The real effects of financial disruptions in a monetary economy

Miroslav Gabrovski, Athanasios Geromichalos, Lucas Herrenbrueck, Ioannis Kospentaris, and Sukjoon Lee;
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WEB APPENDIX

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A. Steady State Equilibrium

In the steady state equilibrium conditions, we summarize the opportunity cost of holding money via the transformation $i \equiv (1+\mu)/\beta - 1$, which can also be interpreted as a benchmark yield on a completely illiquid asset. (Thus, i should not be thought of as representing, for instance, the yield on T-bills; see Geromichalos and Herrenbrueck, 2022 and Herrenbrueck, 2019.) While using i makes the following equations easier to read, the exogenous monetary policy instrument is still the money growth rate μ. Moreover, the stochastic terms $\lambda_{a,t}$ and $\alpha_{F,t}$ are evaluated at their unconditional means, denoted by $\overline{\lambda}_a$ and $\overline{\alpha}_F$ respectively (see the detailed stochastic specifications in Section 4.2 of the paper). The steady state equilibrium is characterized by the following set of equations:

$$i \geq \lambda_m \frac{f_G}{b_G}\left[\frac{u'(q)}{\sigma'(q)} - 1\right], \quad \text{“}=\text{”} \text{ holds if } z > 0,$$

$$q = \min\{q^*,\, \sigma^{-1}(\lambda_m z + \overline{\lambda}_a a)\},$$

$$z = \varphi M,$$

$$a = A,$$

$$A = b_L \frac{\kappa_R + \kappa_O}{\psi} + (1-s_L)\frac{f_F}{b_F}(1-\delta)\frac{\kappa_O}{\psi},$$

$$\psi = \beta\left(1 + \overline{\lambda}_a \frac{f_G}{b_G}\left[\frac{u'(q)}{\sigma'(q)} - 1\right]\right),$$

$$\frac{\kappa_R + \kappa_O}{\psi} + \frac{f_L}{b_L}\frac{\beta\frac{f_F}{b_F}(1-\delta)}{1-\beta\frac{f_F}{b_F}(1-\delta)}\frac{\kappa_O}{\psi} + \left(\frac{1}{\beta\frac{f_F}{b_F}} + \frac{f_L}{b_L}\frac{1}{1-\beta\frac{f_F}{b_F}(1-\delta)}\right)\kappa_F = \frac{f_L}{b_L}\frac{R-w}{1-\beta\frac{f_F}{b_F}(1-\delta)},$$

$$w = \frac{(1-\eta_L)\big(1-\beta\frac{f_F}{b_F}(1-\delta)\big)b + \eta_L\big(1-\beta\big(\frac{f_F}{b_F}(1-\delta) - \frac{f_L}{s_L}\big)\big)\big(R - \beta\frac{f_F}{b_F}(1-\delta)\frac{\kappa_O}{\psi} - \kappa_F\big)}{1-\beta\frac{f_F}{b_F}(1-\delta) + \eta_L\,\beta\,\frac{f_L}{s_L}},$$

$$(1-s_L)\left(1 - \frac{f_F}{b_F}(1-\delta)\right) = f_L,$$

$$b_L = \epsilon \cdot f_F/b_F,$$

$$s_G = 1 - s_L,$$

$$b_G = 1,$$

$$s_F = 1,$$

$$b_F = \epsilon + 1 - s_L.$$

The first six equations represent the money and bond market equilibrium conditions, the next two describe the financial and labor market equilibrium conditions, and the last six pertain to the measures of sellers and buyers in each market. We use this system of equations to solve for the steady state values $(q, z, a, A, \varphi, \psi, w, s_L, b_L, s_G, b_G, s_F, b_F, \epsilon)$.

B. Details for the Empirical Evidence in Section 5.1

B.1. Money Holdings

Data. The left panel of Figure 6 plots the detrended time series of aggregate money holdings as a fraction of nominal GDP, a fraction of money, debt and equity holdings, and a fraction of all financial assets. All are computed using the household balance sheet data from the Board of Governors of the Federal Reserve System, except for nominal GDP (which is from the U.S. Bureau of Economic Analysis; FRED Series GDP). The aggregate money holdings are the sum of checkable deposits and currency (FL153020005), time and savings deposits (FL153030005), and money market fund shares (FL153034005). Households' money, debt and equity holdings are the sum of aggregate money holdings (defined as before), debt securities (LM154022005), corporate equities (LM153064105), miscellaneous other equity (LM153081115), and mutual fund shares (LM153064205). Financial assets are households' total financial assets holdings (FL154090005). The aggregate money holding ratios are then detrended from a linear trend.

B.2. The Dependence of the Severity of Financial Recessions on Anticipated Inflation

Data. The analysis is based on the cross-country panel data from Jordà et al. (2013), which are made publicly available on Moritz Schularick's personal website. The dataset covers the period of 1870–2008 at an annual frequency and 14 advanced economies: the United States, Canada, Australia, Denmark, France, Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom. All the variables used in the analysis are available in this dataset, except for unemployment and anticipated inflation. We acquire the unemployment rate data from the Jordà-Schularick-Taylor Macrohistory Database (6th release; Jordà et al., 2017), which is available from 1901. Anticipated inflation is measured, using the methodology developed in Hamilton et al. (2015), as a one-step ahead forecast from a first-order autoregression model on past observed inflation, where inflation is defined as a percentage change of the consumer price index (CPI).[1]

Estimation. The data consist of 97 recessions (including non-financial and financial recessions) in 14 advanced countries since 1870 (for the analysis of GDP) or 80 recessions since 1901 (for the analysis of unemployment). We estimate the cumulated responses of real GDP per capita and the unemployment rate upon a financial recession, conditional on a broad set of macroeconomic controls, using local projections (Jordà, 2005):

$$\Delta_h y_{it(r)+h} = \alpha_i + \theta_N N + \theta_F F + \sum_{j=0}^{p} \Gamma_j Y_{it(r)-j} + u_{it(r)}, \quad h = 1, \ldots, H, \tag{B.1}$$

[1] The results in Section 5.2 are robust to the number of past observations used to predict anticipated inflation in the AR(1) model. We present the results using past 25 observations. The results remain almost identical with 30, which is the number used in Rocheteau et al. (2018), or 20.

$$\Delta_h y_{it(r)+h} = \alpha_i + \theta_N N + \theta_F F + \beta_{h,N}[N \times (\pi^e_{t(r)} - \overline{\pi^e})] + \beta_{h,F}[F \times (\pi^e_{t(r)} - \overline{\pi^e})] + \sum_{j=0}^{p} \Gamma_j Y_{it(r)-j} + u_{it(r)}, \quad h = 1, \ldots, H. \tag{B.2}$$

The notations are as follows. $t(r)$ refers to the calendar-time period associated with a peak of economic activity (or the start of the rth recession) and $t(r) + h$ for $h = 1, \ldots, H$ refers to the subsequent H years, some of which will be recessionary periods (those immediately following $t(r)$), and some of which will be expansion periods linked to the recovery from the rth recession. Following the specification in Jordà et al. (2013), we set $p = 1$ for the lags of control variables and examine the horizons until $H = 5$. $\Delta_h y_{it(r)+h}$ denotes the relevant measure of change h periods ahead in y for country i from the start of the rth recession. It is either the percentage point change, given by the difference in 100 times the logarithm of the variable, in log of real GDP per capita, or the simple time difference in the unemployment rate. α_i are country fixed effects, N is the indicator of non-financial recessions, F is the indicator of financial recessions, and u is the error term. $\pi^e_{t(r)}$ is the expected inflation rate at $t(r)$, i.e., at the onset of the rth recession, and $\overline{\pi^e}$ is its mean value in the data. The coefficients on the interaction terms between the non-financial/financial recession indicators and the expected inflation rate, $\beta_{h,N}$ and $\beta_{h,F}$, are the measures of the marginal effect of a unit increase in the expected inflation rate on the impact of non-financial/financial recessions, respectively. The vector Y, a set of macroeconomic controls, includes the first differences of likely nonstationary variables (such as real GDP per capita, unemployment rate, loans/lending, CPI, and investment) and the levels of likely stationary variables (such as government short- and long-term interest rates, current account to GDP ratio, and expected inflation).

Tables B.1 and B.2 present the estimated paths of real GDP per capital and the unemployment rate upon non-financial and financial recessions, respectively. Figure 7 plots $\hat{\theta}_F$, $\hat{\theta}_F + \hat{\beta}_{h,F}$, $\hat{\theta}_F + 2\hat{\beta}_{h,F}$, and $\hat{\theta}_F + 3\hat{\beta}_{h,F}$ from the specification (B.2), that is, the estimated paths upon financial recessions when anticipated inflation is at its mean level (which is 3.87%) and when it is perturbed +1, +2, and +3 percentage points above its mean. The main lesson is that recessions—in particular, financial recessions—are more severe when inflation is anticipated to be higher at the onset of recessions.

Table B.1: Responses of Real GDP Per Capita

Specification B.1, without interaction terms					
	Year 1	Year 2	Year 3	Year 4	Year 5
Non-financial recession (N)	-1.701^{***}	-0.603	1.690	1.915	1.829
	(0.461)	(0.868)	(1.379)	(1.755)	(1.890)
Financial recession (F)	-2.854^{***}	-4.560^{***}	-3.750^{*}	-4.888^{*}	-3.882
	(0.665)	(1.250)	(1.985)	(2.527)	(2.722)
Specification B.2, with interaction terms					
	Year 1	Year 2	Year 3	Year 4	Year 5
Non-financial recession (N)	-1.732^{***}	-0.595	1.761	2.011	1.963
	(0.461)	(0.876)	(1.383)	(1.759)	(1.885)
Financial recession (F)	-2.840^{***}	-4.563^{***}	-3.784^{*}	-4.934^{*}	-3.946
	(0.663)	(1.260)	(1.989)	(2.529)	(2.711)
Non-financial recession	-0.0315	-0.423	-0.573	-0.667	-0.828
$\times$ Expected inflation ($N \times (\pi^{e}_{t(r)} - \overline{\pi^{e}})$)	(0.145)	(0.276)	(0.436)	(0.554)	(0.594)
Financial recession	0.133	-0.464	-0.950	-1.176	-1.540^{*}
$\times$ Expected inflation ($F \times (\pi^{e}_{t(r)} - \overline{\pi^{e}})$)	(0.201)	(0.382)	(0.603)	(0.767)	(0.821)
Observations, non-financial recessions	75	75	75	75	75
Observations, financial recessions	22	22	22	22	22
Observations	97	97	97	97	97

Notes: Standard errors are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table B.2: Responses of the Unemployment Rate

Specification B.1, without interaction terms					
	Year 1	Year 2	Year 3	Year 4	Year 5
Non-financial recession (N)	0.417	0.881	1.099	1.244	1.847
	(0.379)	(0.608)	(1.007)	(1.103)	(1.107)
Financial recession (F)	1.302**	2.447***	3.263**	3.738**	3.656**
	(0.522)	(0.837)	(1.387)	(1.519)	(1.525)
Specification B.2, with interaction terms					
	Year 1	Year 2	Year 3	Year 4	Year 5
Non-financial recession (N)	0.480	0.897	0.961	1.098	1.728
	(0.374)	(0.617)	(1.002)	(1.099)	(1.110)
Financial recession (F)	1.337**	2.456***	3.186**	3.657**	3.590**
	(0.513)	(0.847)	(1.375)	(1.508)	(1.523)
Non-financial recession	0.128	0.378*	0.536*	0.546	0.467
$\times$ Expected inflation ($N \times (\pi^e_{t(r)} - \overline{\pi^e})$)	(0.119)	(0.196)	(0.318)	(0.349)	(0.353)
Financial recession	−0.0409	0.334	0.912**	0.943*	0.790
$\times$ Expected inflation ($F \times (\pi^e_{t(r)} - \overline{\pi^e})$)	(0.169)	(0.279)	(0.453)	(0.496)	(0.502)
Observations, non-financial recessions	63	63	63	63	63
Observations, financial recessions	17	17	17	17	17
Observations	80	80	80	80	80

Notes: Standard errors are in parentheses. $^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

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