NBER WORKING PAPER SERIES

DECOUPLING AND RECOUPLING

Anton Korinek
Agustín Roitman
Carlos A. Végh

Working Paper 15907
http://www.nber.org/papers/w15907

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
April 2010

We are grateful to Olivier Jeanne and participants at the 2010 AEA meetings for helpful comments and to Alejandro Izquierdo (IDB) for kindly providing us with data for emerging countries. A shorter version of this paper will be published in the American Economic Review Papers and Proceedings (May 2010). The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

Decoupling and Recoupling
Anton Korinek, Agustín Roitman, and Carlos A. Végh
NBER Working Paper No. 15907
April 2010
JEL No. E44,F34,F41

ABSTRACT

We develop a stylized model that captures the phenomena of decoupling and recoupling 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 (including 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. For large shocks, 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.

Anton Korinek
University of Maryland
Tydings Hall 4118F
College Park, MD 20742
akorinek@gmail.com

Agustín Roitman
Department of Economics
University of Maryland
College Park, MD 20742
roitman@econ.umd.edu

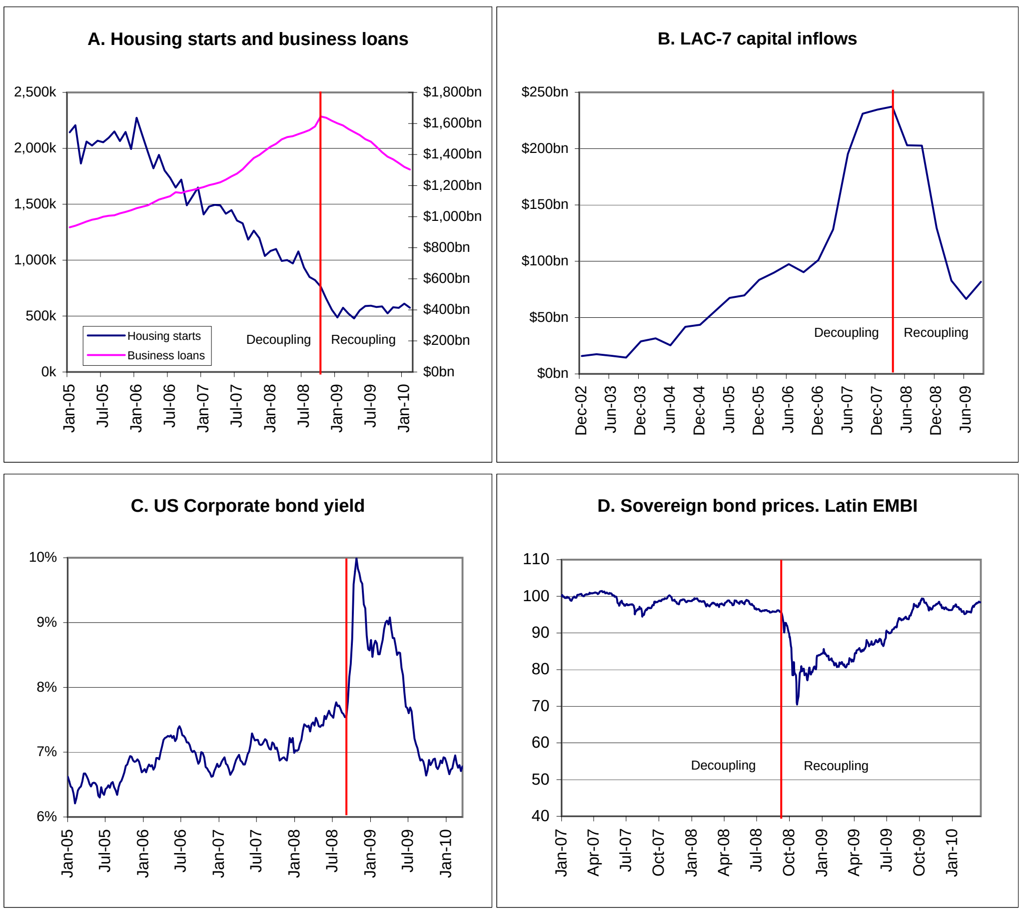
Carlos A. Végh
Department of Economics
Tydings Hall, Office 4118G
University of Maryland
College Park, MD 20742-7211
and NBER
vegh@econ.bsos.umd.edu

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. The rise in U.S. interest rates from about 1 to 5 percent between 2004 and 2006 combined with excessively lax lending standards triggered a wave of defaults on mortgages – particularly in the sub-prime sector – that led to a slowdown in the housing market. As illustrated in Figure 1, Panel A, housing starts peaked in early 2006 and have fallen dramatically ever since. At first (February 2007 to May 2008), however, financial problems seemed to stay confined to the sectors and countries in which they originated, with little repercussion on other sectors in the United States or on emerging countries. Business loans from commercial banks in the United States, for instance, continued to increase steadily throughout this period (Panel A). And, if anything, capital inflows into emerging countries became stronger (Panel B). 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] This period of decoupling is also evident from looking at corporate bond yields in the United States (Panel C) and sovereign bond prices for emerging markets (Panel D), both of which remained relatively unaffected during this period. The decoupling, however, began to unravel starting around May 2008 – and particularly after the collapse of Lehman (September 15, 2008) – as the financial crisis began to spread like wildfire, affecting countries all around the world, with asset and stock prices collapsing in unison. In the United States, business loans plummeted (Panel A) and corporate yields spiked violently (Panel C). In emerging markets, capital inflows collapsed and bond prices fell dramatically (Panel D).[2]

[1] In 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").

[2] This "decoupling-recoupling" sequence is well documented in Dooley and Hutchinson (2009) for emerging markets as a whole and in Izquierdo and Talvi (2009) for Latin America.

Figure 1: Decoupling and Recoupling During the Global Crisis of 2008-2010



Sources: Federal Reserve Bank of St. Louis, U.S. Census Bureau, and Inter-American Development Bank

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 (including 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]

1 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.[4] We can interpret this set-up alternatively 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.

[3]For empirical documentation that episodes of contagion typically involve common lenders, see Kaminsky, Reinhart, and Végh (2003).

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

1.1 Household/Banking Sector

The consolidated household/banking sector consists of a continuum of identical agents that have an exogenous and constant endowment e per period and consume c_t, which provides utility according to the function $U = \log(c_1) + \log(c_2)$. A representative household obtains repayments $R_1 d_1$ from the entrepreneurial sectors at the beginning of period 1, where d_1 is 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. We assume that $d_1 > 0$ to ensure that households have an incentive to lend, i.e. $d_2 > 0$. The optimization problem of households/banks is

$$\max_{d_2} \log(e + R_1 d_1 - d_2) + \log(e + R_2 d_2), \tag{1}$$

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.[5] Since

$$d_2 = e + R_1 d_1 - c_1, \tag{2}$$

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.

1.2 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

[5] As shown in the appendix, this result holds for more general utility functions under certain regularity conditions.

function $U^i = \pi^i$ $(i = 1, .., N)$. 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 bankrupt and lenders obtain the entire output. Formally, the entrepreneur repays the lender

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

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

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

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

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

[6] We 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.

[7] Alternatively, 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.

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

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

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

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

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

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

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

$$\begin{aligned} k_2^*\left(R_2\right) &= F'^{-1}\left(R_2/A\right), \\ d_2^i &= k_2^*\left(R_2\right) - n_1^i. \end{aligned} \tag{3}$$

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

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

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. $n_1^i < k_2^*\left(R_2\right)$.

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

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

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

$$\pi_{\text{con}}^{i} = AF\left((1+\alpha)\, n_1^i\right) - \alpha R_2 n_1^i,$$

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.

2 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 $\left[0, \bar{A}\right]$ 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.

2.1 Unconstrained Economy

If period 1 productivity in sector X is sufficiently high $A_1^X \geq A_{\text{unc}}^X$, the sector is unconstrained and the economy follows standard neoclassical rules. The threshold A^X_{unc} is determined by the productivity level A^X_1 that leads to a sectoral net worth n^X_1 such that

$$(1+\alpha)\, n^X_1 = k^*_2.$$

Households receive the promised amount $R_1 d_1 = R^X_1 d^X_1 + R^Z_1 d^Z_1$ in period 1 and supply loans according to (2), and both entrepreneurial sectors demand loans according to their optimality condition (3).

Within this region, greater sector X productivity means higher entrepreneurial net worth n^X_1 and therefore a lower demand for loans $d^X_2(R_2)$. 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.

2.2 Decoupling

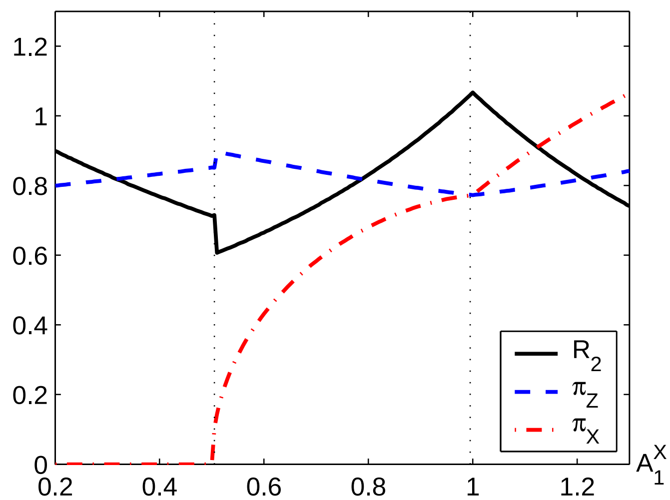
If the productivity of sector X drops below A^X_{unc}, the sector becomes constrained. As long as net worth n^X_1 is positive, the sector can honor its repayments and households receive the promised amount $R_1 d_1$ in period 1. This is the case as long as

$$A^X_1 \geq R^X_1 d^X_1 / F\left(k^X_1\right) \equiv A^X_{\text{fail}}.$$

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]

[8]Note 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.

Figure 2: Decoupling and Recoupling



2.3 Recoupling

For $A_1^X < A_{\text{fail}}^X$, sector X defaults and households receive a total repayment of $R_1 d_1 = R_1^Z d_1^Z + A_1^X F\left(k_1^X\right)$. 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 that they charge. 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).

3 Illustration

In Figure 2, 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.

4 Extensions

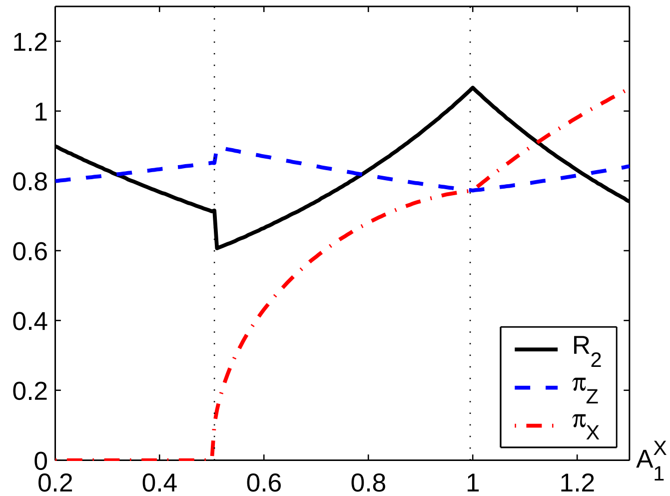
There are several dimensions in which our benchmark model can be extended to provide further insights:

(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.

[9] Note that this channel of transmission is consistent with the evidence presented in Figure 1, where we can see that business loans begin to fall (Panel A) and corporate yield rates spike sharply (Panel C) at the begining of the recoupling period.

Figure 3: Recoupling with Bankruptcy Costs



(iii) *Bankruptcy Costs* If we add to our model bankruptcy costs that reduce the recovery rate on assets seized by banks by a factor δ in case of bankruptcy, then there is a discontinuity at A_{fail} that would cause the interest rate to jump up and welfare to fall, magnifying the impact of defaults. An example of this is given in Figure 3.

(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. Korinek, 2010).

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

5 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.

References

[1] Dooley, Michael P., and Michael M. Hutchison. 2009. "Transmission of the U.S. Subprime Crisis to Emerging Markets: Evidence on the Decoupling-Recoupling Hypothesis," *NBER Working Paper No.* 15120.

[2] Izquierdo, Alejandro, and Ernesto Talvi. 2009. Policy Trade-offs for Unprecedented Times. Washington, DC: IDB.

[3] Kaminsky, Graciela L., Carmen M. Reinhart and Carlos A. Végh. 2003. "The Unholy Trinity Of Financial Contagion." *Journal of Economic Perspectives* 17(4): 51-74.

[4] Korinek, Anton. 2010. "Regulating Capital Flows to Emerging Markets: An Externality View." Unpublished.

[5] Korinek, Anton, Agustín Roitman, and Carlos A. Végh. 2010. "A Dynamic Model of Decoupling and Recoupling." Unpublished.

6 Mathematical Appendix

6.1 Household/Banking Sector

For general utility functions, the first order condition to the optimization problem of the household/banking sector (1) is

$$u'(c_1) = R_2 u'(c_2).$$

By implicitly differentiating this Euler equation, we obtain the slope of the supply of lending

$$\frac{dd_2}{dR_2} = -\frac{u'(c_2) + R_2 d_2 u''(c_2)}{u''(c_1) + R_2 u''(c_2)}.$$

Since the denominator is negative, this expression is unambiguously positive as long as the following condition is met:

Condition 1 $\frac{\partial R_2 u'(c_2)}{\partial R_2} = u'(c_2) + R_2 d_2 u''(c_2) > 0$

Intuitively, the condition states that the consumer's marginal period 2 utility from lending in period 1 responds positively to higher interest rates – the effect consists of the (positive) marginal utility $u'(c_2)$ gained from the higher interest rate minus the (negative) indirect effect that the marginal utility declines at rate $u''(c_2)$ as consumption rises.

There are two alternative sufficient conditions under which the condition is satisfied. First, it is met whenever the curvature of the households utility function as measured by the coefficient of risk aversion $u''(\cdot)/u'(\cdot)$ is sufficiently low so that increases in consumption do not depress the marginal utility at too fast of a rate. This is for example the case for log-utility as in our specification of the household's problem in (1). For that case we find that

$$u'(c_2) + R_2 d_2 u''(c_2) = \frac{1}{c_2}\left[1 - \frac{R_2 d_2}{c_2}\right] > 0,$$

since the payment obtained $R_2 d_2 < e + R_2 d_2 = c_2$ and the fraction is always less than one.

Secondly, the condition is met for arbitrary utility functions whenever the amount lent d_2 is sufficiently low. For example, for the class of CRRA utility functions with a coefficient of relative risk aversion θ, we find

$$u'(c_2) + R_2 d_2 u''(c_2) = c_2^{-\theta}\left[1 - \theta \frac{R_2 d_2}{c_2}\right].$$

As long as d_2 is sufficiently low so that $\theta R_2 d_2 < c_2$, the condition is satisfied. For the standard value $\theta = 2$ that is often chosen in the literature, the repayment received has to constitute less than half of total consumption. This is generally satisfied in models where households derive approximately two thirds of their income from labor.

The response of the period 2 lending rate R_2 to changes in the period 1 repayment is

$$\frac{dR_2}{d(R_1 d_1)} = \frac{u''(c_1)}{u'(c_2) + R_2 d_2 u''(c_2)}.$$

This derivative is negative whenever condition 1 is met, as is the case for the log-utility that we used in problem (1).