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# The Co-movement of Asset Returns and the Micro-Macro Focus of Prudential Oversight

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## Abstract

The integration of micro-prudential oversight with the macro-approach to financial stability—long in the making—raises several issues of coordination of regulatory responsibilities. This paper argues that a decomposition of the covariance of asset returns into an endogenous volatility component—which can be reduced —and an exogenous volatility component – which we have to live with—helps address these coordination issues and provides the basis for financial health diagnostics and supervisory responses to observed symptoms of financial instability. By linking *risk origination* and *risk control,* the paper may also contribute to the search for an operational definition of the term "macro-prudential."


This paper—a product of the Office of the Executive Director for Albania, Greece, Italy, Malta, Portugal, San Marino and Timor-Leste—is part of a larger effort to contribute to the current financial regulatory debate. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted through mlardner@worldbank.org.

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"*The absence of a new economic philosophy that integrates economics and finance has been a great failing.*" Henry Kaufman[2]

"*During normal times prices can be trusted to reflect the "wisdom of the crowds." During times of distress, investors react instinctively and emotionally: the wisdom of crowds becomes the "madness of mobs.*" Andrew W. Lo[3]

## 1. Introduction

A series of insightful papers by Crockett (2000) and Borio (2003) in the aftermath of the East Asian crisis reached the important conclusion that the conditions for financial systems' stability do not necessarily coincide with those for individual financial institutions' stability. Quite the contrary, the pursuit of the latter often generates destabilizing externalities on the system as a whole. They dubbed micro-prudential the traditional focus on individual intermediaries – prone to the fallacy of composition – and macro-prudential the complementary approach – able to combine the stability of individual institutions with a systemic perspective. An integration of the two approaches – a marriage – was strongly recommended.

Yet, the decade separating the East Asian from the Subprime crisis has been dominated more by the traditional micro-prudential approach, embedded in the Basel II capital accord, than by the development of a new macro-prudential mindset, let alone an integration of the two. Only the effects of the dramatic financial crisis of 2007 and its legacy of lingering financial instability has brought macro-prudential supervision and surveillance to the center of the academic and policy debate and led to the establishment of macro-prudential oversight units within financial supervisory authorities worldwide (Banca d'Italia, 2009; Bank of England, 2009).

The question is then: Why did it take so long for the micro and the macro-prudential dimensions of financial stability to come together? Why does the marriage – so clearly announced more than 10 years ago – take place only now? I argue that the delay largely

[2] Financial Times, June 1, 2010.
[3] Financial Times, October 1, 2009.

owes to different cultures and paradigms. The different paradigms in this case are partial and the general equilibrium, respectively, for the micro and macro-prudential approaches.

Such a consideration is not new but perhaps deserves further consideration. In fact, general and partial equilibrium models of asset pricing provide different explanations and testable implications of financial volatility. Should these determinants be found to be complementary, a similar conclusion would – most likely – apply to their normative implications.

This paper addresses two questions. First, can different notions of equilibrium help define diagnostics and remedies of observed financial instability? Second, are the views and remedies of the two – conceptual and regulatory – approaches mutually consistent, and can they be integrated or, instead, are they mutually exclusive?

Since at an aggregate portfolio level total volatility is predominantly shaped by the co-movement of individual assets (covariance terms dominate variance terms), I focus on the covariance of asset returns highlighting their different specifications in partial and general equilibrium and their regulatory implications. The analysis suggests that the observed instability of asset returns can be decomposed into elements that are largely complementary and therefore call for complementary oversight approaches. If the paper is convincing, it will offer an insight – if not a complete story – of how the micro and macro approaches can come together in a consistent story of risk origination and control. The results are related to and consistent with previous studies that have looked into the regulatory implications of asset price co-movements (Adrian and Brunnermeier, 2009).

The paper begins with a brief review of the determinant of risk (i.e., volatility) in the partial and general equilibrium approaches (Section 2) and shows how this leads to different characterizations of asset returns and their covariance (Section 3). It then describes how the two equilibrium concepts offer different rationales for the co-movement of returns, leading to a covariance decomposition along the main sources of financial volatility (Section 4). Section 5 draws on well known empirical evidence to support the proposed notion of covariance decomposition. Section 6 concludes, providing a guide to the selection of the appropriate remedy: whether from the panoply of micro or macro regulatory and supervisory tools.

## 2. Financial risk and returns: Two different mindsets

Borio (2003) pointed to the existence of two complementary – but not yet integrated – ways of looking at financial stability. The first, the micro-prudential approach, deals with risk from the perspective of standard financial asset pricing and treats individual intermediaries as part of a broader portfolio, represented by the whole financial system. The effects of financial risk in this approach are contained within the financial system. The second approach, referred to as macro-prudential, looks instead at risk from the perspective of dynamic macro-financial models and therefore in terms of macroeconomic volatility induced by cyclical factors or by multiple equilibriums associated with imperfect information and incomplete markets. The consequences of financial risk in this approach go beyond the financial system and extend to the real economy. The way both risk and its consequences are conceptualized reveals a partial equilibrium ascendance in the case of the micro approach and a general equilibrium one in the case of the macro approach.

*Financial risk from the partial equilibrium perspective*

The partial equilibrium ascendance may not be obvious in the case of the micro approach because asset pricing is part of the construct of modern finance and therefore fits into a general equilibrium framework. However, taking a closer look, it becomes apparent that asset pricing is largely carved from underlying individuals' preferences and endowments and, as a result of finance separation theorems, financial decisions remain independent of individuals' risk aversion and endowments.

The notion that individual risk preferences do not affect the composition of the efficient portfolio goes back to Tobin and justifies the separation of financial from economic decisions. Separation theorems have become a milestone of modern finance and their impact on current practices of risk management and control has been pervasive. Ross (1976) explicitly referred to this point when he noted that: "Modern financial theory derives much of its analytic power from a few strong assumptions it imposes on models it develops. Without such assumptions the special problems of the financial theorist …would be as intractable and empirically empty in finance as they are in *general* *equilibrium theory*. Perhaps the most successful of the theoretical assumptions employed has been that of separability" (italics added).

The efficient market hypothesis and its separation corollary have "de facto" created the condition for a partial equilibrium analysis of financial markets. In a figurative sense, it could be said that financial economists "outsourced" the general equilibrium perspective – and its focus on the interaction of demand and supply forces. They have adopted a partial equilibrium perspective, focusing their attention on the arbitrage forces that map the equilibrium remuneration of a small number of risk factors into the myriad of observed financial asset prices.[4] As mentioned, general equilibrium considerations remain relevant but largely outside the scope of enquiry of modern finance. Ross said on this matter that, "the forces of demand and supply have no meaning [for finance], since if the price is not the equilibrium price, then the difference between supply and demand is infinite" (Ross, 1987). Perhaps the most notable exception to this approach, in the field of finance, is represented by the consumption CAPM (CCAPM) of Campbell and Cochrane (1995), in which an explicitly link is made between asset pricing and consumer preferences.

As a consequence of its partial equilibrium stance prevailing in finance, the two elements that concur in the determination of asset returns, the quantity of risk and its price, can be seen as exogenous. More precisely, the quantity of systemic risk – e.g., the size of shocks to aggregate wealth – is considered exogenous because it is generated exclusively by shocks of natural or technological origin. The equilibrium price of risk – the "market return" or remuneration of any other risk factor – is instead considered exogenous in the special sense that originates outside financial markets as a result of the interaction of demand and supply in the "real" side of the economy.

The broad exogeneity of risk implies that financial risk is something to cope with but whose outbursts are beyond regulators' responsibility and represent, in fact, acts of God. In other words, solvency ratios and Value at Risk (VaR) will buy stability up to a selected

[4] Ross paraphrased Samuelson's aphorism that for a parrot to become "a learned political economist, all he must learn are two words: supply and demand," suggesting that for the same parrot to become a learned financial economist only one word was needed: "arbitrage." Summers (1985) famously mocked this notion, dubbing finance "Ketchup Economics."

probability level of crisis occurrence, but will not affect the probability of occurrence of the crisis itself. Regulation and supervision, in fact, do not affect the distribution of asset returns. Even in those cases where regulation and supervision are entrusted with removing market imperfections financial risk remains largely a fact of nature – not a fruit of human actions – providing a strong justification for self-regulation as a tool of effective supervision.

*Financial risk from the general equilibrium perspective*

The alternative framework that stands today behind the macro regulatory approach has been moving away from the finance perspective. This shift began in the 1970s, when Cass and Stiglitz (1970) emphasized the restrictive nature of the functional assumptions on which finance separation theorems rested. Other tenets of finance that have come under fire over time are the no-arbitrage assumption and the convexity of the investment set. Grossman and Stiglitz (1980) found the presence of positive arbitrage margins to be the very condition for market existence. Greenwald and Stiglitz (1986) pointed to the significant non-convexities that real world investment policies face as a result of imperfect information and incomplete markets. On empirical grounds, Shiller (1981) – and large number of empirical studies following his seminal contribution – showed that observed stock market volatility is not explained by the expectation of subsequent dividends.

However, it was only in the 1990s that the imperfect information paradigm generated a rich literature on the impact of financial intermediation on economic activity. This literature succeeded in presenting financial risk as the endogenous outcome of a general equilibrium framework. Kiotaky and Moore (1997)and Bernanke, Gertler, and Gilchrist (1999) helped establish the link between the dynamics of asset prices and output and the role played by real and financial assets as collateral in lending operations. The imperfect information also paradigm underlies the classic Diamond and Dybvig (1983) model of banking crises and its multiple equilibria characterization of bank runs. What is common to both models of economic cycles and banking crises is the fact that systemic non-diversifiable risk may be generated by the behavior of economic agents and can therefore be endogenous.[5] This notably brings financial instability – both cyclical instability and full-fledged financial crises – under the responsibility of financial authorities, suggesting that countervailing actions are within the reach of policy makers. Yet, for all their flexibility, general equilibrium models are cumbersome constructions with large strings of parameters that prevent them from becoming a reliable operational guide to asset trading and risk management. As a result, imperfect information – now a standard feature of micro and macroeconomic analysis – never made significant inroads into financial asset pricing.

A noteworthy exception to these trends is represented by the "endogenous risk in finance" approach spearheaded by Shin (2008), which brings the general equilibrium mindset to the derivation of asset prices. Supporters of this approach observe that idiosyncratic shocks at times grow out of proportion and that the resulting noise magnification may reach systemic relevance, as in the case of banking and financial crises. They share with the macro-financial approach the observation that feedback mechanisms, built into existing regulations or balance sheet constraints, tend to magnify (accelerate) exogenous shocks that would have otherwise limited economic impact. They share with the micro approach the focus on the determinants of asset returns.

The distinguishing feature of the macro-prudential literature is represented by the rejection of a self-contained financial reality and the acknowledgment that financial systems may affect the risk profile of the whole economy. According to the macro-financial approach, crisis episodes are "process generated events." They are associated with distributions of returns that move over time and whose parameters are the solution of a market equilibrium problem. In other words, financial instability is not the result of unfortunate realizations of occurrences located far away in the tail of the distribution but of the realization of different return (and risk) distributions over time and across countries. The resulting responsibility of financial supervisors in control of the financial intermediation activity is largely expanded.

[5] Haldane (2010) reaches a similar conclusion: "Tail risk within some systems is determined by God, in economist-speak, it is exogenous … Tail risk within financial systems is not determined by God but by man; it is not exogenous but endogenous."

## 3. Asset returns and their covariance in the two approaches

The link between the partial and general-equilibrium approaches and their regulatory projections – the micro and macro – and a specific characterization of financial risk is reflected by key risk parameters such as the covariance and correlation of asset returns. This section compares returns and their covariance in the conceptual and regulatory perspectives described so far, moving from simple to complex. It looks at returns in a micro-prudential world and in a macro-prudential world where endogenous risk is caused by idiosyncratic shocks or systemic shocks.

*The micro approach*

A traditional risk factor specification of an asset return would take the form of Equation 1, in which returns are a function of the vector of risk factor loadings β and risk premiums, x. If the risk factor is unique and approximated by the "market" excess return over the riskless rate, then equation 1 reduces to the CAPM.

1) $$r_{i,t} = \alpha_i + \beta_i x_t + \varepsilon_{i.t} \quad where \quad \varepsilon_{i.t}\ N.I.D.(0,1)$$
$$and \quad x_t\ N.I.D.(\bar{x}, \sigma_m^2)$$

The covariance of financial returns depends uniquely on the systemic component ($\sigma_m$) due to the i.i.d. assumption of the random variable ($\varepsilon_{i,t}$).

2) $$Cov_{ij,t}(r_i, r_j) = \beta_i \beta_j \sigma_m^2$$

Equation 2 shows that asset returns move together only if they are exposed to common risk factors. This reflects the notion described in the previous section that risk is exogenous and that financial regulators cannot do much apart from enforcing a predefined level of self-insurance on the part of supervised intermediaries.

*The macro approach with endogenous transmission of idiosyncratic risk*

In a macro-financial approach asset returns are still a function of the relevant risk factors – presumably a set of macroeconomic variables – and their factor loadings but their volatility term is more complex. Equation 3 translates in discrete time the return equation derived by Danielsson et al. (2009) from a structural model of liquidity demand and supply. The authors characterize the volatility term as the result of two additive components: an idiosyncratic component ($\sigma_i$), as in equation 2, and an additional term accounting for the effects of idiosyncratic shocks on other assets that are transmitted via a correlation matrix ($P_{i,j}$) whose off-diagonal elements differ from zero, reflecting existing budget or liquidity constraints.

3) $$r_{i,t} = \alpha_i + \beta_i x_t + \varepsilon_{i.t} \quad where \quad \varepsilon_{i.t}\ N.D.(0, \textstyle\sum_j \sigma_{\varepsilon,i}\sigma_{\varepsilon,j}\rho_{i,j})$$

$$and \quad x_t\ N.I.D.(\bar{x},\ \sigma_m^2)$$

The covariance of asset returns is now affected by the presence of a new source of return correlation ($\rho_{i,j}$) that is independent and additional to the common risk factor:

4) $$Cov_{ij,t}(r_i, r_j) = \beta_i \beta_j \sigma_m^2 + \rho_{i,j}\sigma_i\sigma_j$$

The additional cross-correlation term reflects the price effect of "fire-sales" triggered, for example, by sudden capital alignment with required VaR levels (Danielsson et al., 2009) or by margin calls (Adrian and Shin, 2009).

Feedback rules violate the traditional i.i.d. assumption of residuals in the asset pricing equations: idiosyncratic shocks are no longer uncorrelated across assets and spillovers affect the covariance matrix. As a result, the covariance of returns in the macro-financial approach depends on the volatility of the underlying risk factors ($\sigma_m^2$) as in equation 2 and on feedback rules ($\rho_{i,j}\sigma_i\sigma_j$). The sources of systemic risk are now both exogenous ($\beta_i\beta_j\sigma_m^2$) and endogenous ($\rho_{i,j}\sigma_i\sigma_j$), and financial regulators' responsibilities have greater latitude. In addition to enforcing a predefined level of self-insurance (solvency ratios) – as in the micro-partial equilibrium case – they now have to offset endogenously created volatility. This description of asset returns largely reflects the price dynamics described by the Brady Commission on the 1987 stock market crash, where a myriad of parallel hedging transactions enacted by institutional investors in a seemingly uncoordinated fashion were in fact coordinated by the use of similar trading models.

*The macro approach with endogenous transmission of exogenous shocks*

Borio (2003) and Brunnermeier and Sannikov (2010) observe that not only idiosyncratic but also systemic shocks are magnified by the existence of feedback rules. For example, a positive productivity shock will negatively affect the returns of existing capital assets, inducing losses for those financial intermediaries that have invested in the now obsolete assets. Portfolio “fire sales” by intermediaries that have fallen below their solvency ratios will generate additional negative pressure on prices and returns that further reinforce the negative price spiral. If the same balance sheet and liquidity constraints are triggered by both idiosyncratic and systemic shocks (i.e., the same correlation matrix applies to idiosyncratic and systemic shocks), then the return equation becomes:

5) $$r_{i,t} = \alpha_i + \beta_i x_t + \varepsilon_{i.t} \qquad where \qquad \varepsilon_{i.t}\ N.D.(0, \textstyle\sum_j \sigma_{\varepsilon,i}\sigma_{\varepsilon,j}\rho_{i,j})$$

$$x_t = \bar{x} + \eta_t + \omega_t \qquad and \qquad \omega_t\ N.I.D.(0,\ \sigma_m^2)$$

$$\eta_{i.t}\ N.D.(0, \textstyle\sum_j \sigma_{\eta,i}\sigma_{\eta,j}\rho_{i,j})$$

The covariance of asset returns described in equation 5 can be decomposed into three elements: one related to the idiosyncratic component and two related to systemic risk factors.

6) $$Cov_t(r_i, r_j) = \beta_i\beta_j\sigma_m^2 + \beta_i\beta_j\sigma_{\eta,i}\sigma_{\eta,j}\rho_{i,j} + \sigma_{\varepsilon,i}\sigma_{\varepsilon,j}\rho_{i,j}$$

It is interesting to observe that the new cross-correlation element related to systemic shocks is generated by feedback mechanisms associated with the existence of system-wide constraints that magnify the impact of systemic shocks, such as predefined loan-to-value ratios (Fisher, 1933) or loan-to-net worth ratios (Bernanke et al., 1999).Equation 6 shows that in the absence of feedback effects (i.e., for $\rho_{i,j}$=0), the covariance of asset returns reverts to the specification of equation 2. Asset volatility in the partial equilibrium-micro-prudential approach appears to be a special case of the general equilibrium-macro prudential framework. The recent literature on endogenous risk seems therefore to suggest that the macro-approach should not be seen as an alternative view of risk and stability but as an inclusive framework. It is well suited to provide the integrated approach to financial regulation and supervision that is needed to jointly address the concerns of the macro and micro-prudential approach.

The two expressions for the covariance in equations 2 and 6 are mindful, when aggregated at the system level, of the notions of VaR and CoVaR discussed in Adrian and Brunnermeier (2009). Equation 2 corresponds to their unconditional VaR measure; equation 6 to their CoVaR measure, conditional on some level of distress being transmitted throughout the system. Finally, the difference between equations 6 and 2 – given by the last two terms of equation 6 – largely resembles their ΔCoVaR measure, since it captures the externalities that individual asset volatilities would fail to capture.

## 4. Volatility, correlation, and market health

The fact that asset returns under the micro approach may represent a special case of the specification under the macro approach is helpful on two counts. First, it implies that the specifications of the covariance of asset returns provided by the two approaches may shed light on the nature of the observed volatility: whether it is of the "unavoidable" (i.e., nature driven or exogenous) variety[6] or the "problematic" (i.e., manmade and endogenous) variety. Second, it provides the rationale for the construction of a whole family of empirical indicators that may guide regulators and supervisors in the selection of the appropriate policy response to observed volatility of returns. Equations 2 and 6 suggest the following covariance decomposition, where the observed covariance of asset returns is the result of an exogenous risk component, fully accounted for by the micro-prudential approach, and a residual that reflects the endogenous risk components.

7) Observed covariance = Exogenous Covariance + Endogenous Covariance

When aggregated over total assets at the system level, equation 7 largely coincides with system total volatility due to the fact that both the variance terms and the i.i.d. idiosyncratic shocks tend to zero over large portfolios. The ratio of exogenous covariance over observed covariance provides a signal of the state of the health of the financial system at the level of a specific couple of assets or, if aggregated across all assets in the economy, at the level of the system as a whole. Accordingly, the proposed indicator is labeled the Indicator of Market Health (*IMH*) [7]:

[6] Given this paper's focus on supervisory responsibilities, the notion of "unavoidable" volatility refers to the volatility that is beyond the influence of financial supervisors and regulators such as macroeconomic volatility not induced by financial factors. This broader – non financially induced - macroeconomic volatility which is exogenous for financial authorities may still be affected by macroeconomic policy

[7] The ratio is analogous to that used by Mitchell and Stafford (1999) to correct for cross-correlation bias in the t test for firms' specific effect. They build a ratio of (average) variance under independence over (average) total variance to remove the inference bias that weakens tests of market efficiency; I look at the ratio of independent over total covariance as an indicator of endogenous risk presence.

8) $$IMH_{i,j;t} = \frac{Cov_{i,j;t}^{micro}}{Cov_{i,j;t}^{observed}} = \frac{\widehat{\beta_\iota}\widehat{\beta_J}\sigma_{m;t}^2}{Cov_{i,j;t}^{observed}}$$

Values of the *IMH* close to one and stable would point to good health. Low or decreasing values of the *IMH* would, instead, signal problems and call for action. The analogy between health and stability is reinforced by the similar role played by covariance in financial systems and by cholesterol in human health. Both covariance and cholesterol are necessary ingredients in their own systems; they both come in beneficial an damaging forms and the health of their respective systems depends on the share of the damaging component; they both can be controlled by means of preventive discipline; and if left unchecked, both can be fatal. The question remains whether an empirical test can be devised that is as simple and reliable as that for cholesterol.

Although this paper's focus is deliberately not empirical, the last term in equation 8 points to possible estimation strategies of the proposed indicator. There is a growing flow of empirical evidence that appears broadly consistent with the proposed approach, such as the measurement proposed by Adrian and Brunnermeier (2009) of the unconditional VaR (related to the exogenous covariance term) and ΔCoVaR (related to the endogenous covariance term). A promising line of empirical verification may be offered by partitioning historical data into periods closer to equilibrium – where estimation of the betas could be undertaken – and periods where instead the presence of endogenous risk would violate standard regularity assumptions. The identification of suitable sample periods or appropriate controls for estimation of the betas' $(\widehat{\beta_\iota}, \widehat{\beta_J})$ makes it possible to derive a proxy of return covariance in absence of endogenous risk $(Cov_{i,j;t}^{micro.})$. Aggregating bilateral indicators for the whole market along the lines suggested by Engle (2009) or through a simple portfolio aggregation would provide a comprehensive indicator of market health.

The results on asset covariance can immediately be transposed to asset correlation, a key parameter for policy decisions. This would hopefully facilitate drawing policy conclusions from the analysis, a task that is discussed in the last section of the paper. In fact, the covariance decomposition between exogenous and endogenous components closely matches that of the correlation coefficients. In particular, the ratio of exogenous correlation (i.e., conditional on independent idiosyncratic terms) to total correlation depends on the *IMH* and a scale factor (*SF*), as illustrated in greater detail in Annex 1.

$$9) \qquad \frac{\rho_{i,j;t}^{indep.}}{\rho_{i,j;t}^{total}} = \frac{Cov_{i,j;t}^{indep.}}{Cov_{i,j;t}^{total}} * SF_t = IMH_{i,j;t} * SF_t$$

Equation 9 shows that, within a factor of proportionality, the ratio of correlation coefficients follows the *IMH*, suggesting that what works for the latter works for the first and that the *IMH* may help understand what factors affect the movements of observed asset price correlation over time.

The *IMH* offers a criterion to distinguish "micro" from "macro" supervisors' responsibilities that may be judged far from satisfactory in that it identifies "macro" responsibilities with the unexplained portion of asset return variance. However, this is a feature that the endogenous component of volatility shares with other variables at the center of policymakers' attention, such as total factor productivity (TFP), which has often been called a "measure of our ignorance."

It is to be expected, almost by definition, that market based measures of externalities are bound to remain largely imprecise. However – as highlighted by the examples described in the next section – prices do reflect the presence of externalities. They do not price the externality itself but they do reflect the effect externalities have on equilibrium prices. In other words, incomplete markets, while an obstacle to timely and focused risk pricing, do not preclude signals of tensions – spillovers – from surfacing in the economy.

The indicator is meant to intercept spillovers induced volatility and separate it from "non spillover" generated volatility. As such, it offers a "first aid kit" that leaves to the skilled supervisor the difficult task of relating observed symptoms to appropriate diagnostics. And, as documented by Adrian and Brunnermeier (2009), endogenous risk can be econometrically related to a set of observable variables and forecasted. Finally, regularities that apply to market traded assets may generate informed judgments for assets that are not traded, suggesting that the relevance of the *IMH* may extend well beyond the sphere of marked-to-market assets and listed institutions.

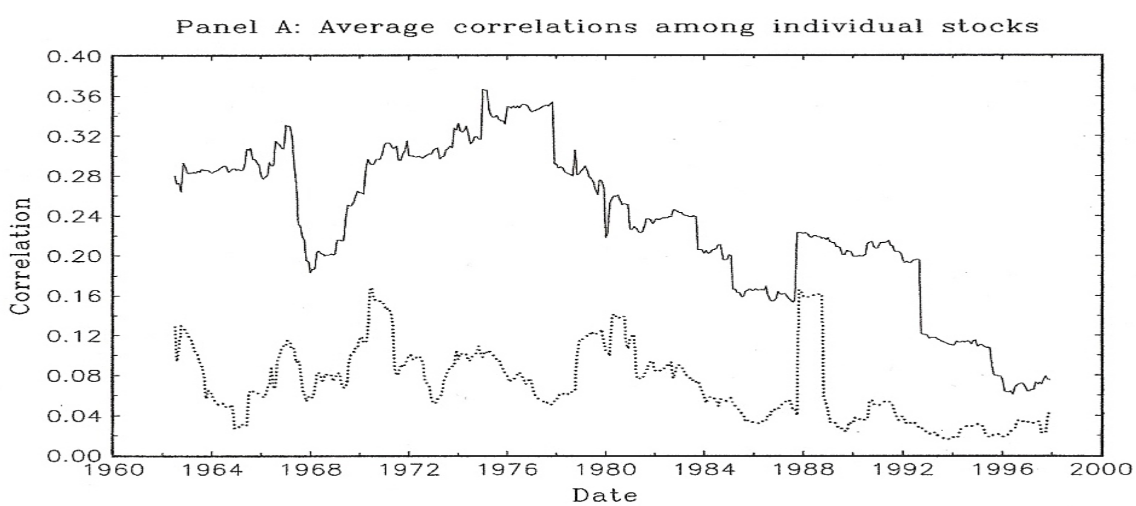
## 5. Empirical evidence of endogenous risk

The usefulness of the proposed correlation decomposition for policy purposes is better illustrated with reference to some empirical evidence. To this end, I shall describe how the *IMH* would behave in a few selected and well known episodes where correlation is affected by endogenous and exogenous risk. The first set of evidence illustrates time series of correlation coefficients exposed to idiosyncratic shocks with and without endogenous transmission mechanisms at play. The second set of evidence shows the different correlation between large positive and large negative returns reflecting, again, the asymmetric presence of endogenous transmission mechanisms.

*Independent versus correlated idiosyncratic shocks*

The empirical evidence provided by several recent studies[8] shows that idiosyncratic volatility ($\sigma_{\varepsilon,i}$) has been growing in size with respect to factor induced volatility ( $\beta_i \sigma_m$ ) since the 1960s, weakening the average cross-correlation among U.S. stock returns. The trend is illustrated by Figure 1, taken from Campbell et al. (2001), which shows the declining average total correlation among U.S. stocks measured over a 5-year period (upper line) and 1-year period (lower line). The trend is abruptly interrupted in October 1987 as a result of the previously described spike in the endogenous component of idiosyncratic volatility.

Figure 1



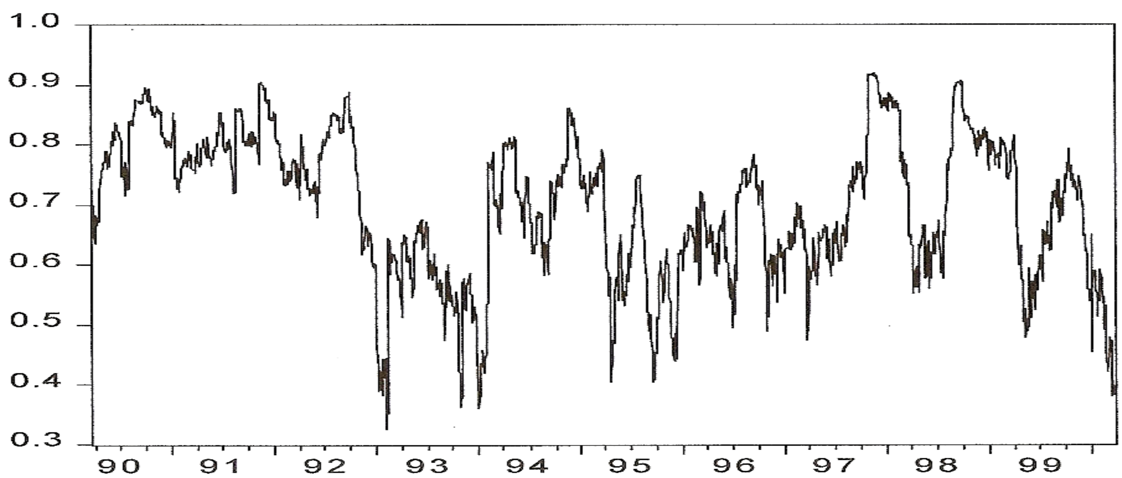

Source: Campbell et al. (2003).

[8] Campbell et al. (2001, 2003).

As expected, correlation fell over the decades as the independently distributed idiosyncratic error ($\sigma_{\varepsilon,i}$) grew in size, but it increased when the cross-correlated idiosyncratic error ($\sigma_{\varphi,i}$) peaked in 1987. The *IMH* would not have recorded the growth of uncorrelated idiosyncratic risk over the 40-year sample but would have fallen in October 1987 as a result of the stock market crash.

Further evidence of the presence of endogenous risk is also provided by the remarkable instability of the correlation of two stock market indexes – Dow Jones and NASDAQ – when both indices should be free, by construction, from the effect of i.i.d. shocks and should record only shocks related to the exogenous risk factor.

Figure 2 Ten Years of DJ-NASDAQ Correlations



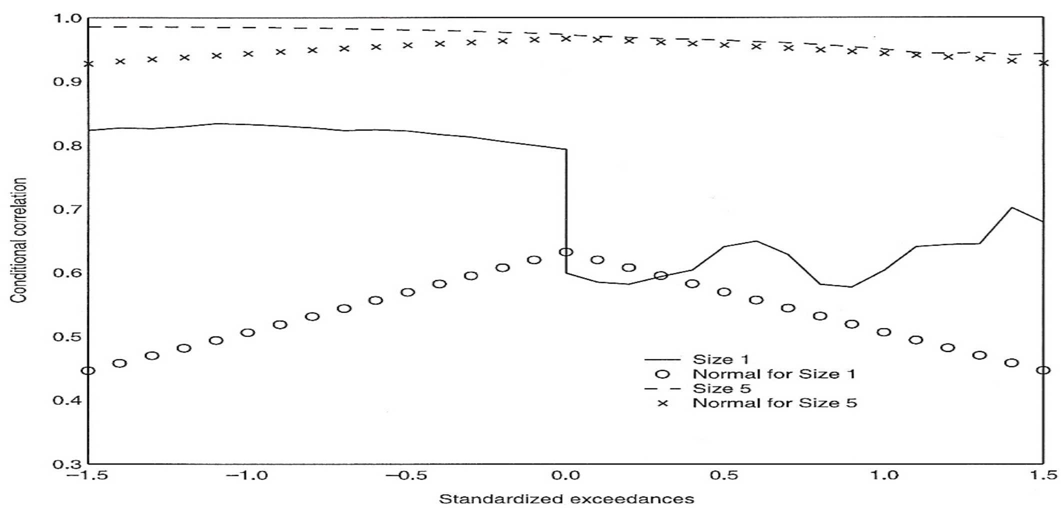

Source: Engle (2002).

Figure 2, taken from Engle (2002), shows that the correlation of the two stock market indexes has historically displayed oscillations at a much higher frequency than would be justified by the simple difference of factor loadings. This implies that some endogenous mechanism of transmission of idiosyncratic or systemic risk has most likely been at play.

*Cross-correlated negative versus independent positive idiosyncratic shocks*

Empirical evidence also shows that the correlation of large shocks is higher when they are negative and it is not volatility per se that affects correlations but "downside" volatility. "Upside" volatility, on the contrary, does not appear to affect the correlations. This pattern is counterintuitive because volatility patterns should be symmetric and correlation values should decrease (not increase as observed) when errors grow in size, leaving very large errors totally uncorrelated. Nevertheless, Longin and Solnik (2001) find that U.S. and European stock market returns are instead characterized by i) higher than expected correlation of large (low frequency) return variations, and ii) departure from normality that is fully attributable to "extreme negative" returns. This evidence may be due to an omitted factor affecting negative returns but, most likely, cross-correlation of returns is caused by feedback rules, triggered by negative surprises.

Figure 3. U.S. Large and Small Stock Correlation versus a Multivariate Normal




Source: Ang and Chen (2002).

Figure 3, taken from Ang and Chen (2002), supports Longin and Solnik's findings and is suggestive of how feedback rules may be triggered by downside returns. The chart plots the observed pattern of return correlations for large traded U.S. stocks and for small traded U.S. stocks together with their theoretical multivariate normal distribution. The asymmetry of correlation patterns is confirmed. For both large and small size stocks, the deviation from the theoretical pattern is considerably larger for negative (left side of the chart) than for positive (right side) returns. The chart also shows that deviations are much larger for small stocks (lower part of the chart) than for large stocks (upper part), supporting a link between the asymmetry of observed correlations and the degree of market liquidity, which is notably much higher for large than for small stocks. Typically the *IMH* would have shown higher values for large stocks than for small stocks, pointing to the higher likelihood that the prices of small stocks may deviate from fundamentals, due to market structure induced frictions.

The two examples provide a flavor of the role that risk of the endogenous variety may have played in the observed correlation patterns, how the *IMH* would have behaved, and the messages it could have conveyed to policy makers.

## 6. Regulatory implications

The covariance (and correlation) decomposition described in previous sections may help in the diagnosis of the causes of financial instability and selection of the appropriate remedies for the observed symptoms. To make this point clearer, this section considers the two market conditions of normality ($|\rho| \ll 1$) and distress ($|\rho| \cong 1$). It illustrates in both cases the policy implications of total volatility dominated by "unavoidable" volatility (IMH$\cong$ 1) and "problematic" volatility (IMH$\cong$ 0). The four cases span a broad set of policy issues.

*Market normality*

The first case is market normality when the absolute value of observed correlation coefficients is dispersed between zero and one. In this case, financial regulators and supervisors may view their actions as redundant and consider it appropriate to delegate oversight to self-regulatory discipline on the part of market players.

Is this approach justified? If the *IMH* values are stable and close to one, the answer is yes and a minimalist approach to regulation and supervision would be supported by the data. An *IMH* value close to one would signal that observed volatility is predominantly of the "unavoidable" (exogenous) variety and self-insurance provides an effective remedy. More generally, the combination of a low correlation coefficient and a high *IMH* suggests low levels of manmade volatility and a preference for rules over discretion as a tool to keep manmade distortions to a minimum in an environment that is still largely unaffected by them.

If, instead, the *IMH* values are low or decreasing, an alarm bell would ring even if observed correlation levels were (observationally) similar to the previous case and apparently close to normality. In this latter case, in fact, observed volatility would be largely – or increasingly – of the manmade variety. This would signal that, despite the appearance of normality, markets would perform their diversification function well below potential, possibly due to endogenous volatility caused by feedback rules. The wide correlation swings observed in the two stock market indexes in the previous section suggest, for example, the presence of liquidity constraints also in normal times, which, if addressed, would further stabilize and reduce observed correlations.

Moreover, the ability to detect manmade volatility in a timely manner is key to remove its causes or offset its effects. Ad hoc interventions may be required to deactivate/offset the feedback rules. Examples include measures as diverse as temporary capital controls to rein in liquidity tensions (the Republic of Korea has successfully adopted targeted capital controls recently), anti-cyclical use of bank reserves (spearheaded by Spain and Colombia), and gradual implementation of tighter bank solvency ratios to avoid destabilizing effects on economic activity (Basel III). Low levels of correlation and a low or falling IMH point to situations where volatility is not threatening financial stability but is largely of manmade origin. In this environment, which is likely to characterize the large majority of cases, ad-hoc regulatory interventions are likely to be needed and a good deal of discretion may be needed.

*Market distress*

The case of market distress may be characterized rapidly growing correlation of returns. Here the case for public intervention seems rather uncontroversial. When markets have become one sided and market activity has come to a halt, regulators must surrogate the market on a temporary base. The question is therefore not whether public intervention is needed but what form of intervention is likely to be most effective and whether the IMH provides additional help in the selection of appropriate crisis management tools. The answer – albeit a tentative one – is that the *IMH* helps distinguish between different forms of intervention: the provision of insurance and the provision of liquidity. For example, a very high IMH would signal that, given the largely exogenous nature of observed volatility, solutions to the crisis must be found outside the financial system. In such an environment, the protection of financial intermediation would not be insured purely by liquidity support but would need to extend to the provision of capital and insurance injections (Caballero, 2010). The rationale for public intervention would be the classic Arrow and Lind (1970) argument, based on governments' "unparalleled risk spreading capacity" across taxpayers and cohorts of taxpayers. This would point to government as the only available source of risk management and diversification at a time when market based technologies have broken down.

An IMH that would remain low or decreasing even when entering a situation of crisis would instead signal the endogeneity of destabilizing forces. This would suggest that crisis management would require the timely removal of those feedback mechanisms that are reinforcing the price spiral and a simultaneous and generous provision of liquidity to offset the liquidity drainage that is taking place in the economy. Concerns are often raised about the effects of such an aggressive policy stance on market incentives. However, it must be noted that, in a world dominated by unit correlation coefficients, market discipline and its benefits have already evaporated. In such an environment, when moral hazard prevents the provision of liquidity or guarantees by the private sector (Rochet, 2005), the public provision of liquidity appears to be the only viable alternative.

The different combinations of endogenous and exogenous risk in the four cases just considered portend situations characterized by different probability distributions of asset returns corresponding to different states of the world. The situation is fundamentally different from the old micro-prudential approach – where only exogenous risk mattered – and only one probability distribution of returns needed to be considered. The regulatory implications raised by the new perspective are broad and complex. Three orders of implications are briefly reviewed below to help sketch the nature of the problems at hand: a) state-contingent regulation; b) regulation externalities; and c) risk of market concentration.

*State contingent regulation*

In a context where returns are generated by probability distributions that change according to the prevailing state of the world, the number of policy responses must be larger than in a world dominated by a single probability distribution of asset returns. Supervisory and regulatory practices around the world provide innumerable examples of policy responses that are hardly codified within the old micro-prudential approach: anti-cyclical prudential practices are a point in case. Many of these cases of “unorthodox” interventions in the financial system would acquire an “orthodox” qualification in the new integrated approach along the lines of the well known aphorism according to which “virtues” in normal times (i.e., market based policies) become “vices” in times of distress, and “vices” in normal times (i.e., government based policies) suddenly become “virtues” when crises strike.

The challenge of a “state dependent” regulatory discipline consists of the definition of a new “cone of authority” for financial regulators and supervisors that may effectively limit their responsibilities and prevent the undesirable outcome that overextended tasks may undermine their independence, weakening the governance of the whole prudential oversight process.

*Regulation externalities*

Both the micro and macro-prudential approaches share a common concern about the destabilizing externalities of regulatory instruments. The micro approach is concerned with the externalities associated with crisis-contingent policies, such as the Lender of Last Resort (LOLR) and the provision of deposit insurance. In fact, it is feared that in both cases, the very availability of these tools – while defusing self-fulfilling runs – could feed instability through the familiar moral hazard channel. In the integrated micro-macro approach, the same set of considerations would extend to a much larger set of regulatory provisions and form of externalities, an example being the cyclical externalities of solvency rules. Externalities would become a standard feature of regulation. The notion that regulatory tools respond to market imperfections – for example, the LOLR as a response to moral hazard – would not make them immune to having parallel and possibly unintended effects. From this perspective, the traditional concern about the moral hazard implications of the financial safety net does not lose its validity; it simply becomes one element of a much larger puzzle (Rochet, 2005; Caballero, 2010).

*Market concentration*

A survey of the regulatory implications of the integrated-prudential approach would be incomplete if it did not mention the specific effect of market concentration on endogenous risk. For the "public choice view," the risk of excessive concentration of market power was linked to the risk of "regulatory capture" by concentrated special interests. For the "public interest view," market concentration generates rent seeking strategies aimed at expropriating consumers of their surplus and small savers of their wealth. In both cases, the damage to social welfare comes from a monopolistic concentration of power. In the case studied here, instead, the damage comes from the fact that portfolios and institutions of growing size do not ensure the traditional diversification benefits expected of their smaller counterparties. Idiosyncratic risk growing in size ceases to be diversifiable and becomes an additional source of endogenous risk. The effects of market concentration are likely to be further magnified by the concurrent effect of complexity, which grows more than linearly with size, as exemplified by the Lehman's case.

The goal of preserving market effectiveness by introducing size limits has not been addressed so far by existing regulations, which have limited outright prohibitions to the domain of allowed bank activities as in the case of the Volker clause. Careful monitoring of the market shares of financial intermediaries appears to be a relevant complement to the menu of financial stability instruments. To avoid this – especially in times of financial distress – what is gained through the adoption of financial stability measures can be offset by the market concentration caused by the consolidation that occurs during crises. Market concentration has also been an outcome of the globalization of the financial industry. The emergence of financial conglomerates, often larger than the size of their country of origin, challenges the very rationale for (and credibility of) public intervention based on governments' "unrivalled" risk-sharing capacity. These are some of the implications of the linkages between size and correlation. Analysis of these complex issues is left for future research.

## 7. Conclusions

Considering the partial equilibrium-micro-prudential approach as a specific case of the macro-general equilibrium approach to financial stability has two orders of implications. First, the macro-prudential approach ceases to represent an alternative to the micro approach and becomes the framework for an integrated micro-macro approach to financial stability policies. Second, if volatility sources considered by the micro-prudential approach are a subset of the sources of total observed volatility, then a decomposition of observed return correlations may rank by their quantitative relevance the explanations and remedies provided by the two approaches. The decomposition may also help in the detection of different sources of risk – exogenous and endogenous. It could link them to specific regulations and controls, providing a basis for the division of tasks among different regulatory bodies and a reference point in the definition of the architecture and governance of financial regulation and oversight.

The decomposition of return covariance and correlation also helps characterize different aspects of otherwise observationally equivalent asset volatility patterns. As a conceptual benchmark, it may guide the choice of the appropriate response to outbursts of endogenous versus exogenous risk. It may also help address the volatility implications of growing financial market concentration under the twin pressure of crisis induced consolidation and financial globalization.

The ability of the integrated prudential approach to address a broader set of challenges comes at the cost of increased complexity of policy analysis. The broader focus of the micro-macro integrated approach requires dropping the implicit assumption that observed returns are samples from a single distribution of returns in favor of the alternative that the observed return distribution is itself a sample from the larger family of return distributions. Uncertainty moves one step up. Regulatory and supervisory responses will have to adapt to this more complex environment. The response to different return distributions may call for different menus of regulatory instruments; that is, regulatory policies will have to take a state-contingent stance. Rules will lose their simplicity and discretion will play a greater role in their application. Governance of the financial regulatory and oversight discipline will be affected as well.

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## ANNEX 1: Endogenous risk and the correlation of asset returns

### A decomposition of the correlation coefficient of asset returns

A general specification of asset returns, inclusive of both exogenous and endogenous risk factors, derived from the macro-general equilibrium framework can be expressed as follows:

$$A-1) \qquad r_{i,t} = (x,t)dt + \left(\sigma_{\varepsilon,i} + \varphi_{\varepsilon,i}\right)dz$$

Equation A-1 is consistent with the characterization of asset returns, in the presence of feedback rules, provided by Danielsson et al. (2009). See the characterization of the return process as provided in eq. 30 of their paper. The two components of the volatility term in equation A-1 offer the basis for an empirical characterization of market integrity, since dominance of the feedback component puts the integrity of market signals (prices) at risk. Indeed, Danielsson et al. show that prices provide a perverse coordination mechanism that magnifies, instead of reducing, the emergence of excess demand or supply in the market.

In particular, the ratio of "unavoidable" correlation to "total" correlation has two components: the ratio of covariances and a scale factor related to the level of volatility. The first component cohincides with our indicator of market health (*IMH*). The second with a scale factor that accounts also for non financial factors induced volatility such as idiosyncratic volatility. In fact, the numerator of the *IMH* coincides with fundamentals induced co-movements (when residuals are independent). The denominator of the *IMH* is given by the sum of both fundamentals and feedbacks-induced co-movements.[9]

$$9) \qquad \frac{\rho_{i,j}^{indep}}{\rho_{i,j}^{total}} == \frac{Cov_{i,j}^{indep}}{Cov_{i,j}^{total}} * \frac{(\sigma_i^{total} * \sigma_j^{total})}{(\sigma_i^{indep} * \sigma_j^{indep})} = IMH_{i,j} * SF$$

In other words, the numerator of the *IMH* represents the covariance that is induced by exposure to a common risk factor (or to common risk factors in a multifactor setting), while the denominator shows total covariance. Under the correct pricing model, market integrity would be signaled by a ratio equal to one. A ratio equal to zero would instead indicate that asset return co-movements are entirely caused by the market structure (i.e., manmade) and not by the exposure to exogenous sources of risk. Decreasing values of the indicator would also signal a growing relevance of non-structural risk factors. The

[9] The ratio is analogous to the correction terms that Mitchell and Stafford (1999) adopt to correct for cross-correlation bias in the t test for firms' specific effect. They build a ratio of (average) variance under independence over (average) total variance to remove the inference bias that weakens tests of market efficiency; I look at the ratio of independent over total covariance as a potential indicator of market efficiency failures.

relevance of endogenous risk for a portfolio of N assets would be signaled by the modal value of bilateral *IMH* indicators.