American Economic Review: Papers & Proceedings 100 (May 2010): 398–402
http://www.aeaweb.org/articles.php?doi=10.1257/aer.100.2.398

Credit Externalities: Macroeconomic Effects and Policy Implications

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Financial crises are often preceded by periods of credit expansion during which firms and households become increasingly vulnerable to a reversal in economic conditions. When economic conditions actually worsen, financing constraints become tighter, causing a deeper contraction of economic activity. These events have led to policy proposals for preventing excessive borrowing during "normal times." If rational agents evaluate financing decisions from a privately optimal standpoint, why would the debt level not be socially efficient?

The theoretical literature has offered an answer to this question based on a pecuniary externality that arises due to the presence of financial frictions: private agents tend to undervalue net worth during a period of financial distress because they fail to internalize the fact that additional net worth would have positive spillovers on other agents' balance sheets.[1] As a result, private agents borrow excessively. The quantitative implications of these "credit externalities," however, remain largely unknown. In particular, these key questions have not been addressed:

- To what extent does the undervaluation of net worth generate too much debt relative to the social optimum?
- How large are the welfare losses due to these externalities?

The main goal of this paper is to report recent progress studying these questions using nonlinear dynamic stochastic general equilibrium models (NDSGE) (Javier Bianchi 2009 and Bianchi and Enrique G. Mendoza 2010). These studies yield two key lessons:

- *Credit externalities can produce a significant increase in financial fragility.* Although excessive borrowing on average is only a few percentage points of GDP, the social planner rules out high levels of debt that have a positive probability in the stochastic steady state of the laissez-faire economy. As a result, the incidence and severity of financial crises can increase substantially.

- *Credit externalities entail nontrivial welfare costs.* The welfare losses from the externality range between 0.1 and 0.3 percentage points of consumption across all states of nature. Moreover, correcting the externality can reduce significantly the welfare losses due to the presence of financial frictions. The implementation of the constrained efficient allocations provides a clear role for macroprudential regulation, in particular, discouraging leverage during normal times.

I. A Basic Conceptual Framework

Consider a DSGE model where borrowers face a credit friction that limits the maximum amount of debt d according to the following class of credit constraints:

$$d_{t+1} \leq g_t(y_t, y_{t+1}, k_{t+1}, k_t, p_t, p_{t+1}) \tag{1}$$

According to (1), the maximum amount of debt that an individual can borrow is given by the value of his collateral, which includes asset holdings k and income y, all valued at the corresponding relative price given by the vector p, (e.g., p could be the real price of housing and k the housing stock, or p could be a relative price in terms of the unit in which debt contracts are

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[1] See, e.g., Ricardo J. Caballero and Arvind Krishnamurthy (2001), Guido Lorenzoni (2008), Anton Korinek (2009).

denominated). The collateral value can depend on current or future possible prices.[2]

The informational or contractual frictions behind this constraint could be motivated by limited enforcement or moral hazard. Since the goal is to produce a quantitative assessment of the inefficiency, what is important in comparing the allocations of the competitive equilibrium with those that are socially optimal is that the social planner is also subject to this credit constraint, which is a pervasive feature of financial markets.

The existing literature has shown that these constraints are capable of generating amplification, propagation and asymmetry in the response of macro variables to aggregate shocks. In Bianchi (2009) and Bianchi and Mendoza (2010) we focus instead on comparing the allocations of the decentralized competitive equilibrium with the allocations chosen by a social planner with limited planning abilities. We assume the planner can intervene in some particular markets, e.g., the financial markets, without any additional instrument relative to the private economy while also being subject to the same financial constraints. The motivation for such a comparison is both theoretical and practical. From a theoretical point of view, one would like to know how efficient the allocations produced by the market are, given the technology and the frictions present in the economy. On the practical side, this analysis can contribute to identifying the kind of regulation needed to make market outcomes more efficient.

Why would the constrained social planner choose allocations that reduce financial fragility in the economy? In the absence of the collateral constraint (1), the allocations chosen by the social planner would be identical to those chosen by private agents. But prices affect the ability to borrow; private agents are atomistic and take prices as given, but the social planner internalizes how these prices affect the access to capital markets. When the collateral constraint binds, private agents do not internalize their contribution to the debt-deflation effects. As a result, private agents undervalue net worth; hence, a social planner can increase welfare unambiguously by reducing ex ante the level of debt.

In the next two sections, I review two variants of this basic framework, one with a credit constraint linked to incomes and goods prices, and a second with a more standard collateral constraint linked to asset values. Constraints bind as an equilibrium outcome, and when they bind, they trigger Irving Fisher's (1933) debt-deflation mechanism by which declines in economic activity and the tightness of the constraint mutually reinforce each other.[3] The focus is on studying how credit externalities affect the probability of becoming financially constrained and the severity of the amplification conditional on these episodes.

The use of NDSGE models is important for two reasons. First, these models capture the important nonlinearities that arise when credit constraints become binding. Second, imposing an always-binding constraint underestimates the importance of the externality, since this prevents the social planner both from preserving some borrowing capacity and from reducing the degree of financial fragility.[4]

II. Currency Mismatch

Bianchi (2009) investigates overborrowing in an endowment version of the representative-agent two-sector NDSGE small open economy model with tradable and nontradable goods. Debt is denominated in units of tradables, and a credit constraint links credit-market access to current income, including nontradable income. This setup, proposed by Mendoza (2002), captures in a flexible price setting the phenomenon called "liability dollarization," which the empirical literature has emphasized as being a key transmission mechanism in emerging markets crises.

The economy is populated by identical infinitely lived households that derive utility from the consumption basket, a constant elasticity of substitution (CES) aggregator with elasticity of substitution $1/(\eta + 1)$ between tradable c^T and nontradable goods c^N. Households can borrow

[2] See Cristina Arellano and Mendoza (2003) for an extensive treatment on credit constraints.

[3] See Enrique G. Mendoza (forthcoming).

[4] If the social planner has an additional choice when the credit constraint binds, it can still reduce to some extent aggregate volatility and increase welfare.

up to a fraction κ of their current income, so that:

$$b_{t+1} \geq -\kappa(p_t^N y_t^N + y_t^T) \tag{2}$$

where b is a one period nonstate contingent bond, p^N is the price of nontradable, y^N is the nontradable income and y^T is the tradable income. Note that (2) captures an important regularity in emerging markets: real exchange rate depreciations are contractionary since they reduce domestic net worth, which leads to a tightening of financing conditions. This in turn results in a lower aggregate demand and further depreciations of the real exchange rate.

The externality arises in this setup because decentralized agents take the real exchange rate as given and do not internalize that larger borrowing can lead to a larger real devaluation that negatively affects the economy's ability to borrow.

Simulations based on data from emerging markets suggest that the externality has important effects on the frequency of crises and their magnitude. In particular, the credit externality increases more than seven times the long-run probability of a financial crisis (from 1.1 percent to 8.2 percent) and causes the maximum drop in consumption to increase by 10 percentage points in these episodes (from 14 percent to 24 percent).

The key parameter driving the inefficiency is the elasticity of substitution between tradables and nontradables. When tradable and nontradable goods become highly substitutable, a lower increase in the real exchange rate is needed to restore equilibrium in response to a negative aggregate shock. As a result, the feedback loop between the real exchange rate and financing conditions is weakened, as well as the externality. For the range of parameter values typically used in the literature, the inefficiency tends to be significant, but for values higher than two the quantitative effects of the externality become small.

The often advocated imposition of taxes on capital inflows, which have recently been implemented by Brazil and Taiwan, can be rationalized by this model. As Bianchi (2009) shows, the social planner's allocations can be decentralized with a state contingent tax on capital inflows. The tax is levied only in normal times, i.e., when the constraint does not bind, in order to make agents internalize the external costs of borrowing.[5]

In practice, state contingent taxes may be difficult to implement since they require large amounts of information and flexibility to adjust them in response to macro shocks. This raises the question of whether there are some simpler forms of intervention that can result in welfare gains. I extend this analysis and show that even fixed taxes can have significant impact on welfare.

Among the class of fixed taxes on capital inflows, the optimal tax is 4 percent, which is about the average of the optimal state contingent tax. This tax can achieve about 70 percent of the welfare gains that would be obtained with the optimal state contingent tax. Beyond the level of 6 percent, taxes generate a distortion of "oversavings" which exceed the benefits of avoiding more recurrent financial crises.

The previous analysis can be enriched by endogenizing the supply side of the economy. To the previous model I add firms that produce nontradable goods using imported inputs and transfer profits to households.[6] When the credit constraint becomes binding, the rise in the real exchange rate reduces the marginal value of production in the nontradable sector, dragging down output and deepening the Fisherian deflation. In fact, for the same baseline calibration as above, the introduction of this supply-side channel more than doubles the welfare losses of the credit externality.

A limitation of this setup is that the ability to borrow is not affected by the value of collateralized assets. The next section shows how the previous normative analysis can be extended to such a framework.

III. Asset Debt-Deflation

Bianchi and Mendoza (2010) study a model in which the credit externality operates through

[5] In a model that shares several features, Gianluca Benigno, Huigang Chen, Christopher Otrok, Alessandro Rebucci and Eric Young (2009) found that a Ramsey planner would subsidize nontradable goods during a financial crisis, a result related to Lawrence Christiano, Cristopher Gust and Jorge Roldos (2004), who found that stabilization plans are optimal in response to crises when they are unanticipated.

[6] This feature of the model is borrowed from Bora Durdu, Mendoza and Marco E. Terrones (2009).

asset prices instead of the real exchange rate and calibrates the model to US data. The model also borrows from Mendoza (forthcoming) the idea that, in addition to household debt, the credit constraint applies to working capital loans that finance a fraction of the wage bill. This introduces a transmission mechanism by which the credit friction affects output and dividend payments, and hence it can magnify the distortions induced by the credit externality. A tightening of the collateral constraint leads to an increase in the effective cost of labor, reducing labor demand. In turn, this makes capital less productive and tightens further the borrowing constraint. As a result, the private economy experiences deeper recessions than is socially optimal.

The economy is populated by identical infinitely-lived entrepreneurs that obtain utility from consuming the only final good in the economy and leisure. An entrepreneur holding land L_t at the start of period t can employ labor h^d to produce general output $y = A_t f(L_t, h_t^d)$ where A follows a Markov process. Working capital loans pay for a fraction θ of the cost of labor in advance of sales. These loans are obtained from foreign lenders at the beginning of each period and repaid at the end of the same period. Profits are given by $\pi_t = A_t f(L_t, h_t^d) - w_t h_t^d (1 + \theta(R - 1))$, where w_t denotes the wage rate. The budget constraint is given by:

$$(3)\quad q_t L_{t+1} + c_t + \frac{b_{t+1}}{R_t} = \pi_t + q_t L_t + b_t + w_t h_t^s$$

where q_t is the price for land and h^s is labor supply. Agents face a collateral constraint that limits total debt, including working capital not to exceed the market value of their assets:

$$(4)\qquad -\frac{b_{t+1}}{R_t} + \theta R_t w_t h_t^d \leq \kappa q_t L_{t+1}.$$

Quantitative analysis shows that the credit externality also has significative effects in this model. In a crisis, asset prices decline about 21 percent for the decentralized equilibrium and 6 percent for the social planner. The credit crunch is also significantly larger due to the externality. The amount of credit available in the decentralized economy drops by 11 percent compared with 1 percent for the social planner. Recessions also become more severe, as output can drop by about two percentage points more.

IV. Discussion

A new paradigm has emerged in financial regulation which supports the need for macroprudential regulation in order to safeguard the stability of the financial system. A key feature of this approach is the consideration of how distress in the financial sector can affect the real economy and how developments in the real economy can feed back again to the financial sector. Our analysis provides further support for this approach by establishing that the externalities that arise due to these feedback effects can be quantitatively relevant.

The models reviewed can be extended in several directions. The fact that a social planner finds it optimal to increase the cost of borrowing during normal times suggests that it could be desirable to adjust capital requirements during the cycle, as is often suggested. Even if this has a cost in terms of lower output expansion, increasing capital requirements in periods of economic expansion should be welfare-improving in the presence of credit externalities. Moreover, it has the advantage of avoiding the moral hazard problems of policies that tend to relax financial constraints during crises, e.g., bailouts.

The interventions of the social planner in the papers reported here are focused on the financial markets but could easily be extended to other markets. In a monetary model, raising the interest rate during a credit boom may be justified on the grounds of the credit externalities discussed in this paper. Even if an increase in asset prices reflects the pure fundamentals of the economy, an increase in the interest rate may discourage leverage and reduce the externalities that agents impose on each other by performing fire sales in periods of financial distress.

While this analysis has focused on excessive debt accumulation, the results suggest that private calculation of risk can lead to socially inefficient choices in other dimensions of the financial markets that may also be quantitatively important. Other examples of underinsurance which seem pervasive in the financial markets include large amounts of short-term debt, and

maturity and currency mismatch. Extending the study of credit externalities in a DSGE framework to evaluations of these and other forms of excessive risk-taking are an important task for future research.[7]

To conclude, it is important to note that the underlying reason behind the externality is the lack of financial development that leads to perverse effects during economic downturns. Therefore, an important goal should also be to improve the institutions that hinder financial development: improving property rights, transparency, contract enforcement, etc. Explicit microfoundations of the limitations in how markets operate would be desirable for conducting a normative analysis that includes policies of this nature. Clearly, there are a number of reasons why financial markets will never be developed enough. Under these circumstances, addressing excessive financial fragility remains an important task in the research agenda.

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[7] A recent paper making additional progress in investigating credit externalities is Olivier Jeanne and Anton Korinek (2009).