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## Crises and Contagion: A Survey<sup>1</sup>

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### Introduction

Financial and economic crises and contagion are the subjects of a vast body of macroeconomic and finance research. Many recent interventions by national governments and multilateral institutions, such as the International Monetary Fund and the European Central Bank, sought to stem the spread of contagion. In September 2008, motivated by concerns about a run on the banking sector, the Irish government provided a two-year guarantee for the debt and deposits of major Irish financial institutions such as Anglo Irish Bank, AIB, Bank of Ireland, and several others. Major Irish banks, including Anglo Irish, had been experiencing deposit outflows and short-selling by institutional investors concerned about the spread of global financial turmoil and the crisis in the Irish property market. At the time financial regulators deemed it to be an illiquidity, not an insolvency, issue (*Wall Street Journal*, 2010).<sup>2</sup> The introduction of a government guarantee to the banking sector was expected to stem the confidence crisis and signal

to capital markets a reduced chance of default, avoiding costly bank failures. The magnitude of the bad loan problem came to light in subsequent quarters. Amidst widening losses on property loans, the Irish government nationalised Anglo Irish Bank and subsequently provided capital to the bank. The Irish government formed the National Asset Management Agency (NAMA), which took land and construction loans off bank balance sheets in an effort to shore up major banks.<sup>3</sup> Over the next two years, the government would inject an estimated total of €46.3 billion into the banking system, including €29.3 billion into Anglo Irish Bank (*Wall Street Journal*, 2011). The costs of the bank sector rescue led Ireland to negotiate an ECB/IMF bailout. The final tally of bailout costs is likely to be larger due to recessionary pressures stemming from fiscal austerity measures (Stiglitz, 2010a).

Before assessing the effectiveness of interventions or designing a global financial architecture that limits the spread of contagion yet takes advantage of the benefits of integration, we need a rigorous understanding of the mechanisms behind crises and contagion. Below we provide a survey of the existing theories of financial crises and contagion. We conclude by discussing the implications of contagion for economies with open capital markets, illustrated by recent global financial crises in East Asia, the US and Ireland.

Economic crises are defined as a sudden downturn in the level of economic activity, accompanied by an increase in unemployment rate and bankruptcies. Financial crises are typically associated with a sudden fall in the exchange rate or stock market prices. Banking crises are characterised by credit contraction, increase in defaults, and even bank runs and bankruptcies. Typically, the various crises are related (both temporally and causally): an economic crisis (whatever the cause) typically leads to a stock market downturn and a weakening of the exchange rate; and banking and financial crises typically lead to economic crises.<sup>4</sup>

This survey is written from the vantage point of hindsight provided by the recent global financial crises. Several earlier theories of crises provide little insight into that crisis, while other

explanations have proven to be more relevant. In any case, the recent global financial turmoil provides a new lens through which one can see crises more generally. For instance, standard interpretations of the East Asian crisis emphasised weak institutions and a lack of transparency, and suggested American institutions as an alternative model, which presumably would reduce, if not eliminate, the incidence of crises. We now realise that whatever is meant by 'transparency' and 'good institutions' is more complicated than was widely thought at the time; in particular, it became evident that there were major deficiencies in governance and in transparency in American financial institutions, both the private institutions and the public ones that were supposed to regulate them. While some commentators had predicted a crisis, based on persistent global imbalances, the recent financial crises in the US and Ireland were not caused by those imbalances, but at least precipitated by the bursting of the housing bubble. For years the Celtic Tiger growth had been backed by solid fundamentals, including investments in infrastructure and human capital, and productivity growth. Like the US and many other markets, Ireland also witnessed a property boom facilitated by low interest rates and easy access to bank loans. As long as investors pursued leveraged bets on the real estate sector, helping to sustain the growth in residential and commercial property prices, default rates on loans remained low. Consequently, banks enjoyed rising equity valuations and low yield spreads. However, as interest rates increased and investor sentiment weakened with the onset of the global financial crisis, the property market collapsed, bank loan losses mounted and major banks became undercapitalised.

Standard models based on previous crises attempting to predict vulnerability to crises would have suggested that the US and Western Europe were not vulnerable. This is, in a sense, in keeping with the long tradition of crises, where each crisis seems attributable to factors that were not singled out as 'explaining' the previous. Indeed, according to the conventional wisdom, where flawed macroeconomic and monetary policies were often

cited as playing a key role in the generation of crises, the US and Europe were given high marks.

There is a large literature on crises and contagion. This survey focuses on the theory, and in particular on how to reconcile crises with standard neoclassical theory and macroeconomics. Crises present a number of puzzles for standard economic theory. While some of the models discussed below resolve some of these puzzles, none to date does so in a fully satisfactory way, or at least in a way which is consistent with much of prevailing finance and macroeconomics:

- A distinguishing feature of most financial crises is a sudden change in the exchange rate. While outside observers may have expressed continuing worries, say about an overvalued exchange rate, the exchange rate adjustment process does not appear to work smoothly (in contrast to standard forward-looking models with rational expectations, where individuals gradually revise expectations in light of the steady inflow of information; typically, there is no new information of a magnitude that should have led to a readjustment of exchange rates of the magnitudes observed). This is an example of the more general puzzle of crises: large changes in outcomes that seem incommensurate with the scale of changes in the underlying state variables (see Stiglitz, 2011; United Nations, 2010).
- Standard models suggest that diversification – the spreading of risk around the world – should have led to a more stable economic system. The 2008 crisis suggested the contrary: diversification helped spread the crisis. There is a growing consensus that diversification may reduce the exposure to small crises, but increase that to larger ones. As more countries liberalised their capital markets, global capital and interbank linkages became more prevalent. Countries around the world experienced spill-overs from the US financial crisis. Irish banks had relied heavily on global interbank loans prior to the crisis. When short-term interbank lending froze up in

the third quarter of 2008 Irish banks faced significant funding constraints.

- Conventional theories imply that even in markets where there is some irrationality, all that is required to make markets work well (to make markets reasonably stable and efficient) is that there be enough (and enough may be a relative notion) rational market participants.<sup>5</sup> The empirical evidence (buttressed by this crisis) is that rational participants exploiting the irrationality of others may make the markets highly volatile.
- After the crisis there is a focus on contagion – on how interdependence can lead a crisis to move from one country to another; but before the crisis there is an emphasis on the benefits of diversification, on how interdependence enhances stability. None of the prevailing models integrates coherently these opposite forces (with the exception of Stiglitz, 2010b, 2010c).
- Policy frameworks have been equally incoherent. The standard response to contagious diseases is quarantine – the equivalent of capital controls. But many in the international community have resisted the imposition of capital controls, even in the event of a crisis.
- Policy decisions have often entailed interventions in the market that are announced to be (or believed to be) temporary, but it is argued that they will have long-run effects, shifting the equilibrium in the countries suffering from contagion. Why such temporary interventions would have long-run effects is often not clear (Stiglitz, 1999a).

A central thesis of this survey is that understanding crises requires an understanding of market imperfections – and especially of the constraints, for instance, on borrowing, imposed by imperfect information – and how those market imperfections interact with irrationalities on the part of market participants and imperfections in the regulatory environment.

In the discussion below, we follow the literature on crises through its various stages, motivated by the series of crises the world has experienced in the last three decades. In retrospect, however, there is a basic taxonomy:

- Models in which the shock giving rise to the crisis is exogenous, and those in which it is endogenous
- Models in which markets are fully rational, and those in which they are not
- Models in which there are multiple momentary equilibria, and models in which there is a unique momentary equilibrium
- Models in which there is a unique steady state (long-run) equilibrium, and models in which there are multiple long-run equilibria

The logic of crises is simple: if there are multiple momentary equilibria then the economy can suddenly switch from one to the other without any large change in any state variable (other than beliefs, which themselves are treated as state variables). If there are multiple steady state equilibria then a shock to the state variables of the economy (whether endogenous or exogenous) can act as a tipping point, bringing the economy into a different ‘orbit of attraction’.

So too, the mathematics of crises is simple: under the convexity assumptions made in most economic models diversification spreads risks and reduces its impact. But, as Stiglitz (2010b, 2010c) points out, non-convexities are pervasive (bankruptcy, learning, etc.), and with non-convexities diversification can amplify systemic risk.

This paper is divided into three sections. The first surveys the literature on what causes crises; the second on contagion and the effect of interdependence in amplifying crises; the third on the role of government. Not surprisingly, theories which stress the efficiency and stability of markets look to government as the

source of the problem; stability is attained by government not interfering in the natural workings of the market. Theories which see the economy as inherently inefficient and unstable look to government to help correct market failures.

Ascertaining which of these theories is correct is not easy, and beyond the task of this short survey. One of the reasons for the difficulties is that there are elements of many of the alternative approaches present in every crisis. No one could look at the recession of 2008 or the Irish banking crisis without noting market irrationalities. But does that mean we could not have had a crisis in the absence of such irrationalities? The major shock was an endogenous one – a housing bubble; the shock was not an exogenous event ('a once in a hundred year flood') but there were exogenous (at least to the economic system) events that perhaps could have triggered a major downturn, reflected in the spike in oil and food prices.

### **What Causes Financial Crises?**

The earliest approaches to the onset of currency and financial crises – the first generation of crisis models – focused on fundamental macroeconomic imbalances and adherence to a monetary policy incompatible with the maintenance of an exchange rate peg (for example, Krugman, 1979).<sup>6</sup>

The 1994–1995 Mexican crisis led policy makers to ask what accounted for the sudden onset of a market panic. Although fundamental macroeconomic problems, including overvalued exchange rates, current account deficits and rising short-term foreign currency government debt, were present, the peso's devaluation alone did not quickly stem the crisis.<sup>7</sup> The crisis (like many before it) posed several questions: (a) why did it occur when it did? The fundamental imbalances had long been recognised. (b) The large immediate fall in the exchange rate, which many thought should have equilibrated the market – leading to what might be viewed as an equilibrium exchange rate – didn't stem the crisis. Why not?



The peso crisis led researchers to turn their attention to information flows and trader behaviour around market panics, which formed the second generation of theories of currency crises (for example, Sachs, Tornell and Velasco (1996); and Agenor and Masson (1999); and more informal discussions by Furman and Stiglitz (1998); and Stiglitz (2010b)).

### *Multiple Equilibria*

The 'second generation' literature explored one possible explanation for the sudden large change in the exchange rate (beyond what can be explained by changes in the shocks to the economy, including new information) and the failure of the exchange rate to equilibrate.

The peso crisis precipitated a massive loss of confidence in the currency and a full-on market panic. Though the importance of confidence is often mentioned, traditional macro models do not include independent variables that quantify confidence. Those that have tried to do so show that confidence can have significant explanatory powers, but few models incorporate confidence in a formal way.

One way of doing so is to assume that there are multiple equilibria.<sup>8</sup> Models of multiple equilibria (sunspots) that formally incorporated 'confidence' suggest that a change in confidence can move the economy from one equilibrium to another. In the case of debt crises, Brazil (and perhaps Greece) provide examples: with low interest rates the country can easily service the debt, so it is rational that interest rates are low; but if interest rates become high the country cannot service the debt, and it is rational that the interest rate is high to compensate for the risk of default (Greenwald and Stiglitz, 2003). The idea of a self-fulfilling market panic originated in the context of a run on a bank. In Diamond and Dybvig (1983), banks have relatively illiquid assets; in other words, if a bank has to sell assets on short notice it sacrifices a part of the asset value in the process. Every period some customers withdraw money from the bank to meet their



spending needs. In a perfect world, all others keep their money in the bank. However, customers are aware that withdrawals will not be honoured if the bank runs out of money (no deposit insurance scheme exists). As they observe other customers' withdrawals they could decide to take their own money out as well in anticipation of a bank run. Such self-fulfilling panics can leave everybody worse off.

### *Market Frictions*

A third generation of models of crises focused on how various market frictions contribute to the onset of a financial crisis, amplifying (rather than dampening) shocks (for example, Kiyotaki and Moore, 1997; Caballero and Krishnamurthy, 2001; and Mendoza, 2010). Moreover, in these models what would normally be equilibrating adjustments to the shocks can be destabilising. While the importance attributed to specific financial frictions varies from model to model, a common theme in these theories of financial crises is the role of market imperfections in explaining both the fast pace of diffusion and the large extent of amplification of negative economic shocks, providing a recipe for a sudden crash.

Market frictions (information asymmetries, costly state verification, costs of contract enforcement, and bankruptcy (see Greenwald and Stiglitz, 1993a)) limit the extent to which firms can use equity or hedging contracts.<sup>9</sup> As a result, firms have to rely on debt, while remaining exposed to risk, and firms act in a risk-averse manner.<sup>10</sup> Optimal financial structures lead effectively to constraints on debt-equity ratios, so that a decrease in firm equity reduces its ability to borrow. The macroeconomic consequences of these micro imperfections are severe, with investment (including inventory accumulation), for instance, expanding in booms by a multiple of the change in equity (the financial accelerator), and the converse happening in downturns (for example, Greenwald and Stiglitz, 1993a; Bernanke, Gertler and Gilchrist, 1996). Not only are the effects of shocks amplified, but they can persist over time.

Other imperfections in financial markets can similarly trigger crises. Many borrowers face collateral constraints that limit borrowing capacity. Contract enforcement is complicated and lenders have only partial information. A collateral requirement can act both as a selection and incentive device (Stiglitz and Weiss, 1986) and can help manage default risk. For example, in Kiyotaki and Moore (1997) creditors cannot force repayment or seize the borrower's human capital, so borrowers can strategically default on the debt. Collateral-based borrowing constraints tied to the value of the firm's real assets become necessary.<sup>11</sup> As a result, the maximum amount of debt the firm can take on, assuming collateral of a given value, is limited. Even a temporary shock to the value of collateral translates into reduced borrowing ability. As a result, a shock sets in motion a feedback effect that decreases investment and the rate of growth for several years. Credit-constrained firms are forced to reduce investment, resulting in further declines in net worth, which in turn lead to tighter borrowing constraints and additional investment cuts.

Greenwald and Stiglitz (1993a) explain how with unindexed debt contracts a macroeconomic shock (e.g. monetary policy tightening) that leads to lower than expected prices results in decreased equity, with real effects that are amplified by the financial accelerator. Non-convexities in the relationship between equity and investment also imply that a distributional shock (e.g. an increase in the price of oil) has macroeconomic consequences, with the contraction in the losing sector exceeding the expansion in the benefiting sector.<sup>12</sup> These financial constraints cause one-time shocks to persist and result in widespread insolvencies.

The banking system itself can amplify especially large downturns. Banks can be viewed as highly leveraged firms (Greenwald and Stiglitz, 2003), so that when their equity is diminished they reduce their lending. Institutional features and regulatory design can increase the extent to which this is prevalent. Excessive reliance on capital adequacy requirements can result in a built-in destabiliser; countercyclical prudential regulations or appropriately designed policies of regulatory forbearance may be able to

offset the effects (see Helmann, Murdoch and Stiglitz (2000) and the various essays in Griffith-Jones, Ocampo and Stiglitz (2010)). Regulation of maturity and currency mismatches in banks and the firms to which they lend can reduce the vulnerability of the banking system – and thereby the economy – to shocks.

During the Irish financial crisis, property developers facing declining real estate valuations were unable to refinance existing loans or obtain new loans. Asset write downs resulting from losses on property loans constrained the banks' ability to raise new financing, in turn limiting loan provision. Business and consumer credit reductions exerted downward pressure on the rate of new investment and consumption growth.

Other institutional rules and policies (in both home and foreign countries), such as the weakening of automatic stabilisers (for example, safety nets), can make countries more sensitive to shocks. Delegating authority of risk evaluation to rating agencies and imposing constraints on what pensions can invest in can contribute to volatility – a sharp downgrade by the rating agencies (as happened in Thailand in 1997) can precipitate a crisis (see Ferri, Liu and Stiglitz, 1999). In Ireland and other GIIPS (Greece, Ireland, Italy, Portugal and Spain) countries, downgrades of sovereign and bank credit ratings limited their capital market access, causing a credit contraction and exacerbating recessionary pressures.

### *Systemic Crises*

In the third generation models just described, financial constraints (operating through collateral requirements, debt-equity constraints or real balance effects), especially in the context of imperfectly indexed debt contracts, can lead to the amplification and persistence of shocks. While research on systemic shocks began well before the Great Recession, the recession has enhanced impetus for this work (see, for example, Haldane, 2009; and Haldane and May, 2011). Greenwald and Stiglitz (2003) and Allen and Gale (2000) describe bankruptcy cascades – how the

bankruptcy of one firm can lead to that of others. The extent to which this occurs depends on financial interdependence. Pecuniary externalities arising in the presence of incomplete risk markets and imperfect information imply that the set of privately profitable contracts will not in general be socially optimal (Greenwald and Stiglitz, 1986). In fact, managerial contracts implicitly based on relative performance can lead to excessively correlated risk taking (Nalebuff and Stiglitz, 1983). Moreover, there are strong incentives especially for large banks to become excessively interdependent and correlated, so that in bad outcomes they will be bailed out (Stiglitz, 2010a; Acharya and Yorulmazer, 2008; etc.).

#### *Market and Individual Irrationalities*

In the original Diamond–Dybvig (1983) model, customers have no information about the bank’s default risk. In real life, some depositors could have information about the bank’s financial health. However, even when customers are able to assess the bank’s financial condition they sometimes end up ignoring their private knowledge and copying the actions of others, which is known as herding (see, for example, Banerjee, 1992; and Bikhchandani, Hirshleifer and Welch, 1992). As a result, bank runs or sudden market crashes can occur even when only a few investors or depositors possess negative information. Such herding may be rational.

In addition to the rational reasons for herding, many have argued that irrationality plays a crucial role in both the onset and the creation of the conditions for and the spread of financial crises (for example, Stiglitz, 1999b, 2004; and Hirshleifer and Teoh, 2009). For instance, as Kindleberger, Aliber and Solow (2005) note, changes in the sentiment of borrowers and creditors over time can explain the well-known cyclical nature of bank lending. (Such changes in sentiment also play an important role in Minsky cycles and credit crises.) Increases in loan supply can be attributed to optimism in good times, while decreases in credit can be linked to pessimism in bad times. Irrational investor pessimism

causes rapid declines in lending, asset prices and exchange rates, typically seen during crises. Investor irrationality can stem from the inability to correctly process available data, compounded by behavioural biases that cause investors to make suboptimal decisions based on the beliefs they have formed (see Barberis and Thaler (2003) for a detailed survey).<sup>13</sup> The resulting overreaction to economic news can cause small negative shocks to trigger large-scale market panics that spread across national borders.

When bubbles break (or when panics lead to irrationally depressed prices) there are large real balance effects and the other effects delineated above arising from the financial accelerator, and these can give rise to a macroeconomic crisis. The devastating consequences of a burst housing market bubble have been seen in the recent US and Irish financial crises.

In open economies with firms that have substantial foreign currency debt (with mismatches in the currency and maturity structure of assets and liabilities), large changes in exchange rates similarly can have dramatic effects on equity values or lead to large increases in collateral requirements, precipitating a crisis, for instance, as firms make large cutbacks in investment. During the 1997–1998 Asian financial crisis, firms with foreign currency liabilities and home currency assets were vulnerable to depreciation of the home currency (Stiglitz, 2001; Cespedes, Chang and Velasco, 2004).

In standard dynamic stochastic general equilibrium models the sources of crises are exogenous shocks, but the most important crises involve the breaking of bubbles, most of which can be attributed to internal market dynamics. Housing prices, for instance, rise to the point where further increases are not sustainable given the constraints imposed by the institutional and regulatory system (even with mild forbearance). When home prices can no longer increase at the rate that has been anticipated demand for housing decreases suddenly with the follow-on effects described above. This pattern, repeated historically, presents a challenge to rational expectations models. There are two possibilities. One is that with short-sighted market participants the economy can

evolve in a manner that is consistent with inter-temporal arbitrage equations for a very long time, before a (say, non-negativity) constraint becomes binding (e.g. Shell and Stiglitz, 1967). The other is that there is uncertainty about the date of unravelling of the process, and a bubble can then be consistent with rational expectations for an extended period of time (Abreu and Brunnermeier, 2003).

We suspect though that it is challenging to fully reconcile bubbles with perfect rationality. In the US, Irish and most other bubbles (Gurdgiev, Lucey, Mac an Bhaird and Roche-Kelly (2011) discuss the Irish property bubble) large numbers of investors recognised that there was a very high probability of a bubble (and took short bets), even if others believed it was not the case. The question is, why couldn't those who knew better correct the market irrationality? Note that the analysis of such situations requires the construction of models in which individuals have different beliefs, and even as they extract information from the market they do not converge to the same beliefs. Recent models focusing on the consequences of short sale restrictions for asset bubbles have provided insights, since those who are more optimistic are given more weight during booms than during recessions (e.g. Scheinkman and Xiong, 2003). This gives rise to higher market volatility, with real consequences of the kind that we noted earlier in this essay.

In practice, delineating rational and irrational causes of crises can be hard not only because investors face imperfect markets, but also because rationality and irrationality interact: there are rational actors willing to exploit the irrationality of others (and imperfections in the regulatory framework). While standard models assume that such rational exploitation of market irrationality stabilises the economy, in fact that often does not seem to be the case. The crisis of 2008 serves as an example. The lending during the housing bubble illustrates a high level of irrationality on the part of market participants. Incentive distortions led to excessive risk taking in mortgage provision. In the end, it was rational for major institutions to make contracts with each other

which amplified risks and made them less transparent, because it ensured (under the assumption of too-big-to fail) large and sustained government subsidies.

### *Destabilising Market Processes*

The collapse of the exchange rate may restore the market equilibrium (by increasing exports and reducing imports) but it may sometimes have the opposite effect on the economy. If domestic firms have foreign currency denominated debt the change in exchange rates has large real balance effects (Greenwald and Stiglitz, 1993a), which leads to large changes in behaviour – production, investment, inventory holdings, etc. – and can precipitate an economic downturn. It affects the ability to repay loans, and that in turn affects banks' ability to lend. Limited access to credit and weak balance sheets impede the normal foreign exchange adjustment mechanism. A decline in the exchange rate can weaken aggregate demand and exacerbate the downturn.<sup>14</sup>

This is but one example of how economic processes that in simplistic models help the economy equilibrate may, in more realistic models, have just the opposite effect. In a recession, wage and price declines weaken aggregate demand, exacerbating the gap between supply and demand and the economic downturn.<sup>15</sup>

### *Trend Reinforcement and 'Orbits of Attraction'*

Battiston, Delli Gatti, Greenwald and Stiglitz (2007) describe a variety of other destabilising circumstances where there is a process of *trend reinforcement*, that is, a negative shock is followed by consequences that worsen the firm's (or the economy's) future prospects. Consider the evolution of a firm's net worth as a stochastic process. A negative shock increases the likelihood that the firm will go bankrupt (reach the zero boundary at an earlier date), but that means that lenders will demand higher interest rates, increasing the pace at which a firm with negative drift moves downward.



There can exist a range of state variables (here, net worth) such that in one set of conditions the firm (economy) converges to bankruptcy (crisis), while in another it does not. Shocks can move the economy from one 'orbit of attraction' to another.

### How Crises Spread

We have provided a brief and by no means exhaustive overview of finance and macroeconomics research into the causes of financial crises. As Stiglitz (2010b) notes, the mechanisms behind shock amplification can help explain not only the onset of crises but also the spread of crises across countries. As countries remove restrictions on international capital flows crises that arise when small shocks snowball due to market frictions increasingly involve multiple economies. In today's global financial and banking marketplace, the issue of propagation of shocks and crises across countries is arguably of predominant importance. Therefore, we next turn to the role of contagion<sup>16</sup> and other factors contributing to the spread of financial crises.

It should be obvious that substantial trade or capital linkages can contribute to the spread of crises. But that does not mean that the linkages exacerbate crises. They may dampen the crisis in one country, while at the same time bringing about a downturn in another. Had the US not exported so many of its securitised mortgages leading up to the recent crisis arguably the US crisis would have been worse. In standard models, however, the global aggregative effect is reduced through interdependence. The worry, however, is that financial interdependence leads to the opposite effect, in a process which is called contagion, by analogy to the spread of disease, where interaction amplifies the overall incidence of the disease.

Of course, even if diversification leads to better overall global economic performance, countries may worry about their own exposure to risks. The last section explained how, as a result of financial constraints, economic systems may amplify shocks; and the costs of offsetting and managing risks may be significant, and

not worth the benefits of increased integration. Stiglitz (2006) has, for instance, discussed the high costs associated with reserves that countries maintain to enable them to better manage the shocks that they face.

Financial linkages can take on several forms:

- A reduction in foreign direct investment, as a result of either financial constraints in the investing country or in the markets for which the goods to be produced are destined
- A decrease in financial inflows, not adequately offset by actions of domestic monetary authorities, that leads to financial constraints and/or higher cost of capital
- A reversal of financial flows – from inflows to outflows – which typically is associated with large changes in exchange rates

While these changes in exchange rates would, in the standard trade models, enhance aggregate demand through an increase in net exports, balance sheet effects (especially important when debt is denominated in foreign currencies) often dominate. Moreover, the changes in financial flows can be motivated either by changes in information or beliefs (investors suddenly realise that the risk of investing in foreign countries is greater than they had previously believed), by changes in financial constraints or by real shocks amplified through financial constraints. The financial constraints can arise from regulation or institutional/informational imperfections. Finally, investor actions can bring about a correlated onset of crises, if investors update their views about the likelihood of a crisis based on witnessing a crisis in another market or if investors (including banks) have exposure to several different markets through their portfolios.

One example of what is sometimes called ‘pure contagion’ involves investors fleeing a country after observing a crisis in another economy that has no trade or capital ties to the original economy. The idea that investors can infer an economy’s prospects from crises in other economies is central to the information

contagion view (Chen, 1999; King and Wadhvani, 1990; etc.) Intuitively, falling asset prices in one market can convey information about the value of securities in other markets if the two markets share some common risks.<sup>17</sup> Imperfectly informed investors learn about the odds of a crisis in their economy by observing crisis episodes overseas.

The caveat about investor rationality applies here as well. The explanations above focused on rational investors. Often at least some degree of irrationality is involved in investor panics. If investors overreact to news or make other mistakes when drawing inference from other crises, contagion can spread faster as a result of investor irrationality. Even if investors do not perceive a dramatic shift in risk, an expectation that other investors will update their beliefs about risk may be sufficient to spur a sell-off.

The channels through which pure contagion exerts its effects are all of those described in the previous section, including the impact of prices (especially through fire sales) on borrowing constraints and real balances.

Several studies focus on the role of direct financial linkages in shock diffusion. Financial linkages can take the form of risk-sharing arrangements or balance sheet exposure to distressed countries or financial institutions. In a series of papers, Battiston et al. (2007), Gallegati, Greenwald, Richiardi and Stiglitz (2008), and Stiglitz (2010b, 2010c) ask when will it be the case that such risk-sharing arrangements exacerbate rather than reduce systemic risk. Gallegati et al. (2008) model diffusion of shocks among interlinked financial institutions. (Linkages can be, for example, viewed as loans extended to other banks.) Interbank loans allow individual banks to diversify away idiosyncratic shocks to their loan portfolios, reducing the likelihood of failures. However, when economic tides turn, bank failures are more likely to be systemic in nature if banks are interconnected. Moreover, bank managers who have incentive conflicts or who do not fully internalise the spill-overs of bank failures tend to establish too many interbank links.

Several other papers explain how the interconnectedness of bank balance sheets can facilitate the spread of shocks affecting an individual bank to other financial institutions. Allen and Gale (2000) provide a model of balance sheet contagion in the banking sector. Contagion occurs due to overlapping claims between different banks. Liquidity shocks to one bank lead to losses at other banks in the economy because their claims on the troubled bank decline in value. This channel can augment the effects of relatively small shocks and lead to contagion and financial fragility in the banking system. Wagner (2010) similarly concludes that banks motivated by the diversification of idiosyncratic risk can contribute to systemic risk. Haldane (2009) shows that these interlinkages may reduce the risk of failure when there are small or uncorrelated shocks, but increase the risk of failure when there are large and correlated shocks.

The analysis of the consequences of financial linkages across countries is, in many ways, parallel to that of interlinkages among banks (or banks and firms) within a country (Greenwald and Stiglitz, 2003; Stiglitz, 2010c). In the international finance setting, capital flows between countries can serve as a similar risk-sharing mechanism (Stiglitz, 2010b). Capital market integration allows individual countries to smooth country-specific shocks to output. Assuming a high level of country-specific risk and a cost of such variability to consumers, risk sharing through international capital flows is beneficial. On the flipside, a major adverse event that affects a single economy has the potential to cause a systemic failure in all economies interlinked through capital markets.

The underlying intuition behind these seemingly perverse results is that in the presence of non-convexities risk sharing may lower expected returns. Non-convexities are pervasive – they arise whenever there are information constraints, bankruptcy costs or learning processes.<sup>18</sup> The process of trend reinforcement described earlier implicitly entails a non-convexity. In that model, with a negative drift to the stochastic process when equity falls below a critical level, increases in risk increase the chance that the firm escapes the death trap.

Cross-border financial flows may exacerbate financial constraints, and therefore increase the magnitude of the global consequences of shocks and imply that much of the burden of a shock to a given country is experienced by countries with which it is financially integrated. For instance, creditors may impose more stringent collateral requirements on foreign borrowers because of the greater information asymmetries. In Caballero and Krishnamurthy (2001) contractual distortions in the treatment of domestic and international collateral can induce fire sales (presumably that are worse than those that would have arisen if cross-border lending was limited), resulting in liquidation of assets at a significant discount in the event of a shock. In a related vein, in Mendoza (2010) information costs, high leverage and borrowing constraints combine to cause fire sales. Traders facing high debt levels and borrowing constraints can be forced into fire sales of assets to less informed foreign buyers, even though the shock is only temporary. Such fire sales can precipitate rapid shutdowns of external capital markets (i.e. countries facing these fire sales lose access to foreign funds) and large consumption contractions.<sup>19</sup> Stiglitz (2002) described how these effects served to deepen the East Asia crisis of 1997–1998.

The spread of crises to economies that have the same creditors or investors (such as global banks or hedge funds) as the economy in crisis constitutes another channel for the transmission of shocks. Creditors or investors that suffered losses in a crisis in one economy are likely to modify their lending or investment strategy with respect to seemingly unrelated economies. When banks face loan defaults, they are likely to scale back lending to all borrowers, even those unaffected by the initial adverse event, due to capital requirements or balance sheet effects. The worse the effect of defaults on the bank's financial health and ability to raise equity, the more pronounced the cutbacks in lending to other borrowers. Because of information asymmetries, lending cuts may be disproportionately large for foreign borrowers. Chava and Purnanandam (2011) find empirical support for the role of lender portfolios in the transmission of shocks to previously

unaffected firms in a study of borrowers dependent on bank debt around the 1998 Russian financial crisis. Rashid (2011) similarly finds that foreign banks play an important role in the transmission of shocks across borders.

Similarly, investors who lose money in one market might liquidate their positions in other economies (to cover losses or meet margin requirements). Shocks, therefore, can be transmitted as a result of portfolio rebalancing by investors with stakes in multiple markets (Kodres and Pritsker, 2002). Investors are expected to respond to shocks that affect a given market by modifying portfolio exposures to shared macroeconomic risk factors. Such cross-market linkages are likely to spread shocks faster during bad times and in the presence of high levels of foreign debt, as was the case for emerging economies in the Asian financial crisis. But even if there are no shared macroeconomic risks globally diversified investor portfolios can also speed propagation of individual country shocks to other economies through investor wealth effects (Kyle and Xiong, 2001; Goldstein and Pauzner, 2004). A crisis in one country leads to a reduction in the wealth of those invested in that country. The decline in wealth causes investors to rebalance portfolios, and possibly even to act in a more risk-averse manner, so they scale back holdings of risky assets in other countries, even when those other countries share no ties or risk factors with the original economy in crisis.

Finally, crises can be transmitted via the real sector, for example, through trade ties and competitive (terms-of-trade) effects. Shocks affecting developed countries eventually affect developed countries' trade partners. The recent US economic downturn resulted in a slowdown in GDP growth and a reduction in import demand, adversely affecting many developing economies that traditionally exported to the US (Stiglitz, 2010b). Adverse exchange rate effects would, in the standard model, be viewed as purely redistributive – one country gains what the other country loses – but with financial constraints, as we have noted, the aggregative effect may still be negative (see also Paasche, 2001.)

In this section we have discussed several alternative theories of financial contagion. Of the various theories, the pure contagion models are the least plausible. As Stiglitz (1999b) notes, while Brazil and Russia had few risk factors in common with Southeast Asian economies, both countries saw significant capital flight in the immediate aftermath of the Asian crisis. Similarly, Brazil suffered in the aftermath of the Russian crisis. In those cases, the effects arose from financial institutions and hedge funds with portfolio exposures to multiple emerging markets both within and outside of Asia, and especially from the financial constraints faced by those firms. More recently, disproportionate contractions in lending by banks in the crisis-affected countries helped spread crises to Eastern Europe and emerging markets.

Our discussion of the circumstances that precipitate contagion and spread of shocks to multiple economies has important policy implications for countries with significant international capital market linkages, including Ireland, which we discuss in the next section.

## **Contagion and Financial and Capital Market Liberalisation**

### *Short-Run Exchange Rate Interventions*

A standard response to the threat of contagion includes an international bailout package, the essential ingredient of which is a commitment of large amounts of financial support, some of which is used immediately for intervention to support the currency, and the rest is left to convince the market that more support will be provided, should the need occur. As Stiglitz (1999a) has commented, there are two things that are odd about these interventions, which often are ineffective (for example, in Russia in 1998, in East Asia in 1997 and in Argentina in 2001). First, why should a temporary intervention in the market have persistent effects? Moreover, if the crisis conveyed information about Mexico's fundamentals that are relevant to Argentina's situation then even if the IMF intervention stabilised Mexico's



exchange rate it would not change market perceptions of the underlying weaknesses in Argentina's economy. Only if market participants were naïve enough just to look at the exchange rate (the outcome of market processes *and* intervention) would the intervention work.<sup>20</sup> And secondly, why should an intervention in Mexico have any effect on Argentina? On the contrary, *if* the market thought that intervention was necessary but that intervention on behalf of Argentina was less likely than in the case of Mexico, an intervention in Mexico, even if successful in supporting the Mexican exchange rate, could have an adverse effect on Argentina.

There are two sets of models in which such temporary interventions might make sense. The first is in the presence of deep market irrationalities – where market participants are truly naïve and only look at exchange rates, not what brings them about; where they have simple beliefs about contagion – that a crisis in one country is like a communicable disease, and if we cure the symptoms in one country it can affect its spread to others. The other is that there are multiple equilibria, and interventions help to move the economy from the 'bad' equilibrium to the 'good' one. A third explanation, which is a variant of the second explanation, is that markets are often prone to overshooting and interventions are an attempt to prevent that. Given the real consequences of overshooting discussed earlier, such interventions may make sense. Note that in each of these explanations market processes on their own are assumed to lead to sub-optimal outcomes. But the advocates of these interventions at the international financial institutions, which typically have placed strong confidence in the efficiency and stability of market processes, need to provide a clear delineation of the circumstances in which markets can be relied upon and those in which they cannot. Critics might argue that in the case of crises the market inefficiencies are so large that they simply can't be ignored, but they are likely present at other times as well (Greenwald and Stiglitz, 1987).

More broadly, however, the models that we have delineated in this paper provide a rationale for such exchange rate

interventions. Markets with rational expectations but imperfect and asymmetric information are typically not efficient; even more so if markets are subject to irrational pessimism. Then the effects of such irrationalities (even if relatively small) can be large and persistent; markets may exhibit excessive volatility, and there can be *real* benefits to government efforts at stabilisation.

### *Optimal Financial Architecture*

Stiglitz (2000, 2002, 2006, 2010b, 2010c) analyses the optimal design of international financial architecture given both the benefits of financial integration in achieving diversification and smoothing of negative consumption shocks and the costs of adverse spill-overs across markets due to financial contagion. Financial integration raises the overall risk of spill-overs of large negative shocks (Stiglitz, 2010c). Stiglitz (2010b) examines the trade-off between contagion and diversification associated with open capital markets in a risk-sharing context. He shows that risk-sharing arrangements can become a negative-sum game in the presence of bankruptcy costs and other commonly accepted financial market frictions. In the absence of such frictions, diversification achieved through risk-sharing arrangements benefits risk-averse investors and consumers. However, a number of plausible market frictions can set in motion a financial accelerator effect that leads the initial shock to gain magnitude and persist. With bankruptcy costs, full diversification may result in lower aggregate output (net of such costs), so much lower that it more than offsets other benefits from diversification. Capital market integration could increase, instead of lower, the likelihood of a financial crisis in a given economy. Even if risk sharing does not initially increase the likelihood of a crisis but only increases the probability of a near-crisis state, the resulting increase in borrowing costs accounts for trend reinforcement, which raises the odds of a crisis in the long run.<sup>21</sup>

One analogy is with fuller integration of electricity grids, which saves on generating capacity but increases the risk of a

broader systemic failure. In practice, well-designed electricity networks make use of circuit breakers. In international finance capital controls serve as such circuit breakers.

If well-designed capital controls could be incorporated to prevent contagion during crisis episodes without compromising the risk-sharing benefits of integration, integration would always be preferred. However, designing and implementing such a mechanism is very challenging in practice. Therefore, the choice of integration depends on the likelihood of a large shock (and ensuing systemic failure) relative to the level of country-specific risk and the costs associated with variability. Moreover, the types and severity of informational and other frictions present in different countries must be considered for a complete assessment of the trade-offs and benefits of capital market integration.

In their analysis of the Asian financial crisis, Furman and Stiglitz (1998)<sup>22</sup> and Stiglitz (2004) argue that while the adverse events affecting East Asian economies were at least to some extent exogenous (irrational investor perceptions, sudden changes in investor willingness to bear risk, interest rate increases in industrialised countries), the rapid liberalisation of capital flows and integration of domestic markets into global financial markets in the absence of a sound bank supervisory and regulatory framework contributed to the severity of the crisis. They find evidence that rapid growth in unhedged short-term debt exposures made East Asian markets vulnerable to sudden capital outflows and heightened the magnitude of the subsequent crisis. Moreover, financial integration limited the flexibility of the macroeconomic policy response because of the concern that interest rate reductions would exacerbate capital flight. In the aftermath of the Asian financial crisis and the Great Recession, the highly volatile, short-term, speculative nature of international capital movements has led many emerging market governments to reconsider the benefits of full liberalisation of capital flows (Calvo and Mendoza, 2000). Recently, the IMF has also argued that certain restrictions on cross-border capital flows may be desirable and included such restrictions in some of its recent programmes (e.g. in Iceland).

Financial liberalisation refers to the opening of a country's financial system to banking institutions (and other financial institutions) from abroad. Research conducted before the crisis suggested that it provided one mechanism for the spread of a crisis from one country to others; as we have noted, the Great Recession reinforced these findings. One policy response is to question the single market principle, under which a bank that is regulated by one jurisdiction is allowed to operate freely in other jurisdictions. There is now a growing consensus that countries have to regulate all financial institutions operating within their jurisdiction (regardless of ownership) and that they should be organised as subsidiaries (not branches), to ensure that there was adequate capital within the country (United Nations, 2010).

Extensive work on crises and their propagation can be used to understand the history of financial crises, to draw inferences about the origins and spread of the recent financial crisis, and to devise policy frameworks to reduce the occurrence and magnitude of future crises. We have identified a number of mechanisms leading to crises and their contagion. Most of the plausible mechanisms require us to go beyond the standard macroeconomic frameworks based on rational agents with rational expectations operating in well-functioning financial markets. What is needed now is a comprehensive model that integrates various crisis transmission channels and provides a coherent set of policy recommendations both to reduce the magnitude and frequency of shocks, to stem contagion and to respond to the crises that nonetheless occur.

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## Endnotes

- <sup>1</sup> The authors thank Charles Larkin, Brian Lucey and Constantin Gurdgiev for their helpful suggestions.
- <sup>2</sup> As we note below, this was a mistake, which is not uncommon in the presence of supervisory failures.
- <sup>3</sup> There were major institutional flaws in the design of NAMA which undermined its ability to fulfil its mission. These are not the subject of this paper.
- <sup>4</sup> We say typically because there are exceptions: in the Great Recession, though precipitated by the US banking crisis, the US appeared to be a safe haven, and its exchange rate appreciated. The subsequent low interest rates and depressed wages helped (at least temporarily) to buoy stock market prices, even though economic activity languished.
- <sup>5</sup> That this is not so in general—that markets with even large numbers of well-informed participants may look markedly different from those in which *all* are well informed—is one of the central messages of Salop and Stiglitz (1976). Grossman and Stiglitz (1980) showed that uninformed market participants could extract some, but not all, of the information from the prices generated by informed traders.
- <sup>6</sup> The essential insight was that with an overvalued exchange rate the country would generate a trade deficit, which foreign exchange reserves could only finance for a limited amount of time. Of course, if markets anticipated this, with rational expectations, the crisis would occur well before foreign exchange reserves were finally exhausted.
- <sup>7</sup> There is some evidence that normal trade adjustments, spurred in part by devaluation, were central to the resolution of the crisis; the bail-out, by temporarily leading to an exchange rate that was higher than it otherwise would have been, may in fact have impeded adjustment.
- <sup>8</sup> In these models, there is no way that market participants can anticipate when the economy might shift from one equilibrium to another.
- <sup>9</sup> See also the earlier work of Myers and Majluf (1984) and Greenwald, Stiglitz and Weiss (1984).
- <sup>10</sup> Either because managers are forced to bear some risk, as part of optimal incentive contracts, or because of bankruptcy costs. See Greenwald and Stiglitz (1990).
- <sup>11</sup> Moreover, the value of firm equity can change rapidly, and there may be many claimants.

- <sup>12</sup> Similarly, Miller and Stiglitz (2010) use a model with collateral requirements to demonstrate how shocks can turn into crises in the presence of high leverage and overvalued assets.
- <sup>13</sup> More recent research has emphasised that individuals discount information that is inconsistent with their priors, and overweight information that is consistent. If a bubble is forming, they tend to weigh more heavily the information that is consistent with their beliefs. There can be equilibrium frictions, where they ‘rationally’ believe that there is a bubble (see Hoff and Stiglitz, 2010).
- <sup>14</sup> Traditional economic theory – and economic policy – has taken ambiguous positions about these destabilising adjustments. It has been standard fare to worry about ‘overshooting’. Excessive exchange rate adjustments, it is thought, impede the adjustment of the market economy to the new (or ‘correct’) equilibrium, and this provides justification for interventions to reduce the magnitude of the exchange rate adjustment. In some cases, there is evidence that such interventions actually impede the adjustment process. Indeed, one set of studies suggests that it was the normal foreign exchange adjustment mechanism which restored Mexico’s growth, and that attempts to dampen the foreign exchange correction (driven by concerns about impact on foreign creditors) slowed down adjustment. In particular, if there had been larger foreign exchange adjustments accompanied by debt restructuring, the economy arguably would have recovered more quickly (Lederman, Menendez, Perry and Stiglitz, 2001, 2003).
- <sup>15</sup> Standard macro theories are of two minds about the role of wage and price rigidities. While the Hicksian IS-LM tradition focuses on wage and price rigidities, the Fisherian tradition revived by Greenwald and Stiglitz (1993a, 1993b, and the articles cited there) emphasises that with imperfectly indexed debt contracts wage flexibility may exacerbate economic downturns. In a model where both wages and prices are flexible, but imperfectly so, the economy can have sustained unemployment (see Solow and Stiglitz, 1968).
- <sup>16</sup> Although many sources mention contagion, no consensus has emerged on the precise definition of contagion (see, for example, Gallegati, Greenwald, Richiardi and Stiglitz, 2008). In the broadest sense, contagion involves spill-overs of economic events from one country to other countries (or, in the context of lending, from one borrower to other borrowers). A narrower view, more specific to crisis episodes, defines contagion as an increase in correlations among two countries in bad times or, in the words of Dornbusch, Park and Claessens (2000, p. 178), ‘a significant

increase in cross-market linkages after a shock to an individual country, as measured by the degree to which asset prices or financial flows move together across markets relative to this co-movement in tranquil time.’

- <sup>17</sup> Bank decisions in anticipation of contagion can increase the level of systemic risk. For example, Acharya and Yorulmazer (2008) consider the lending decisions of banks affected by common as well as idiosyncratic shocks. If one bank fails, investors update their assessment of other banks. Investors are unable to tell if the bank failed for bank-specific or systemic reasons, so they become more reluctant to invest in the remaining banks. Anticipating such investor actions, banks try to minimise unfavourable information spill-overs of bank failures by investing in more highly correlated loans. Thus, the expectation of contagion causes banks to herd, which aggravates systemic risk and the magnitude of contagion occurring *ex post*. Nalebuff and Stiglitz (1983) examine the role of incentive conflicts in explaining herding.
- <sup>18</sup> See, for instance, Radner and Stiglitz (1984).
- <sup>19</sup> The general theory is set forth in Korinek (2008).
- <sup>20</sup> Alternatively, if contagion occurred through ‘real’ channels – Mexican purchases of Argentinean goods were enhanced as a result of exchange rate support, because real balance effects are more important than relative price effects – then the Mexican intervention could reduce spill-over effects. These effects did not play an important role in the discussions preceding most of the bailouts.
- <sup>21</sup> Stiglitz (2010c) uses a life cycle model to show that capital market liberalisation may actually reduce the scope for inter-temporal risk sharing, and thus lower the long-term present discounted value of expected utility.
- <sup>22</sup> After each crisis of the 1980s and 1990s, policy makers identified a factor that seemed to be pivotal as the source of a crisis: an overvalued exchange rate, excessive public indebtedness, insufficient private savings, lack of transparency. But the analysis was *ad hoc* and had little predictive power. Mexico’s problems in 1994 were markedly different from those of Latin America in the early 1980s. East Asian countries had high savings rates and low public indebtedness. The last set of countries to suffer from a financial crisis before the East Asian crisis were those of Scandinavia, generally viewed as the most transparent in the world. Furman and Stiglitz (1998) attempt to identify econometrically the factors that contribute to an economy’s vulnerability to a financial crisis. Needless to say, their results confirm the lack of predictive power of the standard explanations of vulnerability to a crisis.