WORLDQUANT UNIVERSITY

Compiled Notes Module 5

MScFE 660

Case Studies in Risk Management

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Module 5: The 2008 Global Financial Crises

Module 5 discusses the 2008 global financial crises, with a focus on the housing crisis and the failures of individual and institutional actors to mitigate risk. The module begins by describing the property bubble in the US in the early 2000's, which caused sharp increase of houses and property prices. It then continues by using macroeconomic models to analyze the conditions that brought to the 2008 Global Financial Crises and concludes with a description of its spread and the consequences on the global economy.

Unit 1: The Great Recession Building

The 2008 financial crisis, which led to the Great Recession of the late 2000s and early 2010s, began with the financial and economic decisions of the 2000s made by the major economies of the global financial sector. These decisions ultimately led to a major worldwide economic contraction that was probably the closest thing to the Great Depression the world economy has experienced. Therefore, understanding the causes and framework of the financial crisis is fundamental to understanding risk management in the global economy. Critically, the problems with sub-prime mortgages, lending practices, credit ratings and the integral connections between states led to the crisis.

The property bubble

The housing bubble in the United State of America (US), which saw the prices in homes and property expand exponentially during the late 1990s and early 2000s, was one of the backbone investments for financial institutions and investors during the period. Major investment firms, banks and investing bodies began to get involved in subprime mortgages. New Deal-era institutions like the Federal Housing Administration and the Federal National Mortgage Association (commonly known as "Fannie Mae") stabilized the American real estate market and underwrote the expansion of home ownership in the decades after the Second World War. As the housing bubble expanded, mortgage lenders sought to reap even bigger profits by tapping into the "subprime" market. The subprime market consisted of individuals and families who had low credit scores, frequent bouts of unemployment, missed car/utility payments, etc. Typically, lenders would avoid the subprime market altogether.

As housing prices heated up, however, people that had previously been seen as a sub-par candidate for a mortgage transformed into a valuable market opportunity. And besides, lenders could only sell so many houses to the middle and upper class folks that already had mortgages. Big investment firms would collect these subprime mortgages into mortgage-backed securities and would sell them in the financial markets. Subprime lending was inherently risky for obvious reasons. But, by bundling risky debt into large securities with lower-risk debt, investors thought they had mitigated the damage of possible foreclosures by spreading out the risk and limiting exposure. Ultimately, it didn't quite work out that way. The toxic debts of millions of subprime mortgages ended up dragging down even the largest mortgage-backed securities. Bigger, in this case, did not mean more secure.

This risk was exacerbated by the burgeoning market in financial derivatives like credit default swaps. Mortgage-backed securities appeared as low risk as they were grounded in financial instruments called credit default swaps – a process whereby debt is sold with the promise that the debtor will reimburse the creditor if there is a default – which allowed a largely unregulated process of distributing mortgages into a complicated mesh of financial assets and securities. Credit default swaps functioned as a sort of insurance policy which might have softened the blow caused by subprime foreclosures. But, as large investment companies invented larger and more complex derivatives, credit default swaps and other **collateral debt obligations** (CDO) that were based in the mortgage industry ballooned into a much larger market than the actual mortgages. In other words, the derivative market did not function to reduce the risk of financial collapse. The rise of the derivative market amplified the potential for crisis by tying billions of dollars of more investment into mortgage-back securities – including the ones loaded with all the toxic subprime debt.

As the property prices were on the rise, and the money from good mortgages flowed in, the market expanded and delivered on the promises of profit. However, two problems existed within the property bubble - first, the issue of bad mortgages that were not properly regulated, and second, the issue of unscrupulous speculators over-selling the housing market.

The bubble itself was a problem, as the expanding market didn't necessarily match the demand for property, leaving discrepancies between the financial input into the property sector and the demand for housing by buyers. Furthermore, when banks and financial institutions realized they could make money off subprime mortgages and could reap rewards from an expanding sector, they lowered their standards to create more opportunity for mortgage-backed securities to be moved around on the stock markets. Major players in the subprime mortgage industry, like Washington Mutual Bank, began issuing loans to people without even the most rudimentary credit or even employment checks. Mortgages for people with no credit and only part-time employment would have been unthinkable in the economic climate that persisted in the decades after the Great Depression. By the early to mid-2000s, however, these loans began to form ever larger portion of mortgage-backed securities available on the market, and thus of investment banks' asset portfolios. At the time, of course, the American housing market was seen as the bedrock of financial stability. The housing market hadn't failed in over 70 years, why wouldn't it continue to expand?

Lower interest rates on corporate loans and mortgages meant that banks had very low-level returns with some debtors, meaning they would continue to encourage lending to increase their profits and

the gains for the people who invested in them. This encouraged the escalation of bundling mortgages into mortgage-backed securities, as mortgage lenders could sell off those large securities for liquidity that would rapidly be issued as mortgage loans. That meant individual mortgage lenders, big and small, could reap profits on the various fees included in the sale of the mortgage loan, then sell those loans off to larger investors. For individual lenders engaging in what could only be described as wildly risky lending, their individual risk was eliminated by selling off that toxic subprime debt into secondary and tertiary securities markets. On a systemic level, however, that meant billions of dollars of toxic debt flooding into global financial markets.

What further complicated the property market was the lack of regulation which had persisted despite the ongoing financial ups and downs. Despite anti-predatory loan legislation – which aimed to prevent banks and financial institutions from seeking loans from people without due checks and balances – local states in the US decided to override these in the early 2000s, and subsequent legislation prompted many investment firms and banks to encourage homeowners and hesitant investors to get easier access to mortgages. Many of those attempts at "easier access" to homeownership verged on blatantly predatory practices. One of the most notorious was the practice of issuing an adjustable-rate mortgage loan. These loans featured bargain basement "teaser" rates that would attract subprime buyers that might have been turned away by even moderate mortgage payments. When those low rates expired after three to five years, however, artificially low mortgage payments ballooned, and sometimes even *doubled*. Very often, financially illiterate, subprime homebuyers proved to be an easy mark for lenders that had every market incentive to prioritize quantity of loans issued rather than quality. Given the timing of those mortgage rate adjustments issued in the early to mid-2000s, many of them occurred during the crisis itself. In other words, just as home values across the nation began to collapse, mortgage payments rose dramatically.

Coupled with the fact that many subprime mortgage loans also required little to no down payment, millions of mortgages went "underwater" seemingly overnight. An "underwater" mortgage refers to a loan where the lender is owed more than the home is worth. In the years directly preceding the crisis, there were about one million underwater loans in the American housing market. By 2010, that number had increased to an eye-watering 15 million. A combination of higher mortgage payments, collapsing home value, and the mass layoffs in the midst of the Great Recession kicked off a landslide of foreclosures. About a half a million foreclosures in the "normal" year of 2005

skyrocketed into 2.8 million in 2010. All those foreclosures only exacerbated the existing downward pressure on home values, as the market was flooded with millions of homes people no longer wanted (or were able to) buy. This collapse in home value, of course, also rocked the financial institutions that had invested heavily in the subprime industry in the first place, who had portfolios filled to the brim with rapidly depreciating assets.

Federal government and private institutions that might have signaled the danger of the excessive risk taken on by global finance also failed to properly regulate the booming real estate market. In terms of federal regulators, major mortgage regulator **Office of Thrift Supervision** (OTS), failed to sense the emerging toxic mortgage bubble and de-escalate the mounting risk. Indeed, agencies like the OTS were essentially captured by the financial industry due to deregulatory waves in the 1990s and 2000s. Increasingly understaffed and disempowered, regulators like the OTS grew into an increasingly deferential relationship with major financial institutions like and Washington Mutual. As such, federal regulators proved ineffective in defusing the mounting financial crisis. Financial de-regulation, a bipartisan effort that lasted from the 1980s to the Great Recession, both disempowered and delegitimized efforts to rein in the excessed and abuses of Wall Street. The post-Cold War financial boom seemed to be increasing prosperity for many people in the West, especially when compared to the manufacturing recession of the 1970's and early 80s. Both Democrats and Republicans saw any brake on finance as an economic threat. This process culminated – perhaps symbolically – in the 1999 passage of the Gramm-Leach-Bliley Act by a Republican Congress and Democratic President, which repealed some of the last provisions of the 1933 Glass-Steagall (Banking) Act that prevented the horizontal and vertical integration of financial companies. In short, it was the bill that ended fostering the growth of some banks deemed "too big to fail." And it took less than a decade for the financial industry to collapse.

Private institutions that might have prevented the risky behavior that almost destroyed the system also failed. Credit-rating agencies, most importantly Moody's, Standard and Poor's, and Fitch (the "Big Three" which control roughly 95% of the global market), evaluate the potential risk of investments for various clients around the world. Their ratings are ubiquitous around the financial world and provide the benchmark evaluation for the level of risk inherent in every investment. As private companies, the Big Three earned their revenue by charging fees to evaluate the riskiness of all manner of bonds and securities.

As the global financial market expanded in the 1990s and 2000s, in particular due to the housing industry and derivative market, investment banks felt tremendous pressure to have their financial products rated as highly as possible. Just as investment banks sought higher credit ratings, the credit ratings agencies grew fearful that lower ratings might drive their customers to their competitors, even if those ratings were more accurate. So, in order to maintain a booming revenue stream, credit ratings agencies sacrificed integrity and accuracy in order to keep business good. Providing a AAA rating on a mortgage-backed security became, itself a sort of advertisement for the rating firm itself. According to the Congressional investigation into the financial crisis, 90% of AAA rated subprime residential mortgage backed securities originated in 2006 and 2007 were later reduced to junk status. In short, hundreds of billions worth of junk securities ended up being certified as AAA. It turned out that the riskiest investments possible ended up being rated as having no risk at all.

Similar issues were present in other major economies that were closely related to those in the U.S.. Largely, developed countries had increasing levels of personal and commercial debts that were caught up in loosely regulated systems that allowed for similar easy credit found in the US. Other property bubbles developed, mainly in the United Kingdom (UK) and the European Union (EU) economies, creating huge liabilities in the major developed world financial institutions. The spill-over would thus mean that developing states, which in many cases relied on primary resource markets and foreign direct investment, had limited financial capital and relied on developed world financial markets to float their currencies and financial sectors, would adopt similar regulatory and lending practices in their banks. And, of course, many large investment banks in those countries invested heavily in the American housing market as well.

Thus, there is a critical context that saw many prominent financial investment firms and banks being tethered to a system of debt management and risk assessment that was in real terms unregulated at all levels. The rise in household debt and the heavy speculation on the housing market led to an increasingly precarious position for public and investment confidence, which as precedent has shown, is incredibly dangerous (the Crash of 1929, the Crisis of 1987 and the Crises in Asia, to name three examples). The global financial system – having grown increasingly dependent and interconnected during the 20th century as infrastructure, communication and technology had advanced the ways to make money – was thus in a position where easy credit and lending practices were under minimal checks and balances that attempted to protect the most vulnerable investor

and consumer, but failed to prevent the creation of a toxic lending culture. If a problem were to happen in any financial institution, it would either collapse and wreck the financial system both in that particular country and in the countries that were connected to it, or it would receive a government bailout that would facilitate liquidity on an emergency basis. The term 'too big to fail' was used infrequently to describe the institutions that were major players during the Crisis, as it was almost guaranteed to receive a bailout, or the bankruptcy process would see it subsumed or merged into more capable investment institutions.

Brothers in arms

By 2007, the crisis with subprime mortgage had taken a hold of the financial system in America and began to ravage major financial institutions, with the most notable example being Lehman Brothers, an investment bank that was one of the first to move into subprime mortgage investment and had grown into one of the major providers of mortgage finance in America. Having developed several hedge funds that catered almost entirely into subprime mortgages and mortgage-based securities, it was weakened substantially by the crisis that was growing, eventually declaring bankruptcy in September 2008. Having used its portfolio of residential mortgage backed securities as collateral on its own debts, Lehman Brothers was unable to return anything to its creditors as its own assets rapidly depreciated, creating an instantaneous liquidity crisis. Lehman Brothers stock price fell sharply as the crisis became public and the bankruptcy shook the financial sector both in America and globally. Bailouts were engineered to prevent spillover effects of the collapsed investment firm into others. This, however, was in vain owing to increasing levels of overlap and dependence found in the many major American financial institutions. The Dow Jones had already begun to fall, with major selloff of commercial property stocks property investment firms took place, prompting a crisis on the floors of stock exchanges across the world.

Hedge funds, banks and investment institutions that were unable to cover their liabilities and losses collapsed or were given bailouts by their respective governments, but the damage was done, and the Great Recession hit the global economy in late 2008.

Unit 2: Comparative Approaches in Collapse

The problem

In order to understand the financial crisis, we need to understand the effect it had on policy makers and central banks. In a superficial manner, we can understand bankruptcy and the effects of fiscal contagion as a crisis of liquidity. If banks and businesses are unable to take on more debt, or at the very least liquidate both long and short-term assets, they cannot pay debts as and when they are due- even if their total assets exceed their total liabilities- and may be brought into liquidation. When uncertainty floods particular markets and new information forces prices to adjust in the same violent fashion we see in a crash, liquidity is a critical reason for bankruptcy, and with growing uncertainty and the demands of short parties and creditors, businesses can be unable to settle these debts when they cannot sell existing stock or alter their existing positions. This can be referred to as a crisis of a liquidity.

The theory

Broadly, across markets, liquidity is dictated by Money Supply (M_s) and Money Demand (M_d). For consumers, there is a clear opportunity cost between holding money for consumption and investing it, often dictated by their inflation and GDP growth. Between investors and creditors, there exists strong supply and demand relationships for money, which inform general interest rates. This demand and supply relationship is largely affected by the amount of money in the banking system and the policies which govern it. Central banks manage this money supply, through the careful control of M0, M1, M2, M3 and M4 money. Depending on the policy, central banks can take on a number of strategies in the use of required reserves, open market operations and interest rates in increasing and decreasing this money supply. Interest rates can be set in line with a number, or mixture of policy targets, these can be nominal GDP targeting, inflation targeting or the use of Taylor's rule, which dictates that the central bank's target interest rate should increase (decrease) if the inflation rate is above (below) its target, and should increase (decrease) if real economic activity is below (above) its target for real economic activity, according to some function. If central banks decrease money supply dramatically, we expect interest rates to increase as there exists more demand for money in the economy than fractional reserve banking will create, and so interest rates rise – forcing investor and consumer spending to slow as people are incentivized to save rather than spend on investments in the real economy and on goods and service.

The primary challenge debated by macroeconomist John Hicks concerns the *impotence of monetary policy*. As interest rates decrease, they begin to reach a point where they asymptote, as interest rates cannot become negative without allowing for infinite and risk-free profit for rational acting debtors. This informs a key and powerful insight (and limitation) in the IS-LM, and RBC models in macroeconomics – nominal interest rates cannot fall below zero. The challenge then is how central bankers, as in the crisis, can free up targeted liquidity with nominal interest rates already near 0: the answer, Quantitative Easing or QE.

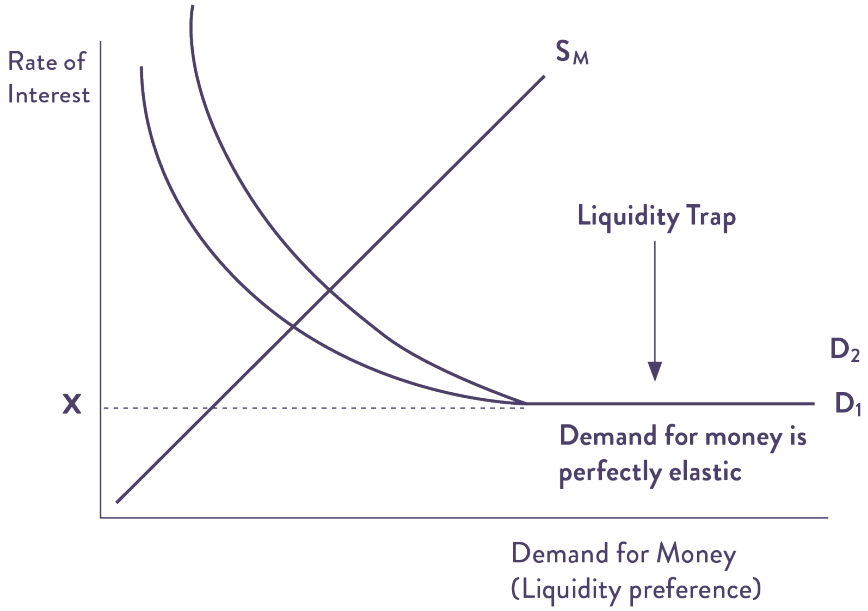


Figure 1: Liquidity Preference Curve
(Adapted from: Stack Exchange, 2018)

In the graph above, we see the Liquidity Preference Curve. This Curve shows interest rates on the y-axis and money-supply on the x-axis. As Money-Supply increases, interest rates decrease at a decreasing rate. This shape is caused by three main phenomena:

1. **Transactions motive**: People rely on various forms of cash in order to transact for goods and services.

2. **Precautionary motive**: People prefer liquidity in the case of unexpected problems.

3. **Speculative motive**: People choose liquidity to act on future investment opportunities when returns improve.

The problem with the flat-end of the Liquidity Preference Curve is its effect on monetary policy. As the curve flattens, large changes in monetary supply no longer cause adequate movements in interest rates to cause an effect on the real economy. This renders traditional Monetary Policy impotent.

The plan

QE generally refers to long-term asset purchases by the central bank when there is a liquidity trap in the hope of introducing liquidity into the market to allow for new investments in the real economy and the restructuring of existing financial investments. QE aims to both be targeted at the source of market contagion and aims to be rather a balance sheet change- in which assets and liabilities never change- rather than the introduction of new exogenous money.

For commercial banks and central banks, these changes can be shown in the tables below, where central banks take on long-term assets, freeing up liquidity.

Commercial Banks' Balance Sheet

Assets	Liabilities
Cash reserves (QE)	Demand deposits
Loans to private sector (QE)	
Loans to Government (bonds) (QE)	Savings deposits
Open market operations with Central Bank (OMO)	
Total Assets	Money

Central Banks' Balance Sheet

Assets	Liabilities
Net Foreign Reserves	
Credit to Government ↑	Currency in circulation
Net asset purchase from banks (QE) ↑	Banks' deposits (reserves) ↑
Total Assets	Reserve Money

In the graph below we can see a fascinating shift in Central Bank Assets, as they bought long-term Government Bonds, MBS and other assets across some key stages. Between 2008 and 2014, we

saw the Federal Reserve in the United States take on an additional $3,53 billion in assets, radically decreasing the duration of fixed-income assets on the balance sheets of financial institutions in the United States.

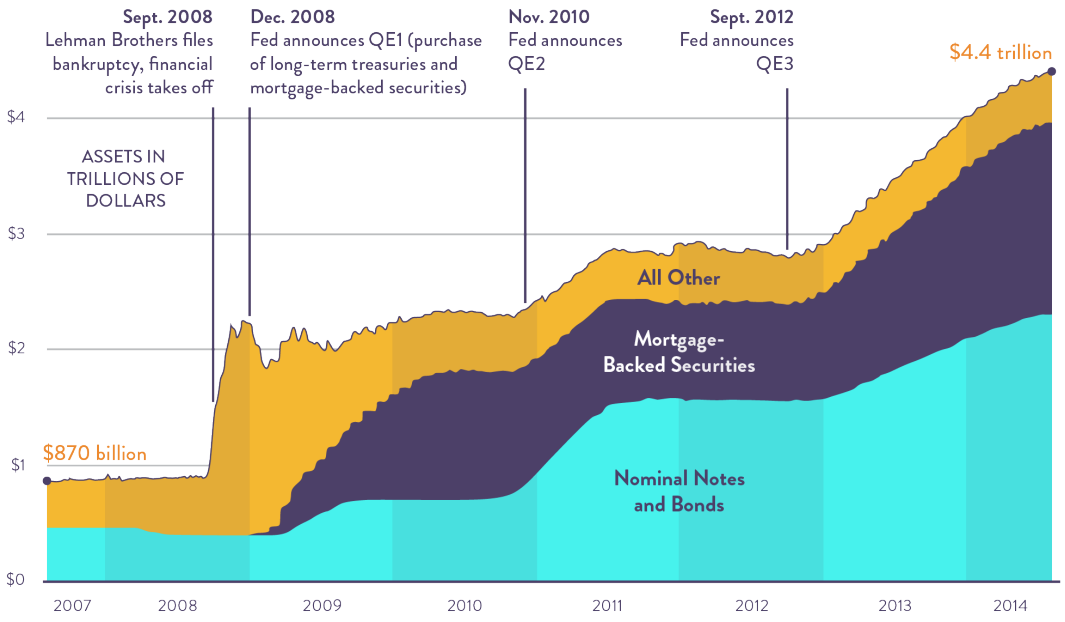


Figure 2: Federal Reserve Assets: key dates
(Adapted from: "Credit and Liquidity Programs and the Balance Sheet: Total Assets of the Federal Reserve", 2014)

The aim of this policy was simple and two-fold. By replacing the long-term assets with more liquid assets, they decrease the balance sheet risk of Financial Institutions. The hope in term was to avoid the contagion and bankruptcy of these institutions and free up room for consumer investment and spending, by allowing banks to issue to loans and credit.

Additionally, by decreasing interest rates ($\downarrow i$) and increasing the risk banks can take on for consumers, they increase consumer investment and spending ($\uparrow C$,I), as well as increasing bond prices which should stimulate the market and fix the liquidity problem in the fixed income markets. This effect, along with the increase in money supply should also, in theory, weaken the country's currency ($\downarrow E$) – increasing net exports ($\uparrow X - M$). The hope was that these interventions should increase GDP ($\uparrow Y$), and stabilize employment and financial institutions.

We will denote these effects using their short-hand, used in most macroeconomic literature and textbooks:

$$\downarrow i \rightarrow \uparrow C, I \rightarrow \uparrow Y$$

(raise output)

$$\downarrow i \rightarrow \uparrow B$$

(raise value of securities)

$$\uparrow M_s \rightarrow \downarrow E \rightarrow \uparrow (X - M), Y$$

Unit 3: Conditions for Failure

Modeling liquidity

In the previous set of notes, we discussed the Liquidity Preference Curve and the role of quantitative easing in the aftermath of the Global Financial Crisis. Monetary policy relies on the ability of monetary supply to affect interest rates and consumption and investment in the real economy. When the economy is frozen, as traditional lending institutions lack the liquidity to make new loans or alter their positions, new investment stops, and the economy goes into a recession as many banks and businesses fail. The problem in this situation is that simply increasing Money Supply does not help, due to the grid-lock in markets.

In [1]:
```
# Import Libraries
from functools import reduce
from  operator import mul

import os

import pandas as pd
import numpy as np
import statsmodels.api as sm

import holoviews as hv
import hvplot.pandas

np.random.seed(42)

pd.core.common.is_list_like = pd.api.types.is_list_like
import pandas_datareader.wb as wb

hv.extension('bokeh')
```

The data

In order to explore the effects of QE further and the effects of monetarist policy on the real economy, we are going to analyze real macroeconomic data sourced from the World Bank Website, using the pandas-data reader API we are going to download data for a number of key indicators across a range of both developed and developing countries. A number of datapoints can be incomplete over time or across countries, so where this is the case the closest proxy indicator was used. Data was sourced for South Africa, China, the United States, the United Kingdom and Japan.

Using plots, we will analyze the effects of changing interest range and money supply on a number of indicators, which the theory predicts. We can then explore these relationships further across a range of variable in order to examine the strength of affect these have at some lag. For those interested in looking into macroeconomic modeling further, using Dynamic Stochastic Generalized Equilibrium Modeling a great Python package exists called pymaclab which has a number of tutorials and example for you to try. This package might be tricky to install, as it has a number of very specific versioning requirements. I would recommend creating a new Anaconda environment into order to explore this further.

For those studious among you, a wide range of indicators are available for students to explore, such as unemployment, real wages and price level, however we are going to be focusing primarily on the role relationship between liquidity, interest rates and the real economy.

In [2]:
```
# Get Countries in World Bank Database
countries = wb.get_countries()
countries.head()
#countries.loc[countries.name.str.lower().str.contains('kingdom'),]
```

Out[2]:

	adminregion	capitalCity	iso3c	incomeLevel	iso2c	latitude	lendingType	longitude	name	region
0		Oranjestad	ABW	High income	AW	12.51670	Not classified	-70.0167	Aruba	Latin America & Caribbean
1	South Asia	Kabul	AFG	Low income	AF	34.52280	IDA	69.1761	Afghanistan	South Asia
2			AFR	Aggregates	A9	NaN	Aggregates	NaN	Africa	Aggregates
3	Sub-Saharan Africa (excluding high income)	Luanda	AGO	Lower middle income	AO	-8.81155	IBRD	13.2420	Angola	Sub-Saharan Africa
4	Europe & Central Asia (excluding high income)	Tirane	ALB	Upper middle income	AL	41.33170	IBRD	19.8172	Albania	Europe & Central Asia

In [3]:
```
# Get indicators in World Bank Database
indicators = wb.get_indicators()
indicators.head()
#indicators.loc[indicators.name.str.lower().str.contains('balance')]
```

Out[3]:

	id	name	source	sourceNote	sourceOrganization	topics	unit
0	1.0.HCount.1.90usd	Poverty Headcount ($1.90 a day)	LAC Equity Lab	The poverty headcount index measures the propo...	b'LAC Equity Lab tabulations of SEDLAC (CEDLAS...	Poverty	
1	1.0.HCount.2.5usd	Poverty Headcount ($2.50 a day)	LAC Equity Lab	The poverty headcount index measures the propo...	b'LAC Equity Lab tabulations of SEDLAC (CEDLAS...	Poverty	
2	1.0.HCount.Mid10to50	Middle Class ($10-50 a day) Headcount	LAC Equity Lab	The poverty headcount index measures the propo...	b'LAC Equity Lab tabulations of SEDLAC (CEDLAS...	Poverty	
3	1.0.HCount.Ofcl	Official Moderate Poverty Rate-National	LAC Equity Lab	The poverty headcount index measures the propo...	b'LAC Equity Lab tabulations of data from Nati...	Poverty	
4	1.0.HCount.Poor4uds	Poverty Headcount ($4 a day)	LAC Equity Lab	The poverty headcount index measures the propo...	b'LAC Equity Lab tabulations of SEDLAC (CEDLAS...	Poverty	

In [4]:
```
# M4 Money Plot
money = wb.download(indicator='FM.LBL.BMNY.GD.ZS', country=['USA','GBR','ZAF','CHN', 'JPN'], start=pd.to_datetime('2000', yearfi
rst=True), end=pd.to_datetime('2017', yearfirst=True))
money = money.reset_index()

money_plot = money.iloc[::-1,:].hvplot.line(x='year', y='FM.LBL.BMNY.GD.ZS', by='country', title='Broad money (% of GDP)')
```

In [5]:
```
# Foreign Direct Investment Plot
investment = wb.download(indicator='BX.KLT.DINV.CD.WD', country=['USA','GBR','ZAF','CHN', 'JPN'], start=pd.to_datetime('2000', y
earfirst=True), end=pd.to_datetime('2017', yearfirst=True))
investment = investment.reset_index()

investment_plot = investment.iloc[::-1,:].hvplot.line(x='year', y='BX.KLT.DINV.CD.WD', by='country', title='Foreign direct inves
tment')
```

In [6]:
```
# Current Acount Balance Plot
XM = wb.download(indicator='BN.CAB.XOKA.CD', country=['USA','GBR','ZAF','CHN', 'JPN'], start=pd.to_datetime('2000', yearfirst=Tr
ue), end=pd.to_datetime('2017', yearfirst=True))
XM = XM.reset_index()

XM_plot = XM.iloc[::-1,:].hvplot.line(x='year', y='BN.CAB.XOKA.CD', by='country', title='Current Account Balance')
```

In [7]:
```
# Exhcnage Rate Plot
exchange = wb.download(indicator='DPANUSLCU', country=['USA','GBR','ZAF','CHN', 'JPN'], start=pd.to_datetime('2000', yearfirst=T
rue), end=pd.to_datetime('2017', yearfirst=True))
exchange = exchange.reset_index()

exchange_plot = exchange.iloc[::-1,:].hvplot.line(x='year', y='DPANUSLCU', by='country', title='Official exchange rate, LCU per
USD')
```

In [8]:
```
# Lending Rate Plot
lending_rate = wb.download(indicator='FR.INR.LEND', country=['USA','GBR','ZAF','CHN', 'JPN'], start=pd.to_datetime('2000', yearf
irst=True), end=pd.to_datetime('2017', yearfirst=True))
lending_rate = lending_rate.reset_index()

lending_rate_plot = lending_rate.iloc[::-1,:].hvplot.line(x='year', y='FR.INR.LEND', by='country', title='Lending interest rate
(%)')
```

In [9]:
```
# Bond Portfolio Plot
bonds = wb.download(indicator='DT.NFL.BOND.CD', country=['USA','GBR','ZAF','CHN', 'JPN'], start=pd.to_datetime('2000', yearfirst
=True), end=pd.to_datetime('2017', yearfirst=True))
bonds.reset_index()

bonds_plot = bonds.iloc[::-1,:].hvplot.line(x='year', y='DT.NFL.BOND.CD', by='country', title='Bond Portfolio(%)')
```

In [10]:
```
# GDP Plot
gdp = wb.download(indicator='NY.GDP.PCAP.KD', country=['USA','GBR','ZAF','CHN', 'JPN'], start=pd.to_datetime('2000', yearfirst=T
rue), end=pd.to_datetime('2017', yearfirst=True))
gdp = gdp.reset_index()

gdp_plot = gdp.iloc[::-1,:].hvplot.line(x='year', y='NY.GDP.PCAP.KD', by='country', title='GDP per capita (constant 2010 US$)')
```

The results

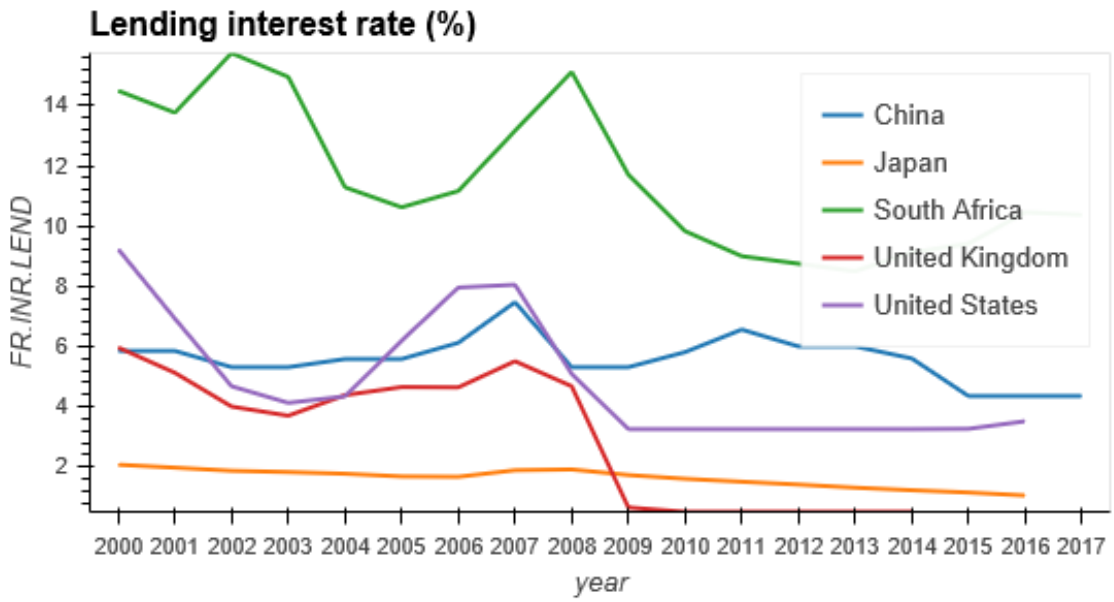
Let's look at these relationships for ourselves. Here we will be building and exploring the relationship and predictions discussed in the previous set of notes and trying to identify them for ourselves in this data.

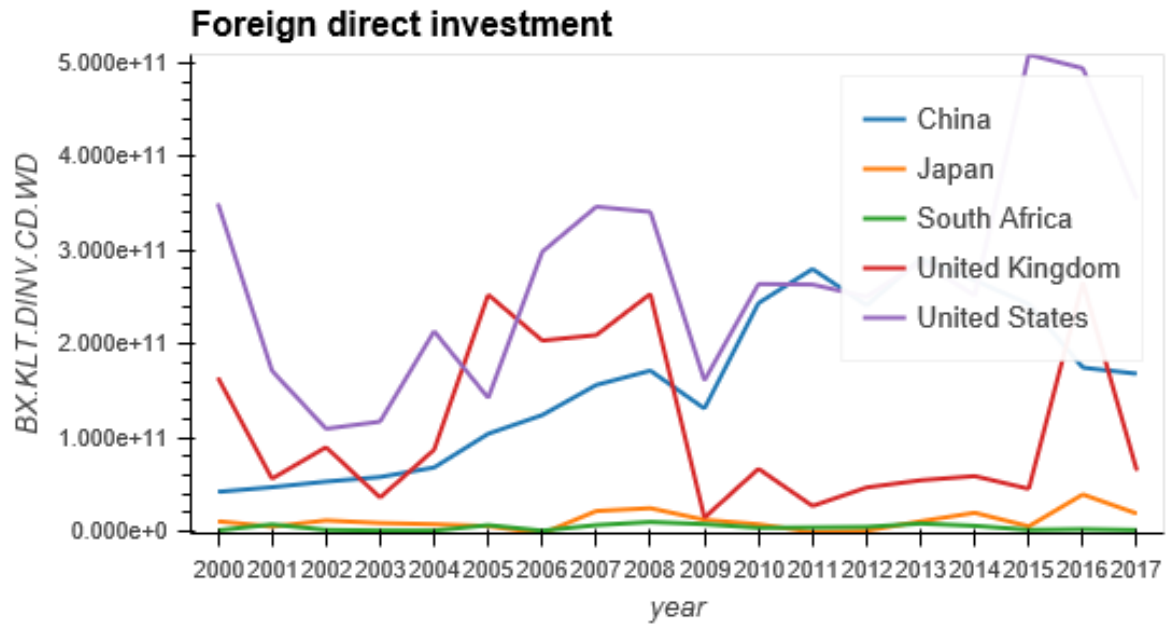
From the graphs below, it appears that consumer lending rates demonstrate mixed interventions and responses. For countries like the US, where we see a quite active monetarist intervention in the lead-up to, and after the crisis, it is clear that the fall in interest rates corresponds with an increase in Foreign Direct Investment at one lag in the future. Similar affects can be observed for China and the UK, to lesser degrees. While the GDP per capita plots appear difficult to interpret, due to their scaling between nations, it is clear for the US and UK data, that we see a correction in GDP from the effects of the 2008 crisis.

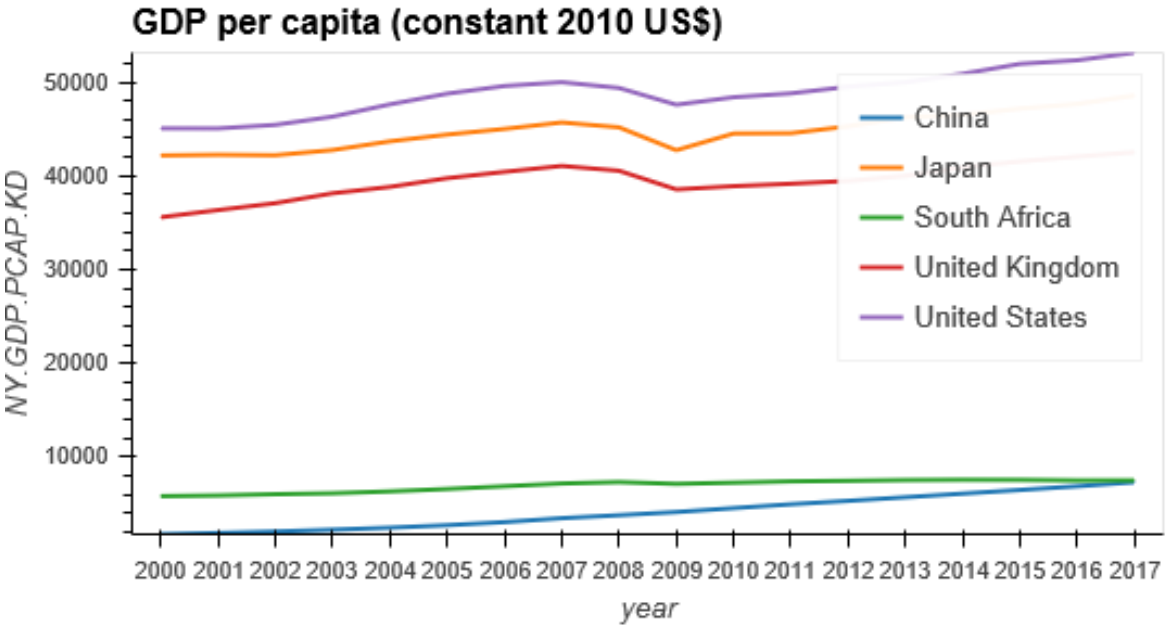
$$\downarrow \boldsymbol{i} \rightarrow \uparrow C, I \rightarrow \uparrow Y$$

(raise output)

```
In [11]: %%opts Curve [width=550]

         lending_rate_plot + investment_plot + gdp_plot
```





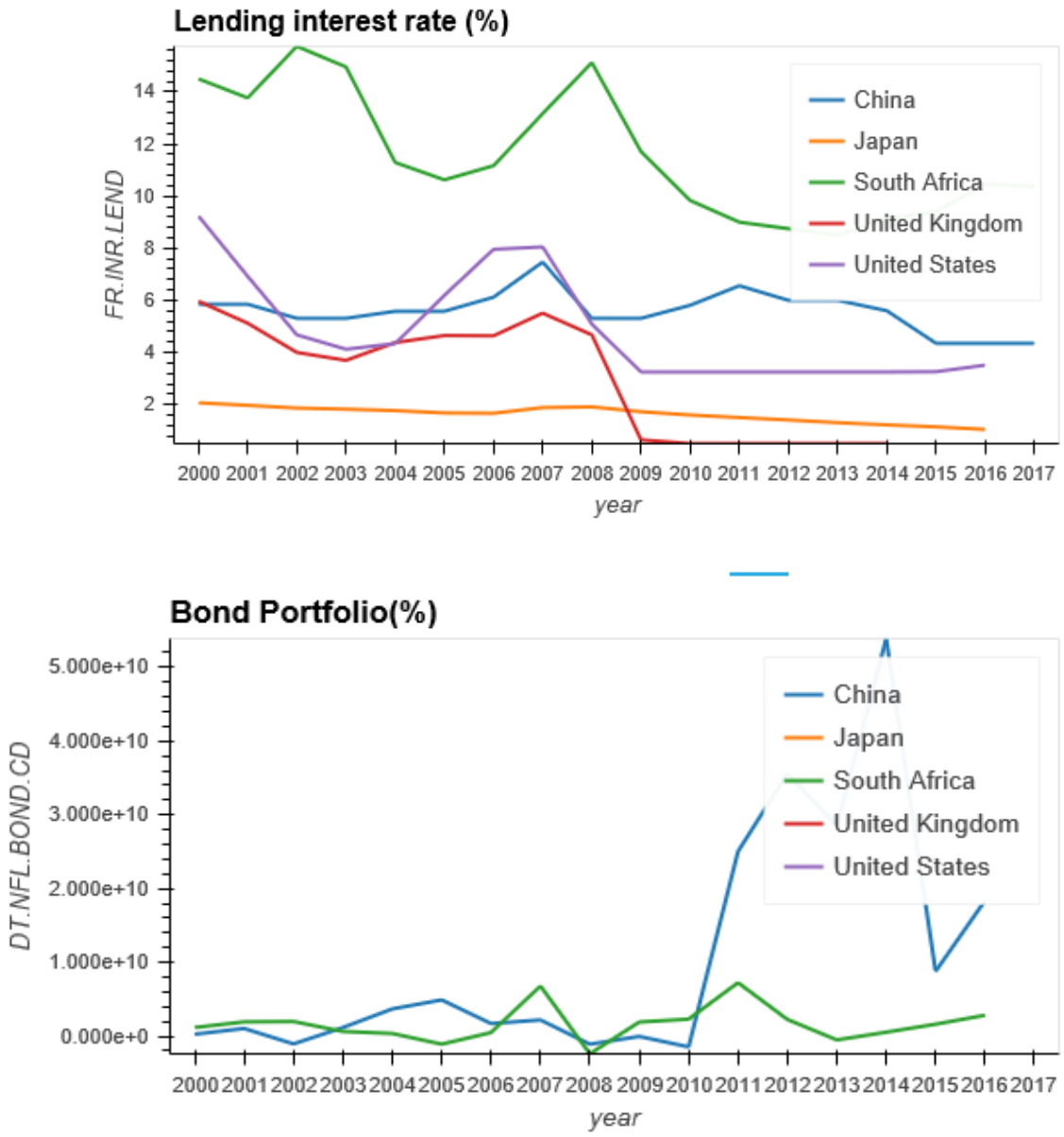


Sadly, the World Bank have missing data for bond portfolios, but we do see corresponding increases in bond portfolio relative to consumer lending rates at some lag.

$$\downarrow i \rightarrow \uparrow B$$

(raise value of securities)

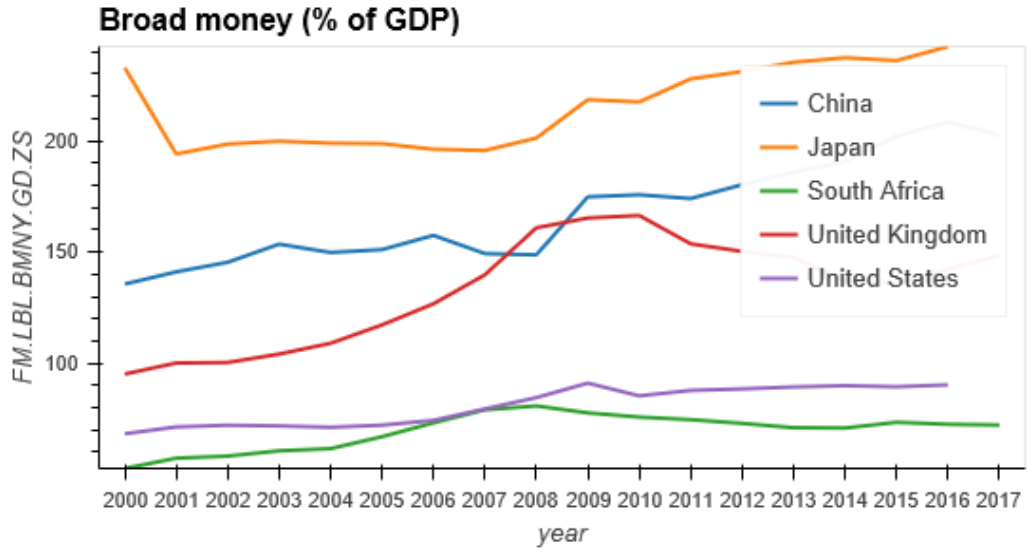
```
In [12]: %%opts Curve [width=550]

         lending_rate_plot + bonds_plot
```

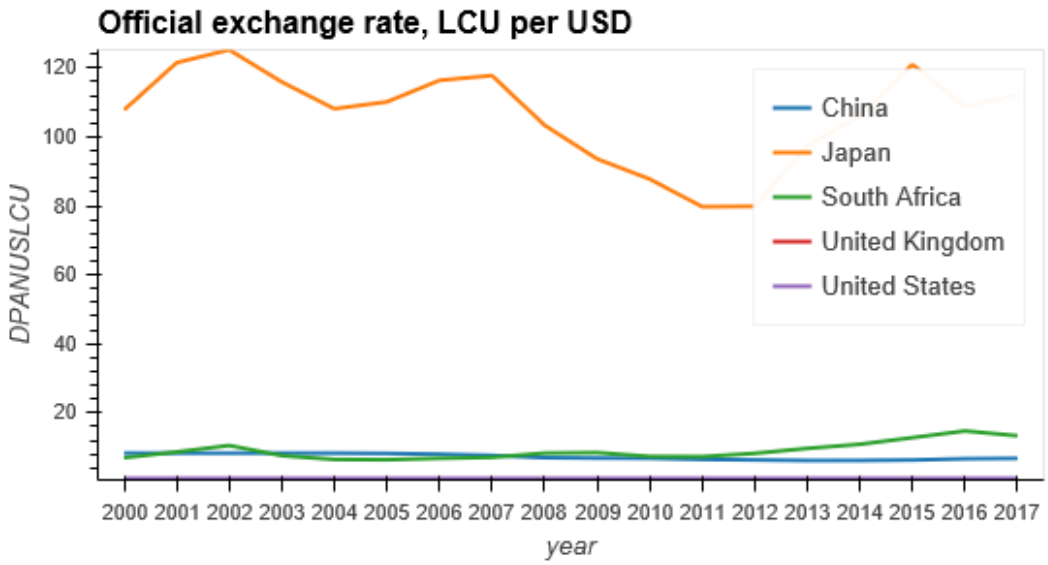


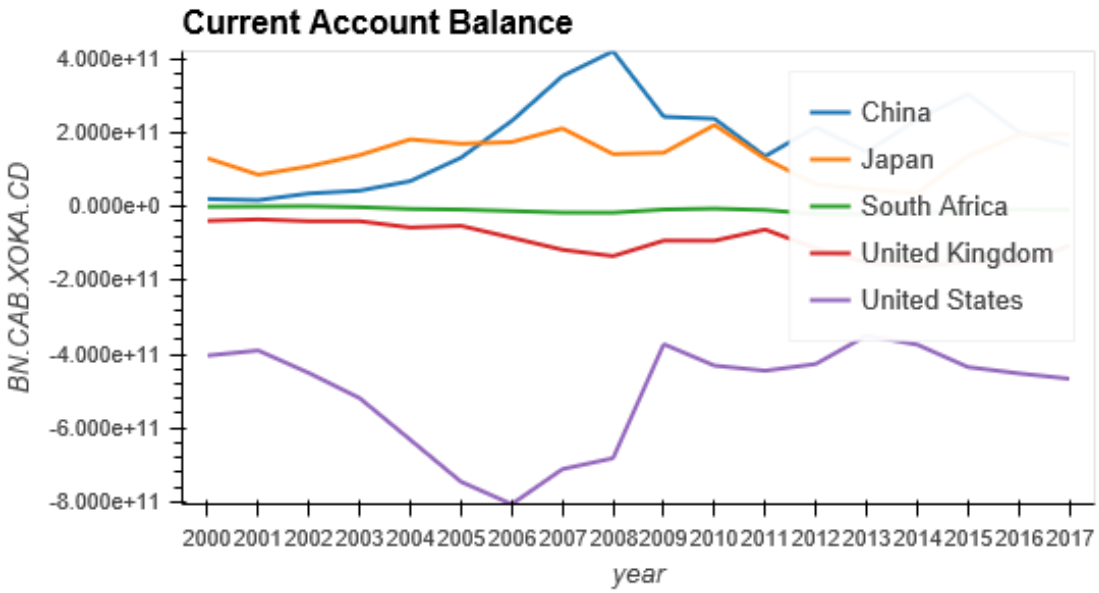
The final effects appear the hardest to interpret, largely due to scaling. For Japan it appears that the increase in M5 money relative, does have a clear effect on the exchange rate and current account balance. Changes to scaling may help better aid in observing these effects, which the theory predicts.

$$\uparrow M_s \rightarrow \downarrow E \rightarrow \uparrow (X - M), Y$$

In [13]:
```
%%opts Curve [width=550]

money_plot + exchange_plot + XM_plot
```







Generally, this type of analysis, based purely on graphs, can be difficult as over short period of time many effects can be observed simultaneously and in subtle and complex ways. For this reason, Macroeconomic Models are interpreted often under the *ceteris paribus* assumption, that all other affects remain constant. It is for this reason that economists often evaluate these models over long period of time controlling for the differences between different countries and shocks over time.

The model

In order to properly test the Liquidity Preference Curve, we are going to try estimate a model using OLS regression. We are going to sample a random group of countries and, controlling for country and year, try estimate this curve using OLS regression. Without extensively going into the assumptions of OLS regression, and the Gauss-Markov Assumptions, we will use data over a long period of time from 1950 to 2017 and will using a random selection of 18 different countries shown below in the code.

In [14]:
```
#c = countries.iso3c.sample(frac=0.1).tolist()
c = ['ARG','QAT','SLV','VGB','AUS','ALB',
     'SUR','PHL','SGP','COL','MAF','LAO',
     'PNG','MAR','GRC','LCA','BRB','ZMB']
```

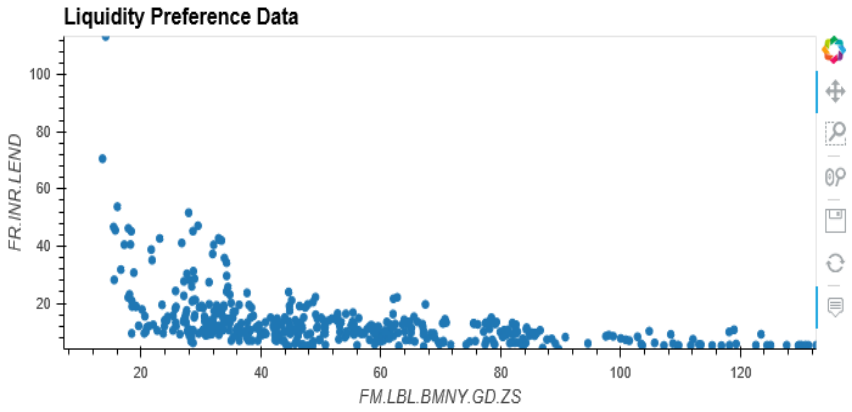
For this analysis we will be making use of the statsmodels package, which we have used before, and while provides an extensive suite of diagnostic tools for use in our analysis. We will start by downloading our data for these countries.

In [15]:
```
money_lt = wb.download(indicator='FM.LBL.BMNY.GD.ZS', country=c, start=pd.to_datetime('1950', yearfirst=True), end=pd.to_datetim
e('2017', yearfirst=True)).reset_index()

lending_rate_lt = wb.download(indicator='FR.INR.LEND', country=c, start=pd.to_datetime('1950', yearfirst=True), end=pd.to_dateti
me('2017', yearfirst=True)).reset_index()
```

We will then move to plotting this data, analyzing visually the downward sloping liquidity curve and possible liquidity trap. In Macroeconomic Modeling, it is often common to estimate a model using a mix of polynomial functions. For our model, we can include $\sqrt{x}$ and x^2, but will estimate the log-log of our data in order to account for the obvious effects of elasticity to this liquidity preference curve. This has been commented out, but students are welcome to experiment with these features. The primary challenge this analysis is that countries have different risk profiles based on a number of historical or structural reasons. Because of this, it is importance that we control for each country, as well as global systematic shocks which may have obfuscated our liquidity preference curve.

In [64]:
```
liquidity_trap_lt = money_lt.merge(lending_rate_lt, on=['year','country'])
liquidity_trap_plot = liquidity_trap_lt.hvplot.scatter(x='FM.LBL.BMNY.GD.ZS',y='FR.INR.LEND', title="Liquidity Preference Data")
liquidity_trap_plot
```

Out[64]:



Based on the graph above, it appears a downward-sloping relationship exists. Based on the long-right tail, there may be evidence for the existence of a liquidity trap in the data. In order to explore this further we will have to model the data.

In [24]:
```
liquidity_trap_lt.loc[:,'FM.LBL.BMNY.GD.ZS'] = np.log(liquidity_trap_lt.loc[:,'FM.LBL.BMNY.GD.ZS'])
liquidity_trap_lt.loc[:,'FR.INR.LEND'] = np.log(liquidity_trap_lt.loc[:,'FR.INR.LEND'])
```

In [57]:
```
import statsmodels.api as sm

liquidity_trap_lt.loc[:,'FM.LBL.BMNY.GD.ZS**0.5'] = liquidity_trap_lt.loc[:,'FM.LBL.BMNY.GD.ZS']**(0.5)
liquidity_trap_lt.loc[:,'FM.LBL.BMNY.GD.ZS**2'] = liquidity_trap_lt.loc[:,'FM.LBL.BMNY.GD.ZS']**(2)


# Compare the models with the inclusion of polynomial terms
#  and control for year
lt = pd.concat([pd.get_dummies(liquidity_trap_lt.country),
                #pd.get_dummies(liquidity_trap_lt.year),
                liquidity_trap_lt.loc[:,'FM.LBL.BMNY.GD.ZS'],
                #liquidity_trap_lt.loc[:,'FM.LBL.BMNY.GD.ZS**0.5'],
                #liquidity_trap_lt.loc[:,'FM.LBL.BMNY.GD.ZS**2'],
                liquidity_trap_lt.loc[:,'FR.INR.LEND']], axis=1).dropna(0)

exo = sm.add_constant(lt.drop(columns=['FR.INR.LEND']), prepend=False)

# # Fit and summarize OLS model
mod = sm.OLS(lt.loc[:,'FR.INR.LEND'], exo)
res = mod.fit()

print(res.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:            FR.INR.LEND   R-squared:                       0.606
Model:                            OLS   Adj. R-squared:                  0.593
Method:                 Least Squares   F-statistic:                     45.99
Date:                Tue, 13 Nov 2018   Prob (F-statistic):           1.33e-75
Time:                        13:38:37   Log-Likelihood:                -132.68
No. Observations:                 434   AIC:                             295.4
Df Residuals:                     419   BIC:                             356.5
Df Model:                          14
Covariance Type:            nonrobust
================================================================================================
                                   coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------------------------
Albania                          0.6780      0.079      8.580      0.000       0.523       0.833
Argentina                        0.2154      0.068      3.176      0.002       0.082       0.349
Australia                        0.0238      0.052      0.461      0.645      -0.078       0.126
Barbados                         0.2964      0.068      4.354      0.000       0.163       0.430
British Virgin Islands       8.668e-17    3.1e-17      2.800      0.005    2.58e-17    1.48e-16
Colombia                         0.6915      0.060     11.507      0.000       0.573       0.810
El Salvador                      0.5626      0.075      7.466      0.000       0.414       0.711
Greece                       -2.354e-16    2.4e-17     -9.815      0.000   -2.82e-16   -1.88e-16
Lao PDR                      2.126e-16   2.03e-17     10.495      0.000    1.73e-16    2.52e-16
Morocco                          0.0940      0.072      1.302      0.193      -0.048       0.236
Papua New Guinea                 0.1008      0.056      1.804      0.072      -0.009       0.211
Philippines                      0.2667      0.052      5.146      0.000       0.165       0.369
Qatar                           -0.1075      0.065     -1.644      0.101      -0.236       0.021
Singapore                        0.0681      0.076      0.899      0.369      -0.081       0.217
St. Lucia                        0.4423      0.065      6.813      0.000       0.315       0.570
St. Martin (French part)              0          0        nan        nan           0           0
Suriname                         0.5406      0.079      6.821      0.000       0.385       0.696
Zambia                           0.4788      0.061      7.899      0.000       0.360       0.598
FM.LBL.BMNY.GD.ZS               -0.5633      0.058     -9.773      0.000      -0.677      -0.450
const                            4.3516      0.208     20.970      0.000       3.944       4.759
==============================================================================
```

```
Omnibus:                       15.947   Durbin-Watson:                   0.378
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               19.959
Skew:                           0.353   Prob(JB):                     4.64e-05
Kurtosis:                       3.779   Cond. No.                     1.06e+28
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The smallest eigenvalue is 6.22e-53. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
```

While the inclusion of a handful of country indicator variables appear insignificant, most variables in the model demonstrate significance in the model at the 1%-level using the Students T-test. Looking at other test statistics, such as the F-test, we see strong joint significance in our model. The coefficient on out interest rate variables is -0.5633, supporting the hypothesis of the Liquidity Preference Curve that the curve should be downward sloping.

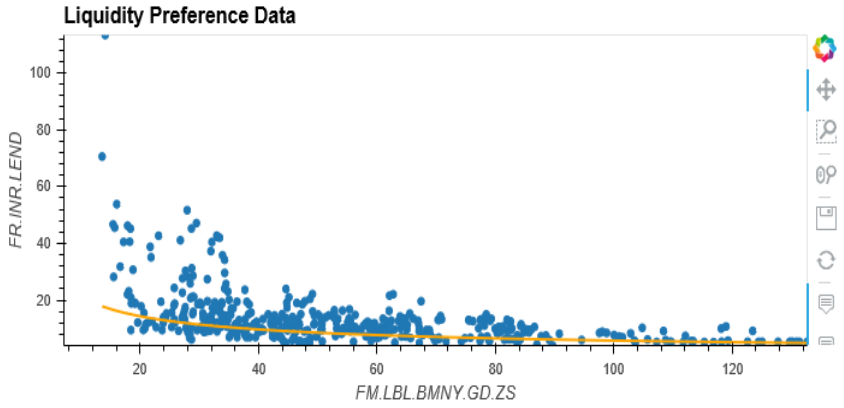
In [70]:
```
model = pd.DataFrame(exo.loc[:,'FM.LBL.BMNY.GD.ZS'])

model['predicted'] = (res.params.loc['FM.LBL.BMNY.GD.ZS']*model.loc[:,'FM.LBL.BMNY.GD.ZS'] +\
                          #res.params.loc['FM.LBL.BMNY.GD.ZS**0.5']*model.loc[:,'FM.LBL.BMNY.GD.ZS']**(0.5) +\
                          #res.params.loc['FM.LBL.BMNY.GD.ZS**2']*model.loc[:,'FM.LBL.BMNY.GD.ZS']**(2) +\
                          res.params.loc['const'])
```

Again, using our data, we can plot our data against our filled model in order to observe the accuracy of our model. From the graph, it appears our model fits the data well. While the model, does not present as strong a curvature, when compared to some points in our dataset- it does appear to demonstrate a flattening to the curve, indicative of monetary policy impotence.

In [71]:
```
plot = model
plot.loc[:,'FM.LBL.BMNY.GD.ZS'] = np.exp(plot.loc[:,'FM.LBL.BMNY.GD.ZS'])
plot.loc[:,'predicted'] = np.exp(plot.loc[:,'predicted'])
```

In [81]:
```
liquidity_trap_plot * plot.sort_values('FM.LBL.BMNY.GD.ZS').hvplot.line(x='FM.LBL.BMNY.GD.ZS',y='predicted', title="Liquidity Pr
eference Model").options(color='#ffa500')
```

Out[81]:



The conclusion

From the model, and the data, is it clear the role quantitative easing played in tackling the problem of a liquidity trap. Analyzing the data since the crisis, we can see largely that market restored and that many institutions were stabilized. As central banks reverse quantitative easing there remains great uncertainty moving into the future. Using modelling we can begin to uncover and understand the role of this policy on markets and financial risk management.

Unit 4: The Global Overspill

The 2007-9 financial crisis created a series of circumstances that led to the Great Recession, a period of global economic decline. Understanding the impact of the recession is critical in analysing how economic crises can lead to dramatic social and political consequences. For an event as massive as the 2007-2009 financial collapse, a comparative approach will be key in understanding the global implications of global finance.

The hardest hit

The United States (US) and the states closely aligned economically and financially with it were the hardest hit as financial institutions weakened and financial markets began to crash in late 2007 and early 2008. Critically, the worst affected areas were banking, financial and credit management, household income and employment. What is critical in American economic history is that, dating back to the 1930s, there had been increasing levels of regulation until the Reagan era began a series of deregulation policies that continued until the crisis hit in 2007. Both Democrats and Republicans adopted somewhat similar neoliberal approaches to expanding wealth in the early 2000s and saw no reason to increase regulation of the banks and of financial investment firms. What this created was a sector that was able to expand through any means possible, which led to increasing levels of mismanagement, over-zealous speculation and increased odds of fraud and dodgy dealing.

The financial crisis and the subprime mortgage bubble were not the only contributors to the Recession, but they play substantial roles in the decline the US and the world faced. The circumstances that created the crisis were long-term and had developed over a period that meant the stagnation of the Recession would not be easy to solve and would permeate into all areas of the US economy. The housing market collapsed, sending the demand downwards for the many repossessed houses and the houses many were desperate to sell, causing serious financial instability in many households. This uncertainty eroded consumer demand, as millions of American households began to put off the purchase of major consumer durables, especially appliances and automobiles. This, coupled with the history of easy credit that was a staple for many big American banks, meant that repaying debts became a serious concern for Americans. The proportion of debt then began to expand, and banks faced serious liquidity problems, making the financial system a potential spill over zone into regional and international markets. Though bailouts from the Federal Reserve were aimed at critical, 'too big to fail' banks and investment firms, this was not always

enough and several declared bankruptcy. This eroded trust in the American economic system, making investment and foreign trade far more difficult as foreign states aimed to protect their own financial and economic systems. Unemployment skyrocketed as companies that were linked to decaying firms and collapsing banks fell apart, and the **gross domestic product** (GDP) dipped sharply over the subsequent few years. Reduced consumer demand meant that even companies that were not connected to the housing market also suffered tremendously – most spectacularly the near collapse of major automotive manufacturers General Motors and Chrysler.

Spilling onto everything

It was only a matter of time before the financial crisis of the late 2000s hit other countries and economic hubs. Critically, the European debt crisis and a global slump in GDP were major features of the Great Recession, and only a few states were able to avoid it. The hardest hit other than the US were the developed states, notably in Europe, Russia, Canada and Japan.

The European problem was largely the result of debts in Europe to the World Bank, the **International Monetary Fund** (IMF) and other states were incredibly high in proportion to the GDPs of the respective states. Having had a century or so of major government spending as a result of increased Cold War defence spending, the expansion of most European welfare systems and the challenges to capitalism during the Cold War all created high foreign debt in European countries. At the onset of the Crisis, Greece, Portugal, Ireland, Spain and Italy had ratios of debt to GDP of more than 60% and this climbed during the financial crisis when investment and trade dried up. But, rather than adopting Keynesian approaches to economic recovery, using government spending to prime the pump for private industry as the American government had done during the New Deal, European governments adopted austerity measures in the face of the Great Recession. Eurozone countries like Greece and Italy did not control their own currency, so ultimately major creditors and the European Central Bank began to largely dictate domestic policy. Just as the American Federal Reserve bailed out investment banks without a similar policy toward individual home foreclosures, European banks prioritized shoring up the portfolios of large investors. Instead of priming the pump, European governments cut spending in an attempt to pay down their debts. These efforts essentially escalated the onset of a major recession, as public spending plummeted along with private investment. Notably, unemployment during the Crisis and the Recession skyrocketed in many EU states and currencies decayed over the period. Though there were IMF bailouts similar to the ones in the Asian Crises, these also served to cause internal political and social disorder as

countries tried to make sense of the imposed financial and economic hardships that saw social spending slashed and economic opportunities few and far between.

The lucky ones

The developing world faced some issues because of the financial crisis, owing largely to their connections to the developed world and their dependence on developed world foreign direct investment and trade. However, these problems were minor compared to the EU-US-developed world crisis. The main reason for this was the level of preparedness and integration present in the countries that were not as heavily affected. Largely, Africa was excluded from the crisis as it had few countries that were integrated into the global economy. The major problem faced by African states was the decrease in demand for raw materials and the decline of some financial markets. South Africa was the only country heavily affected, largely because of their connection to the US and Europe trading spheres.

In Latin America, owing to several localized financial problems – notably in Argentina and Brazil – there was some preparedness for the Crisis, but there were major raw goods and agricultural issues that persisted through the timing of the Recession, causing some economic decline. Similarly, in Asia, there was the drying of trade demand for raw goods and manufactured industry output, causing decline in the more industrialized states. Some states were affected by housing and investment bubbles, most notably Japan, South Korea and the Chinese economic hubs, and decline did occur. Most economic growth in the region – that had been expanding for decades in India, China and Japan – slowed dramatically and required serious policy changes to be made in order for the slowing to stop.

The Recession, based on the reckoning by the IMF and financial survey groups, is said to have largely ended by the end of 2011, but it does persist in a few countries. Debt crises persist, particularly in Europe, and regulatory principles are still being worked through to prevent a similar crisis. This, as the next module will show, is not always the case though.

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