not free information at the relevant moment in which investment banks design portfolios.

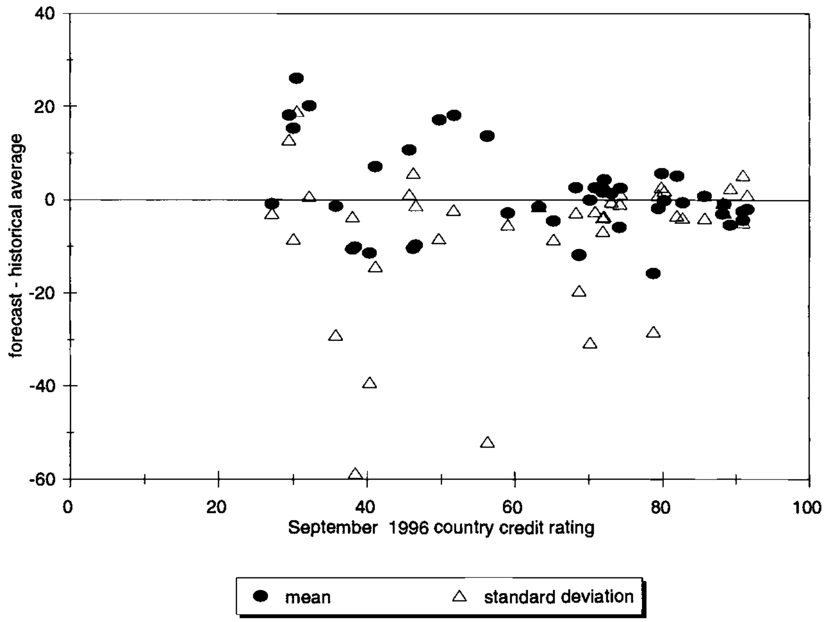

Fig. 1.4 Updates of the mean and variance of asset returns

1.3.2 Contagion Due to Fixed Information Costs

The simulations use the following expected utility function for informed agents:

$$(14)\quad EU^I - \kappa = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \theta^I(r^I,\sigma_i^I)\rho + (1-\theta^I(r^I,\sigma_i^I))r^I - \frac{\gamma}{2}\left[\frac{(\theta^I(r^I,\sigma_i^I)\sigma_J)^2}{J-1} + ((1-\theta^I(r^I,\sigma_i^I))\sigma_i^I)^2 + 2\sigma_J\sigma_i^I\eta\theta^I(r^I,\sigma_i^I)(1-\theta^I(r^I,\sigma_i^I))\right] f(r^I)g(\sigma_i^I)dr,$$

where f and g are normal, independent probability distribution functions and $\theta^I(r^I,\sigma_i^I)$ is the optimal portfolio of an informed investor contingent on updates (r^I,σ_i^I). The simulations consider an evenly spaced grid of rumors about the country i return, with 120 elements spanning the interval $[r^{\min},r^{\max}]$, and allow J to vary from two to forty-two countries. The double integral in equation (14) is computed by Gauss-Legendre quadrature, setting integration limits so that the integral captures 98 percent of the joint cumulative distribution function of r^I and σ_i^I.

Consider first a case simplified to illustrate the theoretical results of section 1.2 within the context of the relatively stable equity markets of OECD countries. This requires the restrictive assumptions that (1) asset returns are uncorrelated ($\eta = 0$), (2) ex ante the mean and variance of asset returns are the same in all countries ($r^* = \rho$ and $\sigma_i = \sigma_J$), (3) the information acquired at a fixed cost reveals the true country *i* asset return (i.e., $E[\sigma_i^I] = \sigma_\sigma^I = 0$), and (4) the expected update of country *i*'s return equals the world return, $E(r^I) = \rho$. The values of ρ, σ_J, and σ_i^I are set to $\rho = 15.31$ percent, $\sigma_J = 22.44$ percent, and $\sigma_i^I = 6.46$ percent. The first two moments are arithmetic averages of the annualized mean and standard deviation of monthly stock returns in U.S. dollars over the period 1979–95 for OECD countries with "stable markets," and the third moment is an average of the estimates of σ_i^I computed using the forecasting framework of Erb, Harvey, and Viskanta (1996). The OECD countries with "stable markets" include OECD members during the entire 1979–95 period for which the standard deviation of returns did not exceed 30 percent. This excludes Greece, New Zealand, Portugal, and Turkey.

Figure 1.5 plots *S*, ignoring κ, as a function of *J* for values of the rumor equal to $r^{\min}$, $r^{\max}$, and the neutral rumor $r = r^* = \rho$. The chart confirms proposition 1 and its implications for very pessimistic and very optimistic rumors. *S* is generally decreasing in *J* for all moderate-to-pessimistic rumors and increasing in *J* for a very optimistic rumor. *S* is decreasing in *J* even for $J < 4$ in the neutral-rumor case because proposition 1 establishes only a sufficiency condition. In this example, however, investors facing pessimistic rumors ($r \leq \rho$) are willing to pay hefty fixed information costs exceeding 30 percent (in terms of mean portfolio return) if $J = 2$. As *J* grows to include about a dozen countries, *S* falls sharply but still converges to a relatively large amount of nearly 4 percent. At 4 percent, the fixed cost would have to be about one-third of the expected portfolio return before the rumor emerged (15.3 percent) in order to induce contagion. Still, this experiment shows that only twelve countries are required for the adverse effect of globalization on information gains to be in full force, and that this effect cuts information gains sharply.

Next we strengthen the effects of the informational frictions by considering the more realistic case in which information cannot reveal true asset returns. Hence, agents only learn updates of the mean and variance of returns drawn from known probability distributions. The moments that fully describe these normal, independent distributions are again determined using the forecasting model of Erb, Harvey, and Viskanta (1996) applied to "stable" OECD markets. This implies setting $E(r^I) = 15.18$, $E[\sigma_i^I] = 21.81$, $\sigma_r^I = 6.46$, and $\sigma_\sigma^I = 1.84$. We maintain for now the assumptions that ex ante all countries are perceived to be identical ($r^* = \rho$ and $\sigma_i = \sigma_J$) and that asset returns are uncorrelated. The resulting *S* function is plotted in figure 1.6.

A comparison of figures 1.5 and 1.6 shows that, when information

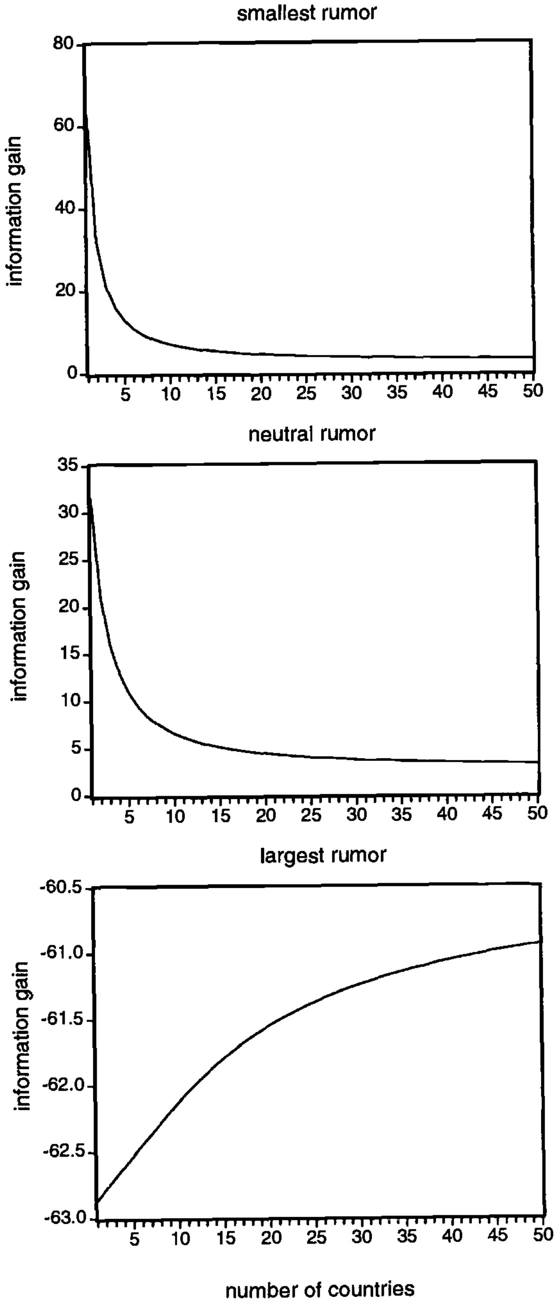

Fig. 1.5 Net gains of information gathering and market size: case I

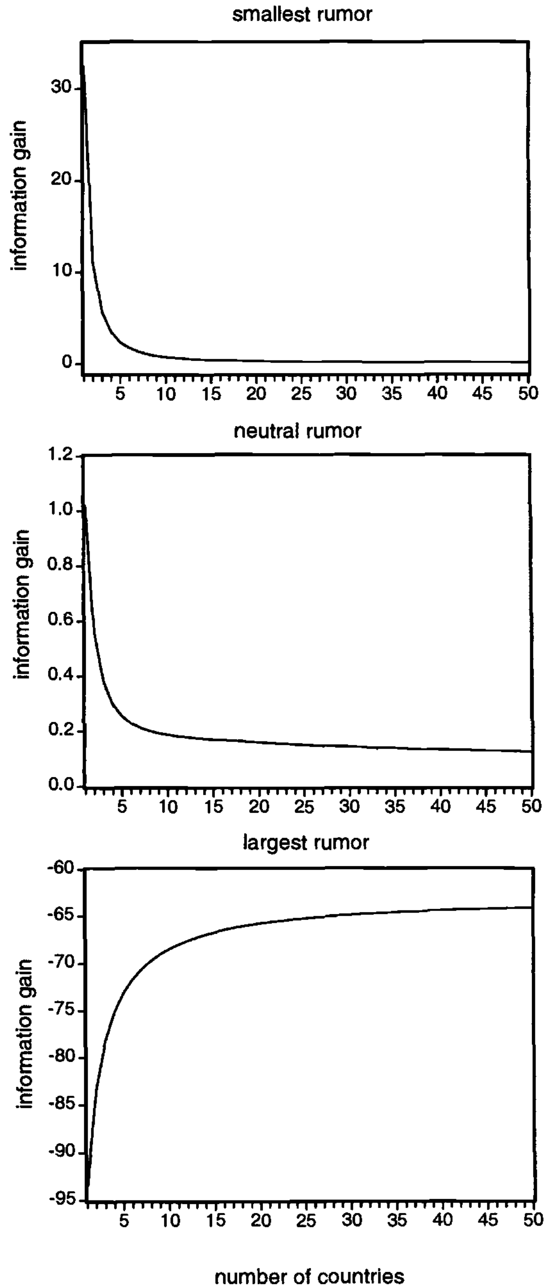

Fig. 1.6 Net gains of information gathering and market size: case II

cannot reveal true asset returns, the gains of information gathering can fall very sharply. In the case of the neutral rumor $r = r^*$ (the middle panels of figs. 1.5 and 1.6), the gains of acquiring information decline from 31 to 1 percent for a market with two countries, and from about 4.0 to 0.1 percent in markets with more than twelve countries. A cost of 0.1 percent is only 0.6 percent of the ex ante mean return of the total portfolio ($r^* = \rho = 15.31$), so in this circumstances investors are very reluctant to pay information costs. S is small even for mildly pessimistic rumors (a rumor that country i's return is 11 percent yields $S = 3.1$ percent for $J = 2$ and $S = 0.4$ percent for $J = 12$). Moreover, in a large market with at least twelve countries, S converges to less than 0.45 percent for any rumor $r^{\min} \leq r \leq r^*$.

The above exercise can be easily modified to consider the fact that the correlation of asset returns in the OECD ranges from 0.3 to 0.6 (see Bohn and Tesar 1994; Lewis 1995; and Erb, Harvey, and Viskanta 1996). This is done by setting $\eta = 0.35$.[9] This positive correlation of returns yields even smaller gains of information gathering, with the value of S for $r^{\min}$ and $J = 2$ falling from 32 to 22 percent. Note, however, that positive correlation between country i and the world fund can bias the results against gathering information on country i because of the implicit assumption that the asset returns of the $J - 1$ countries in the world fund are uncorrelated and hence provide better diversification opportunities. Still, modifying the experiment to introduce correlation of asset returns across countries in the world fund at 0.35 does not alter the results significantly.

We are also interested in exploring how the model behaves when we consider that the global capital market includes a larger number of emerging markets than stable OECD markets. In fact, the growing set of emerging markets is often viewed as a group segmented from OECD markets. Thus, the relevant question might not be whether it is worthwhile to gather information about a single emerging economy in a market with $J - 1$ OECD countries, but whether it is rational to acquire information in a market where most of the $J - 1$ countries are also volatile emerging markets. To simulate this scenario, consider a case in which all countries are identical emerging markets ex ante, with probabilistic parameters set to the averages for the Latin American countries that result from applying the model of Erb, Harvey, and Viskanta (1996) as in the previous cases. The resulting parameterization is as follows: $E(r^I) = 33.12$, $E[\sigma_i^I] = 34.57$, $\sigma_r^I = 49.31$, $\sigma_\sigma^I = 14.04$, $r^* = \rho = 31.21$, and $\sigma_i = \sigma_J = 50.03$. In this case rumors will prevail in a market with at least ten countries if information costs exceed 5 percent, or one-sixth of the ex ante expected portfolio return (which is now 31.2 percent). Information gains still fall very sharply

9. Given the means and variances of asset returns, and the value of γ, higher correlation coefficients would violate the second-order conditions of the optimization problems of informed and uninformed investors.

as the market grows, and the full effect of market growth on S is transmitted with as few as ten countries.

This last case assumed that information gathering yields average updates of the mean and standard deviations of returns equivalent to 1.06 and 0.69 of the corresponding moments computed with historical equity market data. However, figure 1.4 showed that the moments that describe the distributions of updates can vary widely across countries. For instance, in the cases of Argentina, Colombia, the Philippines, Taiwan, and South Africa, information yields sharply lower expected returns than historical equity market statistics, while updates of the standard deviation vary from sharp reductions to moderate increases. In Colombia's case, for example, the average update of the mean return is 0.77 of the equity market forecast, while the standard deviation of returns is virtually the same with or without gathering information. In this case the information gain for a neutral rumor $r = r^*$ is 7 percent if $J = 2$. As J grows to include twenty countries, information gains fall to about 0.5 percent for any rumor $r^{\min} \leq r \leq r^*$. With the ex ante expected portfolio return at 31.2 percent, this implies that investors in a large global market will not pay information costs exceeding 1.6 percent of the ex ante portfolio return. Indonesia's case is quite different, at least over the sample period under study. Information gathered on Indonesia results in sharp upward updates of the mean return, while revisions to the standard deviation remain negligible as in Colombia's case. Since information yields much higher returns than the history of Indonesia's stock market, with about the same standard deviation, S reaches about 18 percent for any rumor $r^{\min} \leq r \leq r^*$ with $J \geq 20$. Thus, investors are willing to pay up more than one-half of the ex ante portfolio return to learn about rumors affecting Indonesia.

It is also important to quantify the international capital flows that may take place in situations in which there is contagion among global investors. To gain an insight on this issue, we simulated the model setting parameters so that the $J - 1$ countries represent stable OECD markets and country i is calibrated to Mexican data using the framework of Erb, Harvey, and Viskanta (1996). The probabilistic parameters are now set as follows: $E(r^I) = 33.12$, $E[\sigma_i^I] = 34.57$, $\sigma_r^I = 49.31$, $\sigma_\sigma^I = 14.04$, $r^* = 22.4$, $\rho = 15.31$, $\sigma_i = 50.03$, and $\sigma_J = 22.44$. In this scenario, the simulations show that if the fixed information cost exceeds 6.5 percent (or about two-fifths of the ex ante mean portfolio return of 15.4 percent), pessimistic rumors about Mexico would prevail. A rumor that reduces the expected return on Mexican equity from the equity market forecast of 22.4 percent to the level of the OECD mean return of 15.3 percent leads to a reduction in the share of the world portfolio invested in Mexico from 1.7 percent to 0.7 percent—a reduction of 40 percent. According to the *Bolsa de Valores de Mexico* (the Mexican stock exchange), direct foreign holdings of Mexican equity exceeded \$50 billion by the end of 1997, and hence a 40 percent cut amounts to \$20 billion,[10] which is a very large amount for a country where foreign reserves rarely exceed that same figure. For rumors that set r below 10 percent, the short-sale restrictions become binding and Mexican equity is eliminated from the portfolio, with a resulting outflow of the full \$50 billion.

1.3.3 Variable Costs and the Contagion Region

The simulation exercises conclude with an analysis of the contagion region created by performance-related variable costs. We maintain the settings of the last example involving Mexico and the OECD. The variable cost function takes the following form: $\lambda = \varphi(\mu(\Theta) - \mu(\theta))$ with $\varphi = 15$ for all $\mu(\Theta) > \mu(\theta)$ and $\varphi = 0$ otherwise.[11] The contagion range shows that, when $J = 2$, the share of portfolio invested in Mexico can fluctuate between 20.2 and 22.5 percent, or about 2.3 percentage points, on account of contagion. With ten OECD countries the range widens by about one-half of a percentage point, with the portfolio share invested in Mexico varying between 3.8 and 6.6 percent.

The total reputational costs avoided by displaying herding behavior or contagion are small. When $J = 20$, and assuming $\Theta = \theta^*$, the maximum reputational cost paid for choosing the largest θ within the contagion range is one-tenth of the mean portfolio return. Thus, contagion can potentially induce large capital flows into and out of emerging markets even in the presence of small total performance-linked costs. The marginal cost, however, is large in the sense that it represents a punishment for poor performance fifteen times the difference between the mean return paid by the market and that paid by the investor's portfolio. Note also that, as shown in section 1.2, the contagion range is increasing in J but does not grow without bound as J rises. The size of the range converges to about 2.8 percentage points as J approaches ∞.

Next we measure the capital flows triggered by reputational effects. Assume that the investors' total wealth corresponds to the holdings of foreign equity by U.S. investors. The latest *Benchmark Survey of U.S. Holdings of Foreign Securities* conducted by the treasury department reports that by end-March 1994 the holdings of foreign equity by U.S. investors amounted to \$566 billion. The model predicts that with $J = 20$ the fraction of U.S. foreign equity invested in Mexico fluctuates between 2.53 and 5.31 percent.[12] Thus, herding panics triggered by reputational effects can

10. The figure on the value of foreign holdings in Mexico's market was quoted in the Mexican newspaper *Reforma,* 15 January 1998, p. 1A, citing as source the Mexican stock exchange.

11. Calvo and Mendoza (2000a) examine the sensitivity of the results to changes in the value of φ and in the other exogenous parameters of the model (η, γ, σ_J, and σ_i). The results show that our findings are generally robust to parameter variations.

12. Interestingly, the treasury's *Survey* estimates the U.S. holdings of Mexican equity at 6.2 percent of the total holdings of foreign equity by U.S. investors.

account for sudden capital flows into and out of Mexico as large as $15.7 billion. If we add foreign investment in bonds, the total foreign security holdings of U.S. investors reach about $870 billion, and thus herding could account for Mexican capital flows of up to $24.2 billion. As noted earlier, in a country where foreign reserves normally amount to less than $20 billion, of which $10 billion are widely regarded as the desirable minimum (see Calvo and Mendoza 1996), these flows can be an important determinant of vulnerability to balance-of-payments crises.

Despite the large capital flows that contagion can produce, it does not appear to embody significant welfare costs. We computed the percentage change in consumption needed for a portfolio within the contagion range to yield the same utility of a portfolio chosen in the conventional mean-variance model without information frictions (i.e., θ^*). These calculations make use of the model's direct utility function: $E - \exp(-\gamma C)$. The welfare costs never exceed 2.5 percent, and for portfolio share variations of 100 basis points around the first-best optimum the costs are actually smaller than one-fourth of a percentage point. Moreover, since $E\hat{U}(\theta)$ and θ^* are invariant to λ, it follows that variations in the marginal reputational cost do not alter this result—although of course lowering the marginal cost narrows the contagion range.

1.4 Concluding Remarks

We used a basic model of international portfolio diversification with incomplete information to show that the globalization of securities markets can reduce incentives for information gathering, and hence produce high volatility in capital flows as a result of contagion. In our model this occurs because globalization generally reduces the gains derived from paying fixed costs for country-specific information or because, in the presence of variable performance-linked or reputational costs, globalization widens the contagion range of portfolios within which investors find it optimal to mimic arbitrary market portfolios.

The notion that a fixed information cost may be of practical relevance, given the large amount of investment resources in the hands of securities firms, seems controversial. While it is quite reasonable to argue that fixed costs are less relevant for these firms, it is important to note two related issues that are particularly complex in an international context. First, the cost of learning about the macroeconomic features of a country is not very different regardless of the size of the country and the amount of the investment involved. Hence, information gathering in an international setting is relatively costly. Second, the possibility that fixed costs can be easily overcome by clusters of investors setting up securities firms in which other investors could invest can be a source for further complications, rather than a solution. For instance, as Calvo and Mendoza (2000b) show, market volatility can be exacerbated by the interaction of a cluster of "sophisticated" (i.e., informed) traders with a group of uninformed investors in the face of systemic shocks forcing sophisticated traders to sell their assets, assuming that traders face binding borrowing constraints.

Contagion resulting from variable performance costs, or reputational considerations, can be challenged on the premise that securities firms would not be maximizing the payoff to their investors if they implemented incentive schemes like the one we studied, which yield inefficient, contagion-driven outcomes. While we lack specific evidence on incentive structures to determine if they resemble the one we assumed, the survey evidence documented by Shiller and Pound (1986, 1987) indicates that reputational concerns, the "fear of being different," and contagion by word of mouth seem to play an important role. Moreover, in some instances the perverse incentive structure may be the result of government regulation. In Chile, for example, individual private pension funds are required by government regulation to produce returns within a certain range of the average return for all pension funds. Thus, the regulation sets a cost for producing below-market returns and no gain for producing above-market returns, which is the main feature of the incentive structure leading to contagion in the model we studied.

In light of our findings, it is natural to raise the question of whether globalization is necessarily welfare improving, and to suggest that the pros and cons of abolishing capital controls may deserve further consideration. Our results do not challenge classic notions related to the efficiency gains derived from global market integration in a frictionless environment, although evidence indicates that these gains, at least from the perspective of risk sharing and consumption smoothing, could be small (see Mendoza 1991 and Tesar 1995). However, this paper does suggest that in the presence of severe information frictions, capital flows can be extremely volatile and optimal portfolios are generally Pareto-inefficient.

The inefficiencies seemed small when we computed the corresponding welfare costs in a basic model in which all agents are global investors; but it is easy to imagine situations in which these costs can be substantial, as the recent experiences of Mexico, Argentina, Russia, and several East Asian countries indicate. One example is the case of a typical developing country that depends on capital inflows to finance imports of consumer and capital goods, and uses the latter as inputs to produce tradable and nontradable goods. There could be two types of agents in this economy: "workers," who derive income only from labor services and cannot access global capital markets to insure themselves against income fluctuations induced by capital flows; and "global investors," with their wealth and income globally diversified. Contagion in this environment could be devastating for "workers," particularly those that produce nontraded goods, and to the extent that "investors" enjoy nontradables consumption, their welfare could also suffer. Heterogeneity in this setting would play a key role, since it is well known that welfare costs of country-specific risk implied by limited world asset trading in pure consumption-smoothing models are trivial (see Mendoza 1991), unless there is a channel linking volatility and growth (as in Obstfeld 1994 and Mendoza 1997).

Increased global market volatility can also induce large social costs if it serves as a vehicle that enhances distortions leading to self-fulfilling crises. For example, if, as in Calvo (1998), there are situations in which the ability of a government to roll over its debt is compromised by a sudden run on its securities in global markets, agents may expect that current fiscal adjustment may need to be so large in order to pay for maturing debt that it will cripple the economy and affect adversely future government revenues. The latter could justify the expectation that the government will default, making the beliefs about default self-fulfilling.

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Comment Rudiger Dornbusch

Calvo and Mendoza's paper is an enviable piece of research in being both topical and thoroughly elegant. The theory is state of the art, the execution is flawless. Here is a theory of speculative attacks caused by masses of investors who find it far more profitable to run away than to ascertain whether the rumors are true: "Don't ask questions, run" is the bottom line and this follows rigorously from the model. It is an uncomfortable conclusion but not altogether an implausible one, since the world does appear to warmly welcome emerging market assets one day and then, on sheer rumor, desert those assets at the drop of a hat.

Fortunately for world capital markets, Calvo and Mendoza's conclusions are far less threatening than they might appear at first sight. While the conclusions do follow rigorously from their assumptions, the authors omit a key aspect of this world—financial intermediaries. Calvo and Mendoza envisage a continuum of "unit-size" investors who face fixed costs of

Rudiger Dornbusch is the Ford Professor of Economics and International Management at the Massachusetts Institute of Technology.