

Decoupling and Recoupling

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The financial crisis that has engulfed the world over the past three years started out in a relatively small set of sectors in a select number of countries, particularly the real estate sector in the United States. At first (February 2007 to May 2008), financial problems seemed to stay confined to the sectors and countries of origin, with little repercussion on other sectors in the United States or on emerging countries. In fact, policymakers in the developing world would brag about this “decoupling” from the United States as a sign of the economic maturity reached by their domestic economies.¹ However, starting around May 2008 – and particularly after the collapse of Lehman (September 15, 2008) – the financial crisis began to spread like wildfire, affecting countries all around the world, with asset and stock prices collapsing in unison.²

This paper develops a stylized model of decoupling and recoupling that captures these phenomena in an environment where heterogeneous entrepreneurial sectors face financial constraints in their relationship with a common set of lenders. In response to adverse shocks, a financially constrained sector must reduce its borrowing and cut down on production. In particular, as the constrained sector absorbs less and less capital, the real interest rate in the economy declines. Other sectors that compete for the same inputs (in-

cluding capital) thus experience lower costs, which boosts investment, output, and profits, reflecting the phenomenon of “decoupling.” As long as the shock is small, the entrepreneurial sector repays what is owed and the lenders’ ability to supply funds is unaffected. If the adverse shock exceeds a certain threshold, however, the constrained sector is no longer able to honor its debts in full and lenders experience losses that erode their lending base. This induces them to cut their supply of credit to the rest of the economy, which reduces output and profit for all other entrepreneurial sectors, capturing the phenomenon of “recoupling” or contagion.³

I. Model

We assume an economy with one homogenous consumption/investment good that spans over two time periods $t = 1, 2$. The economy consists of a combined household/banking sector that provides finance and values consumption, and N entrepreneurial sectors that access finance to engage in production and value final profits. We can interpret this set-up as a world in which (i) households provide finance to N different countries through global capital markets or (ii) a closed economy with N different productive sectors.

A. Household/Banking Sector

The consolidated household/banking sector consists of a continuum of identical agents that have an exogenous and constant endowment e and consume c_t , which provides utility according to the function $U = \log(c_1) + \log(c_2)$.⁴ A representative household obtains repayments $R_1 d_1$ from the entrepreneurial sectors at the beginning of period 1, where d_1 is

³For empirical documentation that episodes of contagion typically involve common lenders, see Graciela L. Kaminsky, Carmen M. Reinhart, and Carlos A. Végh (2003).

⁴For analytical simplicity, we combine households and banks in our benchmark model. As discussed below, our results would be magnified if we separated the two sectors and allowed for leverage in the banking sector.

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¹In mid-September 2008, Brazil’s president, Lula da Silva, was quoted as saying “What crisis? Go ask Bush.” A few weeks later, Brazil’s stock market and currency plummeted by 20 and 13 percent, respectively (Bloomberg.com, December 3, 2008, “Lula, Like Bush, Gives Bad Shopping Advice”).

²This “decoupling-recoupling” sequence is well documented in Michael P. Dooley and Michael M. Hutchinson (2009) for emerging markets as a whole and in Alejandro Izquierdo and Ernesto Talvi (2009) for Latin America.

the total amount owed by the entrepreneurs and R_1 is an average gross real interest rate. The household also provides d_2 in loans to the entrepreneurial sectors at a gross real interest rate of R_2 to be repaid in period 2.⁵ The resulting optimization problem is

$$\max_{d_2} \log(e + R_1 d_1 - d_2) + \log(e + R_2 d_2),$$

leading to the first-order condition

$$R_2 = \frac{c_2}{c_1}.$$

It is easy to show that c_1 is a decreasing function of R_2 . Since

$$(1) \quad d_2 = e + R_1 d_1 - c_1,$$

this implies that d_2 , the supply of loans to entrepreneurs in period 1, is increasing in R_2 . Further, a reduction in d_1 will shift leftward the supply of loans for a given R_2 .

B. Entrepreneurial Sector

We assume that each of the N entrepreneurial sectors consists of a continuum of identical entrepreneurs of mass 1 that are risk-neutral and value their profits π^i , which they consume at the end of period 2, according to the linear utility function $U^i = \pi^i$ ($i = 1, \dots, N$). Let d_1^i be the initial debt obligation of a representative entrepreneur in sector i and R_1^i the corresponding gross real interest rate.⁶ The entrepreneur enters period 1 with a predetermined debt obligation of $R_1^i d_1^i$ that is due in period 1 and with productive output of $A_1^i F(k_1^i)$, where A_1^i is a productivity parameter that can take values in $[0, \bar{A}]$, k_1^i is a predetermined level of capital that fully depreciates at the end of period 1, and $F(\cdot)$ is a decreasing returns-to-scale production function.⁷ If production is insufficient to cover the debt, the entrepreneur goes

⁵We will assume, of course, that $d_1 > 0$, which ensures that households will want to lend (i.e., $d_2 > 0$).

⁶We index R_1^i by i because, even though this falls outside the scope of our model, different sectors could have faced different gross real interest rates in light of the possibility of default.

⁷Alternatively, the value of A_1^i could be interpreted as the outcome of a random productivity shock that was realized before we begin our analysis.

bankrupt and lenders obtain the entire output. Formally, the entrepreneur repays the lender

$$\hat{d}_1^i = \min \left\{ d_1^i, A_1^i F(k_1^i) / R_1^i \right\},$$

where \hat{d}_1^i is the actual payment. Hence, the total repayments from the N entrepreneurial sectors to households is $R_1 d_1 = \sum R_1^i \hat{d}_1^i$.

The entrepreneur's net worth at the beginning of period 1 is

$$n_1^i = \max \left\{ A_1^i F(k_1^i) - R_1^i d_1^i, 0 \right\}.$$

The entrepreneur then decides how much debt d_2^i to issue as a function of R_2 and how much to invest in next-period production. Total period 2 investment is financed from net worth and borrowing:

$$k_2^i = n_1^i + d_2^i.$$

This capital investment produces period 2 output of $A_2^i F(k_2^i)$, where we set for simplicity $A_2^i = A \forall i$. This implies that we can rule out bankruptcy in period 2.

However, we assume that there is a moral hazard problem in period 1, which imposes a credit limit on d_2^i . After having borrowed in period 1, a producer has an opportunity to move the project into a scam that hides income in period 2. Creditors can challenge this in court but can recover at most a fraction $[\alpha/(1 + \alpha)] \in (0, 1)$ of the entrepreneur's total assets because of imperfect enforcement. To avoid losses from potential fraud, creditors limit the amount of borrowing by entrepreneurs to

$$d_2^i \leq \frac{\alpha}{1 + \alpha} k_2^i \text{ or } d_2^i \leq \alpha n_1^i.$$

The optimization problem of a representative entrepreneur in sector i consists in choosing d_2^i to maximize profits subject to the borrowing constraint and is described by the Lagrangian:

$$\mathcal{L}^i = AF(n_1^i + d_2^i) - R_2 d_2^i - \lambda^i (d_2^i - \alpha n_1^i),$$

where λ^i is the shadow price on the borrowing constraint. The problem results in the first-order condition

$$AF'(k_2^i) = R_2 + \lambda^i.$$

If the constraint is loose, this reduces to the standard neoclassical condition. Entrepreneurs invest and borrow optimally:

$$(2) \quad \begin{aligned} k_2^*(R_2) &= F'^{-1}(R_2/A), \\ d_2^i &= k_2^*(R_2) - n_1^i. \end{aligned}$$

The optimal capital stock is independent of individual-specific variables and only depends on the cost of capital R_2 in the economy. This yields period 2 profits of

$$\pi_{\text{unc}}^i = AF(k_2^*(R_2)) - R_2[k_2^*(R_2) - n_1^i],$$

where it is straightforward to show that $\partial\pi^i/\partial n_1^i > 0$ and $\partial\pi^i/\partial R_2 < 0$ as long as the entrepreneur is a net borrower, i.e. $n_1^i < k_2^*(R_2)$.

If the constraint is binding, a wedge opens between the entrepreneur's cost of funds and the marginal product, in which case the level of borrowing and investment are determined by the constraints

$$\begin{aligned} d_2^i &= an_1^i, \\ k_2^i &= (1+a)n_1^i. \end{aligned}$$

The capital stock is now independent of the real interest rate in the economy and only depends on entrepreneurial net worth. This results in period 2 profits given by

$$\pi_{\text{con}}^i = AF((1+a)n_1^i) - aR_2n_1^i,$$

which also satisfies $\partial\pi^i/\partial n_1^i > 0$ and $\partial\pi^i/\partial R_2 < 0$.

Note that if $n_1^i = 0$ because of bankruptcy in period 1, the entrepreneur cannot borrow and invest due to the constraint, and thus produces and consumes zero in period 2.

II. Equilibrium

For given initial conditions, a decentralized equilibrium in the economy consists of a bundle $\{(d_2^i, k_2^i, R_2)\}_{i=1}^N$ that is a solution to the maximization problems of the household/banking and the entrepreneurial sectors and satisfies the market clearing condition for debt

$$d_2 = \Sigma d_2^i.$$

Our characterization of the economy's equilibrium allows us to study the phenomena of decoupling and recoupling. For simplicity, we assume there are two productive sectors labeled by $i = X, Z$, of which sector Z has a value of A_1^Z that is sufficiently high so as to be always unconstrained during the ensuing experiment. We study how the equilibrium changes as we vary the productivity of sector X over the range $[0, \bar{A}]$ for given initial capital and debt positions. To capture the traditional role of entrepreneurs as net demanders of finance, we assume that the initial debt and capital levels of both entrepreneurial sectors are such that they remain net borrowers in period 1.

A. Unconstrained Economy

If period 1 productivity in sector X is sufficiently high $A_1^X \geq A_{\text{unc}}$, the sector is unconstrained and the economy follows standard neoclassical rules. The threshold A_{unc} is determined by the productivity level A_1^X that leads to a sectoral net worth n_1^X such that

$$(1+a)n_1^X = k_2^*.$$

Households receive the promised amount $R_1d_1 = R_1^X d_1^X + R_1^Z d_1^Z$ in period 1 and supply loans according to (1), and both entrepreneurial sectors demand loans according to their optimality condition (2).

Within this region, greater sector X productivity means higher entrepreneurial net worth n_1^X and therefore a lower demand for loans $d_2^X(R_2)$. As a result, the interest rate R_2 declines, and the optimum amount of investment as well as profits in both sectors increase. A positive shock in sector X therefore spills over positively to sector Z .

B. Decoupling

If the productivity of sector X drops below A_{unc} , the sector becomes constrained. As long as net worth n_1^X is positive, the sector can honor its repayments and households receive the promised amount R_1d_1 in period 1. This is the case as long as

$$A_1^X \geq R_1^X d_1^X / F(k_1^X) \equiv A_{\text{fail}}.$$

Within this region, lower period 1 productivity for a constrained entrepreneur tightens the constraint, leads to lower loan demand and a lower interest rate R_2 . Sector Z reacts by increasing investment and profits, i.e., a negative shock in sector X spills over positively

to sector Z . The worse the productivity shock for sector X , the better off is sector Z – there is decoupling.⁸

C. Recoupling

For $A_1^X < A_{\text{fail}}$, sector X defaults and households receive a total repayment of $R_1 d_1 = R_1^Z d_1^Z + A_1^X F(k_1^X)$. With sector X being wiped out, period 1 productivity in this region affects directly the capital position of households/bankers. A lower period 1 productivity for a constrained entrepreneur reduces period 1 wealth of households/bankers, which makes them less willing to lend and increases the interest rate R_2 at which they are willing to provide a given amount of loans. As a result, sector Z invests less and obtains lower profits. Within this region, negative shocks to sector X spill over negatively to sector Z – there is recoupling (i.e., contagion).

III. Illustration

In Figure 1, we illustrate the three regions that arise as we reduce the productivity parameter A_1^X from \bar{A} ($= 1.3$) to 0.2 (i.e., as we move from right to left): unconstrained, decoupling, and recoupling, each separated by a dotted vertical line. We use $F(k) = \sqrt{k}$ for the production function and set the following parameters: $\alpha = .5$, $e = 0$, $A = 1.2$, $A_1^Z = 1$, $k_1^i = 1$, and $R_1^i d_1^i = .5$ in each sector i .

For high values of the productivity parameter A_1^X , i.e., to the right of the figure, both sectors are unconstrained and lower productivity in sector X decreases profits (i.e., welfare) in both sectors as the cost of capital increases. In the center of the figure, there is decoupling: since the demand for loans of sector X is progressively constrained, the interest rate declines and sector Z is better off. In the left region of the figure, sector X goes bankrupt and the supply of loans to the entrepreneurial sector is reduced, pushing up the interest rate R_2 .⁹ This hurts sector Z , i.e., there is recoupling.

⁸Note that there are two effects on the welfare of sector X : on the one hand, it is hurt by the binding constraint, but on the other hand it benefits from the lower interest rate. The net effect of the two can initially be positive. However, as productivity declines further and the sector approaches the bankruptcy threshold, sectoral welfare will unambiguously decline until it reaches zero at the threshold.

⁹Note that this behavior of interest rates is consistent

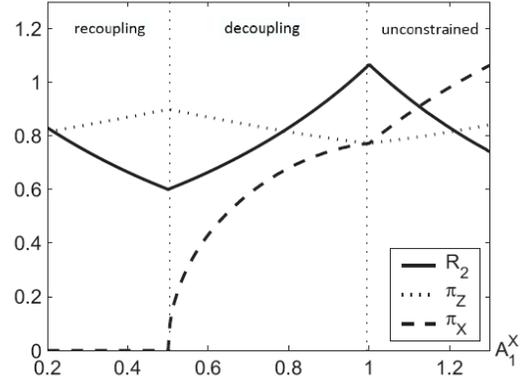


FIGURE 1. DECOUPLING AND RECOUPLING

IV. Extensions

There are several dimensions in which our benchmark model can be extended to provide further insights:

- (i) *Dynamics* In the recent financial crisis, decoupling and recoupling occurred sequentially, whereas in our model we are, strictly speaking, conducting a comparative statics exercise. In a multi-period version of our model, recoupling could occur after an episode of decoupling, if a series of adverse shocks progressively depletes the net worth of a constrained sector to the point where it is pushed into bankruptcy.
- (ii) *Factor Prices* In our benchmark model, the only factor of production is capital. More generally, other factors, such as labor or commodities, are complements to capital in standard production functions. The less capital is employed in the economy, the lower is the demand for other factors. This would lead to a fall in commodity prices and, in labor markets with sticky wages, to unemployment.
- (iii) *Bankruptcy Costs* If we add to our model bankruptcy costs that reduce the receipts of banks by a factor $1 - \delta$ in case of bankruptcy, then

with the behavior of actual lending rates during the recent crisis, though not with the Fed Funds rate: after the demise of Lehman, lending rates (and, since there was widespread rationing, shadow lending rates) shot up sharply.

there would be a discontinuity at A_{fail} that would cause the interest rate to jump up and welfare to fall, magnifying the impact of defaults.

- (iv) *Leveraged Banks* Modifying our benchmark model by separating households and the banking sector and introducing leverage in the latter can amplify the propagation of defaults. Leverage implies that the impact of a shock on the net worth of banks is magnified. Hence, if banks experienced financial constraints in their relationship with households, our contagion results would be strengthened.
- (v) *Efficiency Considerations* In the framework we have described in this paper, the decentralized equilibrium is constrained-efficient, since there are no actions that a planner could undertake to coordinate the economy on a better equilibrium. However, if we introduce additional degrees of freedom for our agents, such as the possibility to choose the amount of initial debt, inefficiencies may arise. This is particularly the case if there are relative prices, such as exchange rates or asset prices, that are adversely affected by contagion dynamics (see e.g. Anton Korinek, 2010).

We explore these extensions in more detail in our companion paper (Anton Korinek, Agustín Roitman and Carlos A. Végh, 2010).

V. Conclusions

We have presented a stylized model that captures the decoupling-recoupling phenomenon observed after the subprime crisis erupted in the United States in February 2007. There are two “sectors” in our model that experience first decoupling and then recoupling as productivity falls in one of them. These two sectors could be given a literal interpretation (i.e., the real estate and manufacturing sectors within a country being financed by the financial sector) or a broader interpretation in terms of different countries (i.e., United States and Brazil being financed by international capital markets). In our companion paper, we embed this mechanism in a model with leverage and show how this decoupling-recoupling cycle is further amplified.

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