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The effects of the corona shock on the banking sector and the real economy

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THE EFFECTS OF THE CORONA SHOCK ON THE BANKING SECTOR AND THE REAL ECONOMY

- This economic memo isolates two important channels through which the "corona-shock" affects the economy, namely a dramatic fall in asset prices and an increase in the dispersion of future shocks to the economy.
- Both a fall in asset prices and an increase in volatility are contractionary, but they operate through entirely different channels: a fall in asset prices reduces the banking sector's net worth, an increase in volatility reduces banks' borrowing for precautionary reasons.
- A CCyB that is reactivated early reduces the impact of an asset price shock the most, since it forces banks to accumulate more net worth. In contrast, a CCyB that is reactivated late reduces the impact of a volatility shock the most. Overall, the corona-shock warrants an early build-up of the CCyB.

Motivation and executive summary

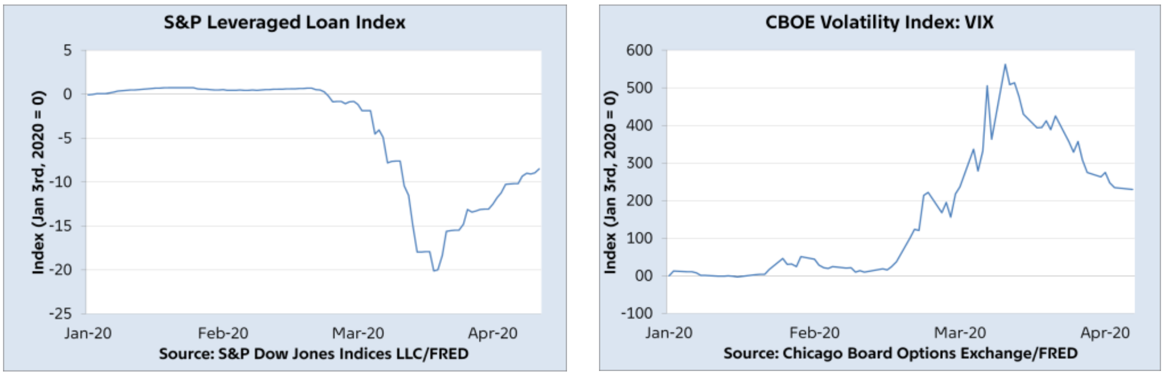
The global pandemic of SARS-CoV-2, or more colloquially, the coronavirus, has caused mayhem in almost all economies across the world. While governments and central banks are ramping up measures of unprecedented scale to provide relief to the private sector, the full extent of the "corona-shock" to the economy is not yet fully understood.

The purpose of this memo is twofold: first, to isolate two important channels through which the "corona shock" affects the economy, namely a dramatic fall in asset prices and an increase in the dispersion of future shocks to the economy. Particular emphasis is placed on the role of bank balance sheets in the transmission of the shock

The key result is that while both a fall in asset prices and an increase in volatility are contractionary, they operate through entirely different channels: the fall in asset prices weakens the banking sector's balance sheets by reducing its net worth, which forces it to reduce lending. In contrast, the volatility shock leads banks to reduce borrowing and lending for precautionary reasons.

The second purpose of this memo is to investigate the effectiveness of macro-prudential regulation in mitigating the effect of the shock. Specifically, the question studied here is whether the regulator should be lenient or strict in the timing of the reintroduction of the countercyclical capital buffer (CCyB). The CCyB is modelled as policy rule that requires banks to reduce their leverage when they have ample net worth. This rule captures the spirit of

The effects of the corona-shock on Asset Prices and Volatility Chart 1



Data is normalised to 0 on 2 January, 2020.
Federal Reserve Bank of St. Louis.

standard CCyB rules based on the credit-to-GDP gap, as bank lending co-moves with bank net worth.

The main finding is that a strict CCyB, i.e. one that is reactivated early, reduces the impact of an asset price shock the most, since it forces banks to accumulate more net worth. In contrast, a lenient CCyB reduces the impact of a volatility shock the most. The reason is that the precautionary response of the banking sector leads banks to accumulate net worth, which may inadvertently trigger the strict CCyB, causing an additional fall in bank lending and investment. In response to the corona-shock, which is a combination of an asset price shock and a volatility shock, the regulator should reactivate the CCyB early, as the effects of the asset price shock dominate.

Modelling the Corona-Shock

While there are many unknowns about the nature of the corona-shock, two of its immediate effects stand out.

First, as displayed in the left panel of Chart 1, the shock caused a dramatic fall in asset values, here represented by the S&P leveraged loan index.

Second, as shown in the right panel of Chart 1, the shock led to a sharp rise in market volatility, to levels not seen since the financial crisis of 2008.

Of course, in the data, the fall in asset prices and the increase in volatility cannot be seen in isolation: They mutually affect and reinforce each other; historically, higher stock market volatility is associated with lower prices of stocks and risky corporate bonds.

The approach pursued in this note is to model the corona-shock as the joint impact of two structural shocks: A "level"-shock that causes a fall in asset prices and a "volatility" shock that causes a rise in volatility. The advantage of decomposing the corona-shock in this way is that the macroeconomic impact of each shock can be better understood in isolation.

A 30-Second Brush Up on a Banking Model

The analysis uses a structural macroeconomic model in which banks, firms and households make optimal decisions in a forward-looking way. The model builds on work by Gertler and Kiyotaki (2015) and their follow-up work in Gertler, Kiyotaki and Prestipino (2020). It is described in detail in Mikkelsen and Poeschl (2020).

The key features of the model are: 1) explicit modelling of banks' balance sheets; 2) time-varying financial fragility. Financial fragility arises whenever bad enough fundamentals of the banking sector open up the possibility of a self-fulfilling debt rollover crisis – i.e. a bank run – due to a loss of confidence of the banks' creditors.

The balance sheet of the banking sector looks as follows:

A Typical Bank Balance Sheet Table 1

Assets	**Liabilities and Equity**
Bank Loans = Leverage x Net Worth	Debt = (Leverage – 1) x Net Worth
	Equity = Net Worth

Importantly, a borrowing constraint limits banks' lending to a multiple of their equity, that is, their leverage. Consequently, if the net worth of the banking sector is low, the model economy exhibits a high degree of financial fragility: if the net worth of the banking sector is already low, even a small negative shock might wipe out the net worth of the banking sector. Once the net worth of the banking sector is wiped out, creditors become unwilling to roll over their lending to banks, which then leads to a rollover crisis.

The key message of Mikkelsen and Poeschl (2020) is that this time-varying risk of a rollover crisis leads to endogenously time-varying volatility. This means that the volatility of macroeconomic aggregates like GDP and asset prices varies over time not because the volatility of the exogenous shocks varies over time. Instead volatility varies over time due to the optimal decisions of banks and their creditors, which sometimes can result in a rollover crisis.

Impulse Responses to Asset Price and Volatility Shocks

In this section, the impact of shocks to asset prices and volatility is investigated in a model that is calibrated to the US economy. As shown in Mikkelsen and Poeschl (2020), the model is able to quantitatively account for the dynamics of key financial and macroeconomic variables during the 2008 financial crisis.

The Macroeconomic Effects of an Asset Price Shock

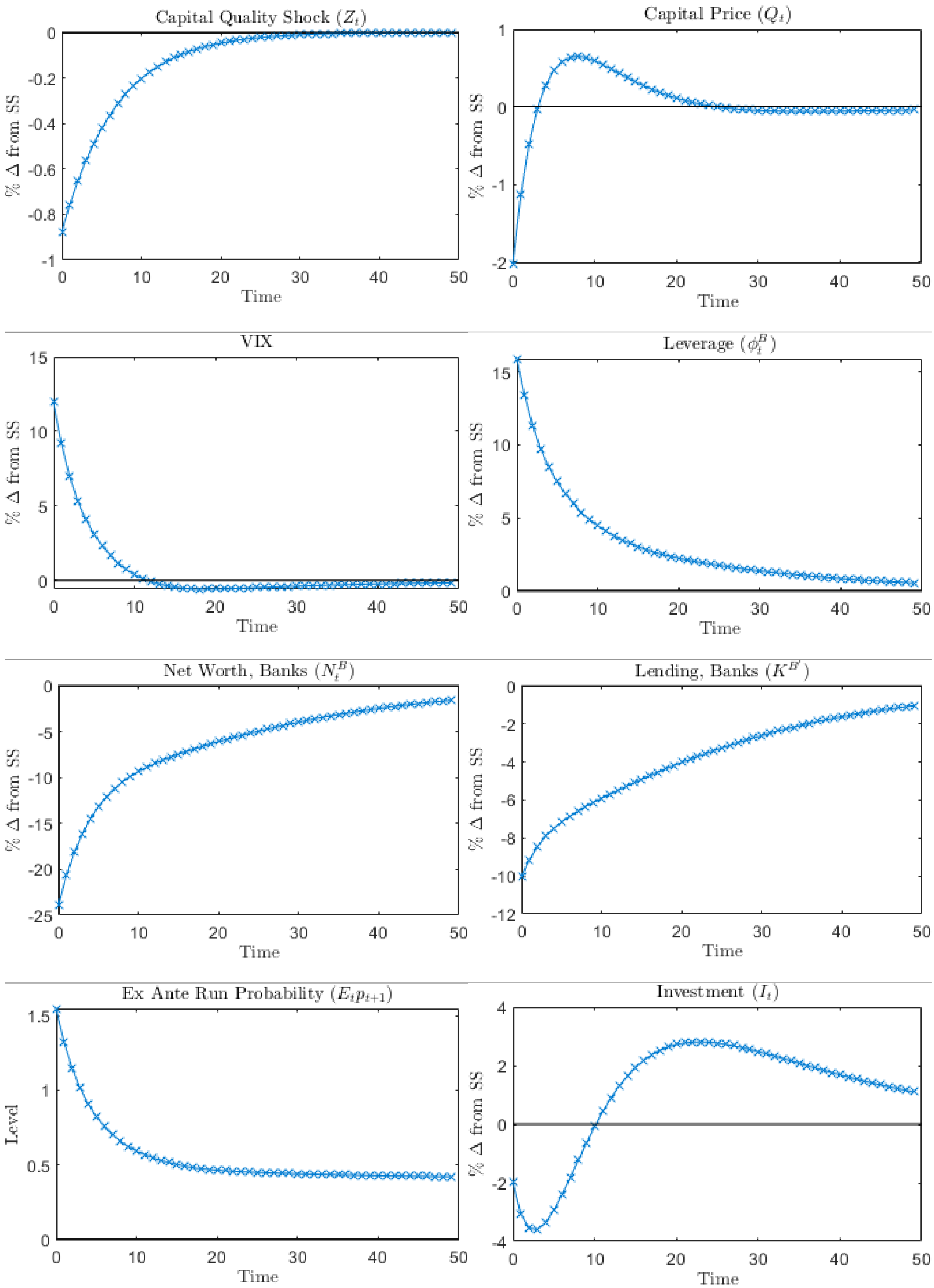
Chart 2 shows the impact of a two standard deviation asset price shock. This shock is modelled as a destruction of a fraction of the capital stock of the economy, leading to a 12 per cent fall in bank lending.

The main channel through which the asset price shock operates is through a reduction of bank net worth.

Specifically, by destroying a fraction of the capital stock of the economy, the asset price shock destroys a fraction of the banking sector's assets. That reduces the net worth of the banking sector. Since the lending capacity of the banking sector is tied to its net worth, bank lending falls, which leads to a fall in investment and asset prices.

An Asset Price Shock

Chart 2



Impulse response to a two standard deviation capital quality shock.
Author's calculations, based on the model by Mikkelsen & Poeschl (2020).

Lower asset prices lead to higher expected returns on assets. Since the leverage of the banking sector is tied to the expected return on assets, this allows the banking sector to increase its leverage.

Due to the higher leverage, the likelihood of a financial crisis increases. This uncertainty about whether or not a financial crisis might occur in the future increases the expected volatility of future asset prices, as measured by the VIX. This highlights how the leverage decisions of banks and the rollover decisions of their creditors can cause an endogenous increase in volatility.

The Macroeconomic Effects of a Volatility Shock
Next, the impact of an increase in volatility due to an exogenous increase in the dispersion of future shocks is studied. Chart 3 shows the isolated impact of a two standard deviation volatility shock.

The model has two volatility regimes. In the low-volatility-regime, the dispersion of asset price shock is low, in the high-volatility-regime, it is high. A volatility shock is modelled as an increase in the likelihood of ending up in the high-volatility-regime in the next period, increasing the risk of extreme outcomes.

The main channel through which this exogenous volatility shock affects the economy is a precautionary *reduction* of bank leverage. This is the key difference from the impact of the asset price shock, which leads to an *increase* in leverage.

A volatility shock increases future volatility, which reduces expected returns, as risk-averse households reduce their demand for risky assets. This forces the banking sector to reduce its leverage and thus its lending. The reduction in lending leads to a fall in investment and asset prices.

Higher asset returns and lower leverage allow the banking sector to accumulate more net worth in the future, entailing that net worth rises over time. Overall, the first key result is that lending will fall following either an asset price shock, or a volatility shock, but net worth will move in opposite directions.

Due to the lower leverage, the likelihood of a financial crisis decreases. This highlights that higher exogenous volatility, in the form of a higher dispersion of the exogenous shocks hitting the economy, reduces endogenous volatility that arises due to the optimal behaviour of banks and their creditors. This "volatility paradox" is the second key result from the model.

Discussion of the Different Propagation Mechanisms of the Two Shocks
It is noteworthy to emphasise that despite leading to the same outcome – namely a reduction in bank lending, the asset price shock and the volatility shock propagate through entirely different mechanisms:

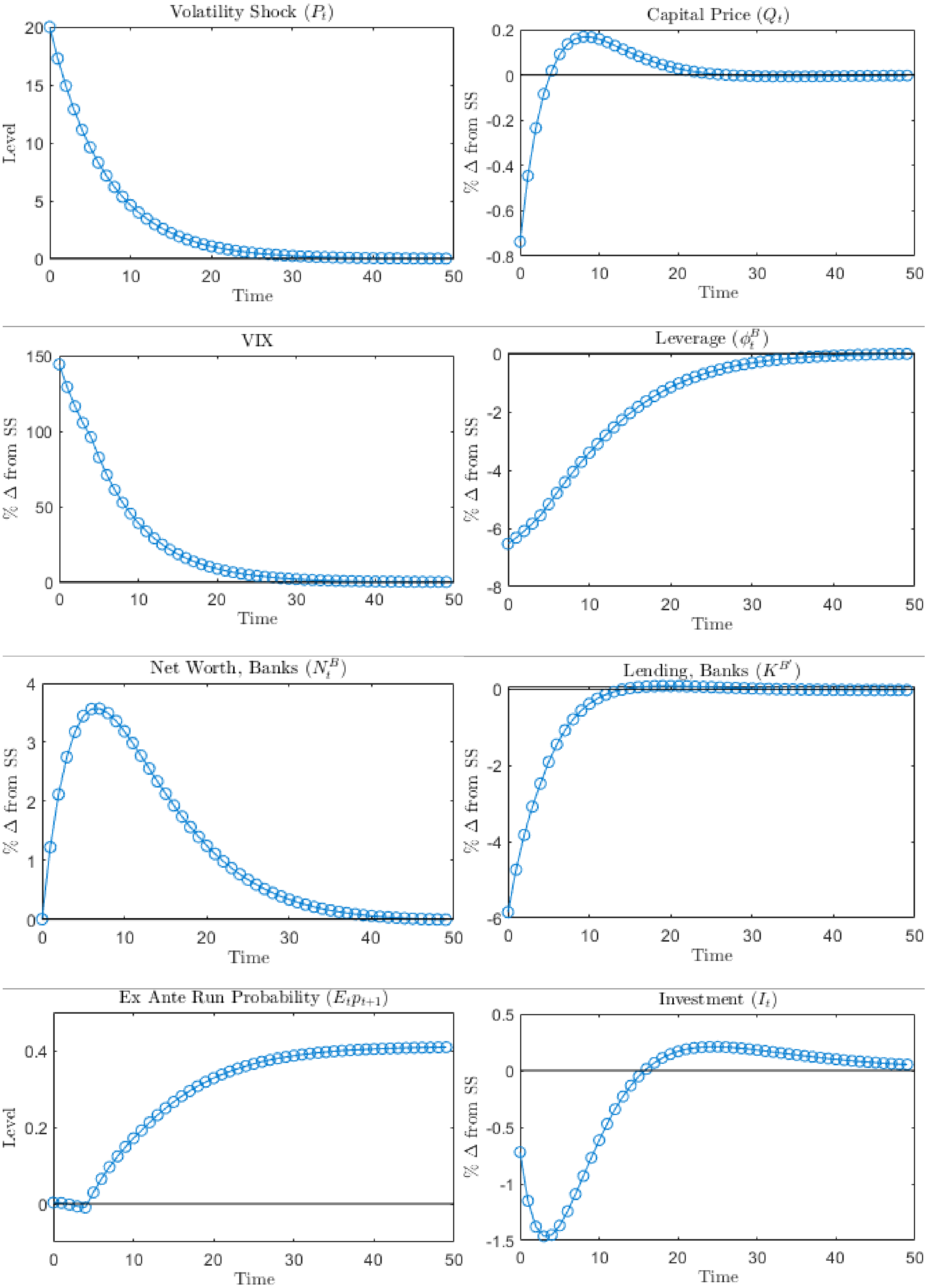
The asset price shock leads to a reduction in net worth and an increase in leverage, which leads to an increase in the likelihood of a rollover crisis, raising endogenous volatility.

The volatility shock instead leads to an increase in net worth and a decrease in leverage, driven by the precautionary behaviour of the banking sector. This reduces the likelihood of a rollover crisis and reduces endogenous volatility.

This inverse relationship between endogenous volatility and exogenous volatility due to precautionary behaviour is often referred to as the volatility paradox.

A Volatility Shock

Chart 3



Impulse response to a two standard deviation volatility shock to capital quality.
Author's calculations, based on the model by Mikkelsen & Poeschl (2020).

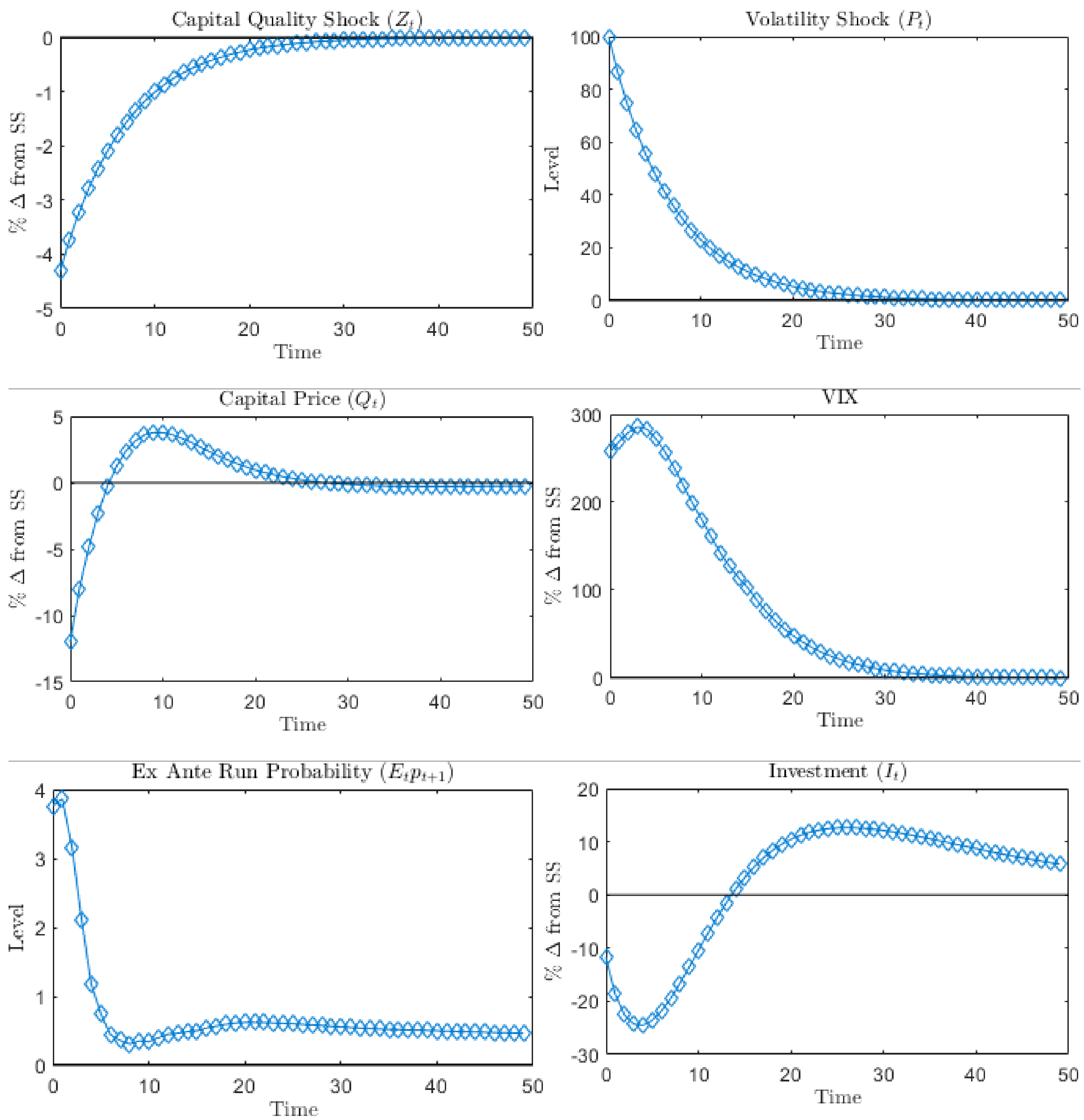
Replicating the Corona-Shock

This section analyses the combined impact of a 10 standard deviation asset price shock and a 10 standard deviation volatility shock. The results of the experiment are displayed in Chart 4. The magnitudes of the shocks are chosen to replicate a fall in asset prices by around 10 per cent and an increase in volatility by around 300 per cent.

This fall in asset prices and increase in leverage also corresponds roughly to those seen after the corona-shock, as well as those experienced in the US during the 2008 financial crisis.

A Corona Shock

Chart 4



Impulse response to a joint 10 standard deviation capital quality and volatility shock.
Author's calculations, based on the model by Mikkelsen & Poeschl (2020).

Following the corona shock, the model predicts that the probability of a rollover crisis increases to about 3 percent per year, compared to around 0.5 percent per year in the stochastic steady state.

Regarding the impact on the real economy, investment falls by about 25 percent, returning back to steady state after about 12 quarters.

Implications for setting the CCYB

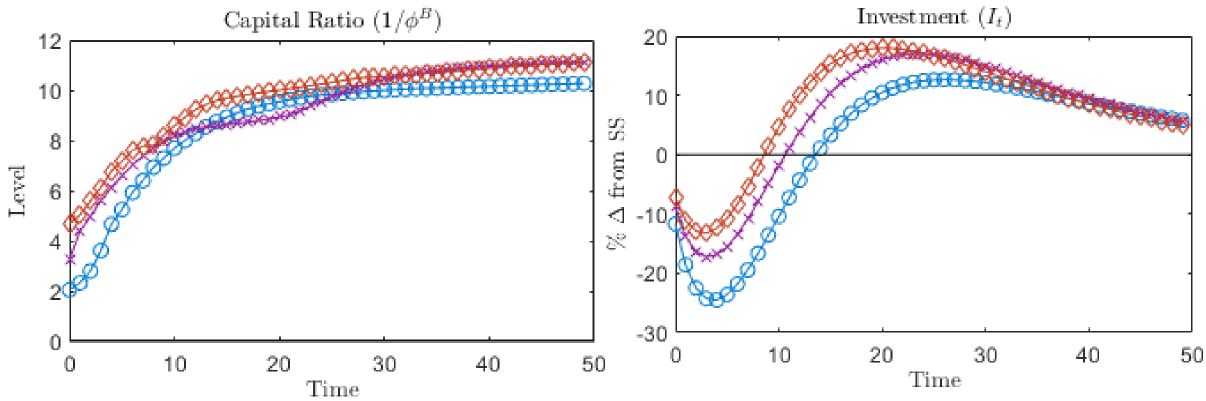
One of the policy prescriptions adopted by many financial regulators across the world in response to the corona-shock was a reduction of the countercyclical capital buffer (CCyB). Did this measure help to dampen the impact of the corona-shock? And when should regulators start to rebuild the buffer?

The left panel of Chart 5 shows the banking sector's capital ratio under three different scenarios. The first scenario, in blue, is the baseline model response to the corona shock under the hypothesis that no regulatory action had been taken. The two alternative scenarios assume that a capital buffer of 12.5 per cent is imposed on the banking sector during times of high net worth. The second scenario (purple line) assumes a CCyB that is lenient in the sense of being released when net worth falls below 85 per cent of its steady state value and reintroduced if net worth increases above 85 per cent of its steady state value. The third scenario (red line) assumes a CCyB that is strict in the sense that it is released when net worth falls below 75 per cent of its steady state value and only reintroduced if net worth increases to above 75 per cent of its steady state value.

The right panel of Chart 5 displays the effects of the different scenarios on the real economy. Investment declines the least under the strict CCyB scenario: At its trough, investment in the baseline model falls by around 25 per cent, in the model with lenient regulation by about 20 per cent and in the model with strict regulation only by about 10 per cent. The strict buffer is more beneficial, since in this case the banking sector will be better capitalised in more states of the world, which shields the banking sector better from net worth shocks.

Chart 6 shows that it is important to know the nature of the shock to determine which macroprudential regime is the most desirable.

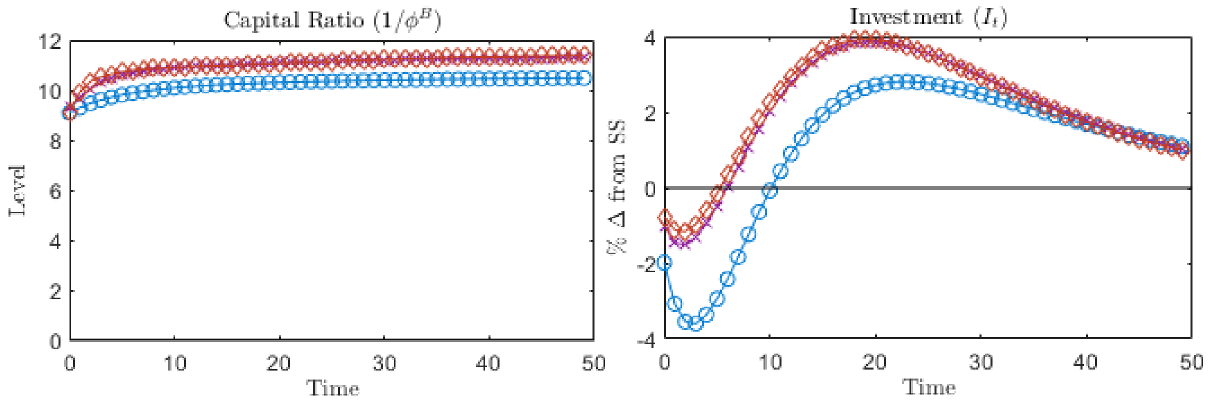
The Effects of a Lenient and a Strict CCyB following a Corona-Shock Chart 5



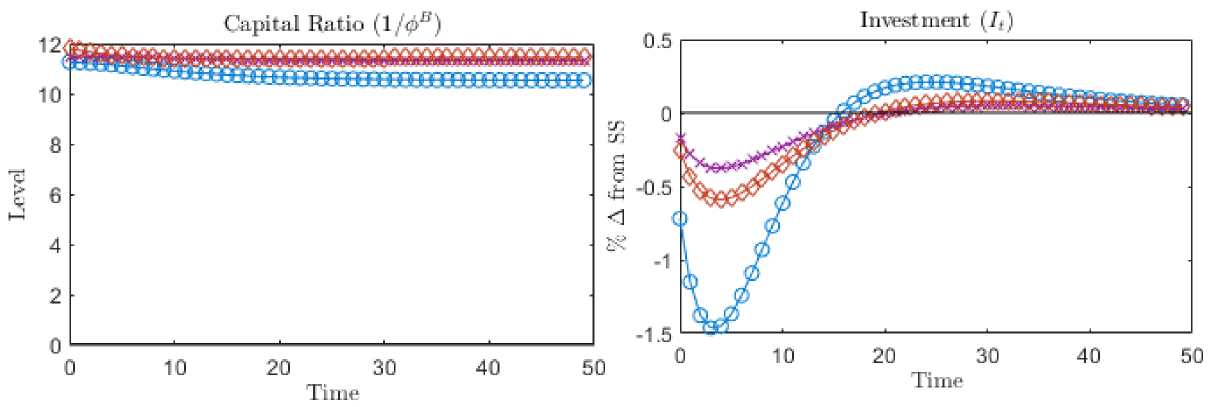
The blue line is the impulse response in the baseline model, the purple line the impulse response in the model with a lenient CCyB and the red line the impulse response in a model with a strict CCyB.
Author's calculations, based on the model by Mikkelsen & Poeschl (2020).

Macroprudential Regulatory Outcomes under Alternative Corona-shock Scenarios Chart 6

Corona-shock: Asset Price Shock Only



Corona-shock: Volatility Shock Only



The blue line is the impulse response in the baseline model, the purple line the impulse response in the model with a lenient CCyB and the red line the impulse response in a model with a strict CCyB.
Author's calculations, based on the model by Mikkelsen & Poeschl (2020).

In case the corona shock materialises as only a volatility shock, an increase in the probability of extreme outcomes for the asset price shock, the lenient CCyB policy leads to a smaller fall in output than the strict CCyB policy.

The lenient buffer is more beneficial, as banks accumulate cash buffers in their own precautionary interest in response to a volatility shock. Under the strict buffer rule, the higher net worth activates the capital buffer, which causes a contraction in investment. This does not happen under the lenient rule.

Conclusion

Two of the most important and immediately observable consequences of the corona-shock were a fall in asset prices and an increase in volatility on financial markets. This memo analyses the impact of such-shocks on the banking sector and the real economy in a model with endogenous financial fragility.

The first main result is that the asset price shock and the volatility shock lead to a fall in aggregate bank lending, investment, and asset prices. They do however operate through entirely different mechanisms: The asset price shock reduces bank net worth and increases leverage. In contrast, the volatility shock reduces leverage and increases bank net worth.

The second main result is that a rise in exogenous volatility induces the banking sector to reduce leverage for precautionary reasons, reducing endogenous volatility that arises from the possibility of a financial crisis.

Finally, a CCyB can help to dampen the impact of both shocks, but its timing depends critically on the nature of the shock: In response to an asset price shock, a policy that forces banks to build up capital buffers early is beneficial, whereas in response to a volatility shock, a policy that allows banks to build up capital buffers later is more beneficial.

Bibliography

Gertler, Mark, and Nobuhiro Kiyotaki. "Banking, Liquidity and Bank Runs in an Infinite Horizon Economy." *American Economic Review*, 2015.

Gertler, Mark, Nobuhiro Kiyotaki, and Andrea Prestipino. "A Macroeconomic Model with Financial Panics." *Review of Economic Studies*, 2020.

Mikkelsen, Jakob, and Johannes Poeschl. "Banking Panic Risk and Macroeconomic Uncertainty." *Danmarks Nationalbank Working Paper*, 2020.

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