WORLDQUANT UNIVERSITY

Compiled Notes Module 3

MScFE 660

Case Studies in Risk Management

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Module 3: Understanding the Asian Crises

This module discusses the economic crises experienced in Asia during the late 1990's. By examining the economies impacted during the so-called 'Asian Contagion' and using a comparative approach to market models and macroeconomic analysis, the module provides an understanding of foreign exchange risk. The module begins with a thorough explanation of the genesis of the financial crisis which expanded in several Asian countries starting from Thailand and continues by applying the IS-LM-IP macroeconomic model to analyze them. The module concludes by explaining the strategies used to recover the economy of the affected countries including the introduction and consolidation of regulatory systems.

Unit 1: The Waves of Crashes

In July 1997, several Asian economies were gripped with fluctuating markets and instability as fears of a major economic crisis grew across the global markets. The crisis – which began in Thailand and spread to other economies in Asia – saw several currencies collapse alongside increasing foreign national debt and a serious decline in growth amongst the 'Asian tigers'. Critically, the economic and monetary policies of the affected countries were examined as the **International Monetary Fund** (IMF) and other global economic bodies stepped in to prevent the crisis from spreading to European and American markets. In this context, it is important to understand is the role of currency valuation and the credit and lending element of financial markets, and how these both played a role in the crunch faced by Asian markets in the late 1990s.

The tiger roars

Several states across Asia – including Thailand, South Korea, Indonesia, Malaysia, the Philippines, Hong Kong, and Singapore – experienced economic booms between the 1960s and 1990s. Rapid growth in these countries accelerated, with nominal **gross domestic products** (GDPs) rising and currencies swelling in strength.

This was largely attributed to post-colonial economic growth across the region. In the decade following Indian independence in 1947, most other colonial states had been granted full political autonomy, either as a result of negotiations or civil conflicts. Many of these states – barring Hong Kong, which remained a British colony until 1997 – experienced growth in the years following independence. While the Cold War did play a significant role in the area – the Korean peninsula, Vietnam, Laos, and Cambodia under the Khmer Rouge all experienced violent conflicts – there was significant investment from major Western and Communist-bloc countries that helped spur the economic development. With investment coming from European and American investors, confidence in the so-called "tiger economies" – South Korea, Thailand, Indonesia, the Philippines, Malaysia and Singapore – increased substantially during the mid-to-late 20th century.

Asia's two largest and most populous countries, China and India, experienced relatively slow growth until the 1980s and 1990s due to a variety of factors, including varying degrees of political and economic instability. Upon independence, British India was partitioned into India and Pakistan (and later Bangladesh), causing violence and economic uncertainty. As a reaction against colonialism,

India imposed high tariffs on imports and embraced centralized economic planning. This limited growth and foreign investment until reforms in 1991 opened, or liberalized, the Indian economy. China, following the success of Mao Zedong's Communist Revolution in 1949, suffered from socio-political disorder and disastrous economic policies, which stunted growth until the early 1980s. Additionally, Japan, though slow to recover from its defeat in World War II (1939-1945) emerged as one of the world's strongest economies by the 1970s. However, its economic bubble collapsed in 1989, ushering an extended period of deflation. Due to both the size of their economies and their respective histories, India, China, and Japan were all excluded from the Asian economic crisis of the 1990s.

For many smaller Asian countries, the local availability of raw materials, closer trade links with Western states – notably the United States (US) – and the growth of foreign direct investment (FDI) meant that their private sectors grew exponentially through the early 1990s.

Because of the abundant opportunities to make money and the perception of ongoing economic growth, banks and financial institutions relaxed controls on money lending and credit distribution to public and private interests. Public infrastructure projects, private business ventures and a booming real estate sector created an environment of extreme economic confidence. This created a series of 'asset bubbles'. A 'bubble' largely occurs when the value of an asset or security – a plot of land, gold or some kind of item with a fluctuating price – is inflated, causing a supply versus demand problem. If the price or value rises too sharply, fewer options of sale will crop up, causing a supply issue with something that needs to be devalued, thus creating instability in all other related sales or markets. Notable bubbles in the past – such as the Dutch 'Tulip mania' of the 17th century or the dot-com bubble of the late 1990s – have seen the same progression: an asset is floated on the market, investors hype up the price, there is a shortfall in the demand for the asset and the value collapses, dragging with it any institution or individual unable to cover their liabilities.

Problems on the rise

Despite unprecedented growth, problems simmered beneath the surface of the financial and economic systems in Asia. The growth of foreign debt and budget deficits in the various countries involved in the crisis created an environment of panic. For example, between 1987 and 1996 Thailand saw deficits rising to over 5% of their nominal GDP. The problem of deficits was present in

a many of the states that eventually contracted the so-called 'Asian flu' or 'Asian economic contagion'.

South Korea had a number of large companies floated by capital investment that operated on extensive borrowing and foreign direct investment from the United States, leaving large liabilities for both banks and the conglomerates owned by major families. Linked to this was rife government corruption and the lack of a formal banking regulation system that would keep credit and lending in check. The Hanbo scandal of early 1997 initiated the

visible rot in the South Korean economy, as high-ranking government bureaucrats and corporate executives were involved in corrupt insider trading. The scandal – named after the largest steel corporation in South Korea – saw a highly publicized trial that revealed the extent of the scandal's cost, which was in the billions of dollars. Hanbo exposed a problem found in many other companies, as the government and big business had a serious reliance on declining markets scarred with deficient practices.

In Indonesia, corruption and largely unregulated banking practices under the government of Suharto – a US-supported anti-communist who had led Indonesia since 1968 – meant easy credit was often distributed, making bad debt a common feature of the financial sector. The level of mismanagement of government funds was severe and involved, for example, the positioning of Suharto's children and friends in companies that enjoyed monopolies in the Indonesian economy. Additionally, several major companies and financial institutions borrowed heavily from the US, which in turn weakened the long-term growth of Indonesia's currency, the rupiah.

The Philippines and Hong Kong faced similar issues. The Philippines began austerity measures in the early 1990s and the government of Fidel Ramos responded by continuing deregulation and institutional reform. Interest rates were increased, creating a situation where the peso (Filipino currency) could be devalued. Hong Kong, though still colony of the British, developed into a financial hub for the region. Major growth was, however, underpinned by a currency that was inflated much higher than it should have been, causing concern that any major fall would trigger a crisis in the currency peg.

These examples highlight a few critical, overarching problems in the Asian financial sector in the years preceding the crisis. First, the rise in foreign debt and deficits meant that any minor financial crunch or upset in inflation rates or currency values meant that a state could easily find itself with a

failing financial sector. Second, the actions and motivations of an incumbent government played heavily on the stability of a financial system and how it was able to maintain itself. If there were high-level corruption bleeding the state's coffers dry or influencing the ways in which the financial or asset sector moved, it would eventually play out badly for the overall economy, should any upset occur that damaged public confidence. Both conditions, found in the case of the Asian Crisis of 1997, created circumstances that led the US Federal Reserve to increase tariffs against the Asian markets to prevent any possible overspill from their unregulated banks into the American markets. By early 1997, the currencies of Thailand, the Philippines, Malaysia, South Korea and Indonesia were in trouble, with speculative attacks posing a real threat to the stability, particularly in the Southeast Asian economic region.

Unit 2: A Helping Hand?

Like in the previous module, in this module we are going to introduce important macroeconomic theory for use in understanding and modeling the Asian Crisis. This model will expand on models we have explored in previous modules and will be used in understanding both the macroeconomy and, later, financial markets.

In [3]:
```
import numpy as np
from scipy.optimize import fsolve
from scipy.stats import iqr
from scipy import signal
import pandas as pd

import holoviews as hv
import hvplot.pandas
```

In [4]:
```
# There is a compatilibility issue with this library \
#and newer versions of Pandas, this is short fix to the problem, \
#if you have issues at this chunk comment it out and you should be fine.
pd.core.common.is_list_like = pd.api.types.is_list_like
import pandas_datareader.wb as wb
```

In [5]:
```
hv.extension('bokeh')
np.random.seed(42)
```

The IS-LM-IP model, aims to dissect key relationship between the goods (IS) and money (LM) markets, and their relationship to a country's real exchange rate (IP). The model can be defined according to three important relationships: **Investment-Savings** Relationship (IS), **Liquidity-Money** Relationship (LM) and the **Interest-Parity** Relationship (IP), shown in the equation below:

$$IS: Y = C(Y-T) + I(Y,i) + G + NX\left(Y, Y^*, \frac{1+i}{1+i^*}, \bar{E}^e\right)$$

The Investment-Savings Relationship is defined according to the effect interest rates have on the real economy. In this equation, consumer spending is represented by C as a function of real income (Y), and taxes (T); investment (I), is a function of income (Y), and real interest rates (i); Government Expenditure is represented by G; and Net Exports (NX), is a function of Real Output (Y), Expected Real Output (Y^*), Real Interest Rates (i) , Expected Real Interest Rates (i^*) , and changes in the Exchange Rate .

$$LM: \frac{M}{P} = L(i,Y)$$

The Liquidity-Money Relationship is defined according to the relationship between real money supply ($\frac{M}{P}$) and the demand for money (L), as a function of real interest rates (i) and Real Output (Y).

$$IP: E = \frac{1+i}{1+i^*}\bar{E}^e$$

The Interest-Parity Relationship is a simple extension of the Interest Rate Parity Condition, $E_{USD/Rp} = E\frac{\text{expected}}{USD/Rp}\frac{1+i_{Rp}}{1+i_s}$, used in Finance, where E represents the exchange Rate, E^e represents the expected exchange rate, i represents the current real interest rate, and i^* represents the expected real interest rates.

While the IP Relationship holds to prevent arbitrage, the IS and LM curve need important explanations.

Let's start with the IS Relationship. The IS Relationship serves as a simple decomposition of real GDP into government, consumers, investors and balance of payments. Using this decomposition, we can begin to dissect the role of a particular group in the economy and analyze their response to changing interest rates. While the idea of Ricardian Equivalence isolates the effects of interest rates on consumers and government, the effect of the economy and interest rates on investors is important in the IS Relationship.

Investors respond to demand. As profit-maximizing agents, if demand increases they too seek to increase their supply in order to maximize their profits. In order to meet this demand and remain competitive, they need to invest in capital stock, in the form of machinery and working capital. In order to make these investments, investors must either fund this investment through income or borrowing and so are affected by Y and i. While much debate exists in economics concerning the direction of the causal relationship between aggregate supply and aggregate demand, we can imagine they that respond to both Y and i simultaneously and independently in deciding upon their investment level.

Next, let's chat about the LM Relationship. The LM Relationship describes the effect real GDP has on real interest rates. As real GDP rises, more money is required in the economy to ensure people can meet their desired level of spending. While we shall be discussing this dynamic further in later modules, by investigating the liquidity preference curve, it is important to note that this increases

the demand for interest rates. If every person in the economy wants to spend in the economy, signaled by rising real GDP, and no one wants to save, then savers can demand a higher interest rate for their money.

In [13]:
```
def i(*args, **kwargs):
    i = np.linspace(-6, 6, 100).reshape(-1,1)
    i = i[i!=0]
    return i

# These degine our IS-LM equations
def IS(i=i(), Z_1=0, df=True):
    return pd.DataFrame([i, -i+Z_1], index=['Real Interest','Real Output']).T if df else -i+Z_1

def LM(i=i(), Z_2=0, df=True):
    return pd.DataFrame([i, i-Z_2], index=['Real Interest','Real Output']).T if df else i-Z_2

def IP(i=i(), Z_3=0, df=True):
    return pd.DataFrame([i, i-Z_3], index=['Real Interest','Exchange Rate']).T if df else i-Z_3

# This equation is used to find the Price-level and Real Output from our graphs
def findIntersection(fun1,fun2,x0):
    return fsolve(lambda x : fun1(x) - fun2(x),x0)
```

In [73]:
```
def IS_LM_IP(z_1=0, z_2=0, z_3=0):
    is_eq = IS(i(), Z_1=0)
    lm_eq = LM(i(),Z_2=0)
    ip_eq = IP(i(), Z_3=0)

    is_shock = IS(i(), Z_1=z_1)
    lm_shock = LM(i(), Z_2=z_2)
    ip_shock = IP(i(), Z_3=z_3)

    result = findIntersection(lambda x: LM(i=x, Z_2=z_2, df=False), lambda x: IS(i=x, Z_1=z_1, df=False), 0.0)
    result = result + 1e-4 if result==0 else result

    is_lm_plot = hv.Curve(lm_eq, vdims='Real Interest',kdims='Real Output').options(alpha=0.2, color='#1BB3F5') *\
            hv.Curve(is_eq, vdims='Real Interest',kdims='Real Output').options(alpha=0.2, color='orange') *\
            hv.Curve(lm_shock, vdims='Real Interest',kdims='Real Output', label='LM').options(color='#1BB3F5') *\
            hv.Curve(is_shock, vdims='Real Interest',kdims='Real Output', label='IS').options(alpha=1, color='orange') *\
            hv.VLine(LM(i=result[0], Z_2=z_2, df=False)).options(color='black', alpha=0.2, line_width=1) *\
            hv.HLine(result[0]).options(color='black', alpha=0.2, line_width=1)

    ip_plot = hv.Curve(ip_eq, vdims='Real Interest',kdims='Exchange Rate').options(alpha=0.2, color='#33CC00') *\
            hv.Curve(ip_shock, vdims='Real Interest',kdims='Exchange Rate', label='IP').options(color='#33CC00') *\
            hv.VLine(IP(i=result[0], Z_3=z_3, df=False)).options(color='black', alpha=0.2, line_width=1) *\
            hv.HLine(result[0]).options(color='black', alpha=0.2, line_width=1)


    return is_lm_plot + ip_plot
```

The IS-LM-IP model is a complex model to illustrate, and an even more complex model to estimate. In most textbooks, the IS and LM Relationships are represented on a single plot, with an additional plot next to it used to illustrate the IP Relationship.

The IS curve is represented through an upward-sloping curve, intersecting with a downward-sloping LM curve on the same plot. These curves are usually drawn as non-linear function, but for the sake of illustration and understandability, we will be representing their relationships as linear.

These two curves describe the effect of changes in real interest rates on real GDP, as well the role of money-supply on an economy.

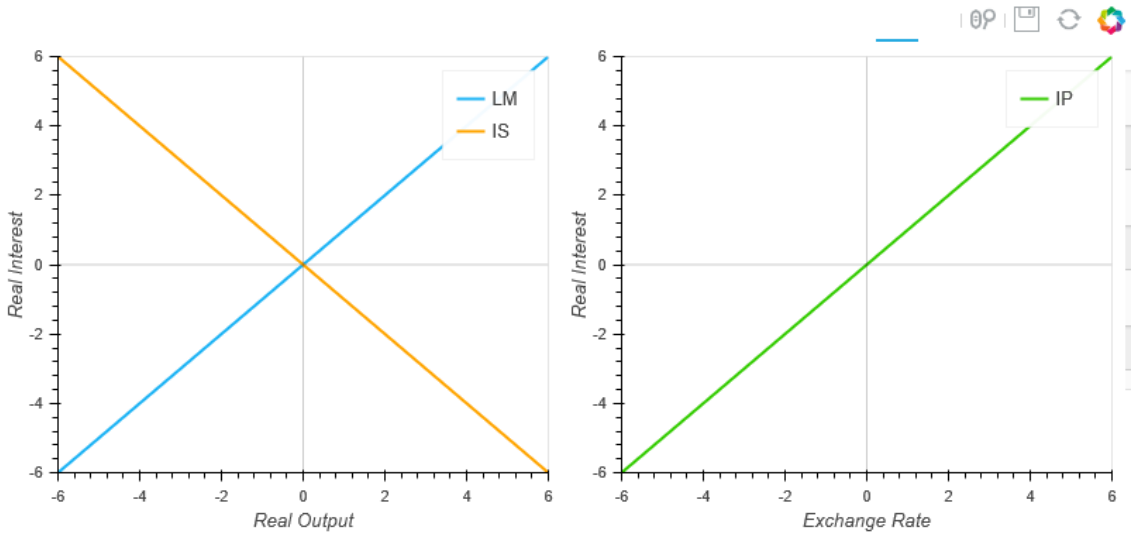
The IP curve is represented through a linear upward-sloping curve, defining the effect of changes in real interest rates on the exchange rate. From the IS-LM-IP equations it is fairly clear what terms serve as exogenous shocks to the equilibrium conditions. For the IS curve, T, E^e and i^* are all exogenous to the model, for the LM model, $\frac{M}{P}$ is exogenous to the model, and for the IP curve, i^* and $\bar{E}^e$ are exogenous to the model. These exogenous factors all serve to shift our curves either left or right, creating new equilibrium level of real GDP, real interest and the exchange rate.

Using the sliders below, you can explore the effect of these shocks on the IS-LM-IP curve in order to dissect their impact on an economy at equilibrium. Using the faint gray lines, you can read off the new equilibrium level of real GDP, real interest and the exchange rate. In the graphs, z_1 represents shocks to the IS curve, z_2 represents shocks to the LM curve, and z_3 represents shocks to the IP curve.

```
In [74]: %%opts Curve [width=400, height=350]
hv.DynamicMap(IS_LM_IP, kdims=['z_1', 'z_2', 'z_3'], label="IS-LM-IP Model")\
.redim.range(z_2=(0,10), z_1=(0,10), z_3=(0,10))
```

Out[74]:

z_1: 0, z_2: 0, z_3: 0



In analyzing the Asian Crisis, an important feature to understand are the effects of fixed and floating exchange rates on real output and interest rates. You will notice that with changes to z_1 and z_2, exchange rates want to fluctuate as changes in the real economy affect real interest rates and the

exchange rate. For many governments, exchange rate certainty is crucial in maintaining their nation's competitiveness in certain industries. As financiers, the threat of changing exchange rates is obvious. Exchange rate risk is a serious threat to any investment made in foreign currencies, which can drastically affect the cash flows of a business. For a company, this can affect its competitiveness or profit margin, as is the reason why many companies look to a host of strategies in mitigating this risk. It is for this reason that many governments have sought to implement policies of fixed or pegged exchange rates, in which they aim to maintain a set value of their currency against USD in order to better facilitate trade between their national the other developed countries.

Keeping this exchange rate constant is a challenging task, which requires countries to amass large currency reserve, which they use to maintain this equilibrium. For the government, the ability to maintain these fixed exchange rates involves changes to the money supply – adjusting the LM Relationship to ensure real interest and exchange rates remain constant.

If under fixed exchange rate regimes, $E = E*$, then according to the Interest-Parity Condition, $i = i^*$ at all times. In order to keep this constant, unlike most economies, where money supply is used to stabilize GDP, inflation and employment, using the LM curve, $\frac{M}{Y} * P$ must be altered to keep i constant. During the Asian Crisis, it is drastic changes in the economy at the time, that led to fixed exchange rate policies to collapse, sending ripples throughout Southeast Asia and developed markets.

Unit 3: The Build-Up in Thailand, Indonesia and South Korea

Viewing the action

Now that we have introduced the IS-LM-IP Model, it is time for us to start analyzing its validity and predictive accuracy of this model against real-world data. In these notes we will be sourcing data from the World Bank data portal, using the *'pandas-datareader'* API. By this point in the course, you should be familiar with the libraries we are using, though comments have been provided throughout to aid students in following the code. In some cases, proxies will be used for a particular data-point, due to the availability of specific data-points on the World Bank data portal. Students interested in running this code on their laptops or personal computers, please note that the graphs take a while to render, so patience is recommended. If you have limited system resources, it may be best to close out of other RAM intensive applications to prevent your computer from slowing down.

In [1]:
```
# import libraries
import numpy as np
from scipy.optimize import fsolve
from scipy.stats import iqr
from scipy import signal
import pandas as pd

import holoviews as hv
import hvplot.pandas
```

In [2]:
```
# There is a compatilibility issue with this library \
#and newer versions of Pandas, this is short fix to the problem, \
#if you have issues at this chunk comment it out and you should be fine.
pd.core.common.is_list_like = pd.api.types.is_list_like
import pandas_datareader.wb as wb
```

In [3]:
```
hv.extension('bokeh')
np.random.seed(42)
```

In this set of notes, we will be comparing the United States to nations involved in the Asian Crisis, like the Philippines, South Korea, Malaysia and Indonesia. You will need a reliable internet connection to download this data.

In [37]:
```
# We downloaded the availible countries and
#  looked up the iso number of the countries we are interested in
countries = wb.get_countries()

selected_countries = countries.loc[countries.name.str.lower().str.contains('malaysia')|
                    countries.name.str.lower().str.contains('philippines')|
                    countries.name.str.lower().str.contains('korea, rep.')|
                    countries.name.str.lower().str.contains('indonesia')|
                    countries.name.str.lower().str.contains('united states'),:]
```

For students interested at experimenting further with this model and this set of notes, use the indicators DataFrame to search through different economic indicators.

In [157]:
```
# We download and select our desired indicators
indicators = wb.get_indicators()

indicators.head()
```

Out[157]:

	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	

To make downloading our data more accessible and more consistent, we will be creating a class, which initializes the set of countries and date-range used in the analysis. Using the _'get*indicators*'function, you may download a particular indicator and applying various transformations, such as detrending, scaling and interpolation to aid in comparison and interpretability.

In [44]:
```
# This time we have created a class to make downloading and
#  tranforming our data easier and more consistent
class Indicators:
    def __init__(self, country=['USA'], start='1987-01-01 00:00:00', end='1987-01-01 00:00:00'):
        # This class that initialization parameters for use in all downloads
        self.country = country
        self.start = start
        self.end = end
        self.indicator = None

    def get_indicator(self, indicator='CM.MKT.TRAD.CD', long=True, detrend=False, scale=True, interpolate=True):
        # We download the data
        self.indicator = wb.download(indicator=indicator,
                                     country=self.country,
                                     start=self.start,
                                     end=self.end)
        # reshape it
        self.indicator = self.indicator.reset_index().iloc[::-1,:].reset_index(drop=True) if long else self.indicator
        self.indicator = self.indicator.rename(index=str, columns={indicator: indicators.loc[indicators.id == indicator,'name'].
tolist()[0]})
        indicator = indicators.loc[indicators.id == indicator,'name'].tolist()[0]

        # and if required, interpolate missing data
        self.indicator.loc[:,indicator] = self.indicator.groupby('country')[indicator]\
        .apply(lambda x: pd.Series(x).interpolate()) if interpolate else self.indicator

        # detrend the data
        self.indicator.loc[:,indicator] = self.indicator.groupby('country')[indicator]\
        .apply(lambda x: pd.Series(signal.detrend(x))).reset_index().iloc[:,2].values if detrend else self.indicator

        # scale the data
        self.indicator.loc[:,indicator] = self.indicator.groupby('country')[indicator]\
        .apply(lambda x: (x-x.iloc[0])/iqr(x)) if scale else self.indicator

        # convert the data for easier use
        self.indicator.year = pd.to_numeric(self.indicator.year)

        return self.indicator
```

In [45]:
```
# we initialize our class with our countries and dates
Country_Indicators = Indicators(country=selected_countries.iso3c.tolist(), start=pd.to_datetime('1987', yearfirst=True), end=pd.
to_datetime('2007', yearfirst=True))

# we have created a simple helped function
#  to mark when the crisis takes place
line = hv.VLine(1997).options(color='black', line_width=2)
```

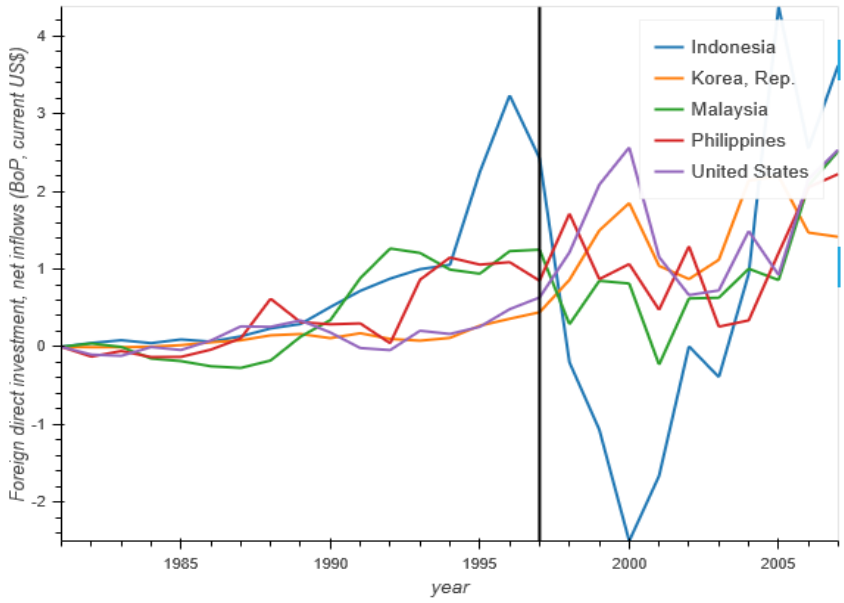
In the run-up to the Asian Crisis, changes in western macroeconomic policy sent shockwaves throughout Asia. The Plaza Accord of 1985 led to the strong devaluation of the Chinese renminbi and the Japanese yen against the USD. This changed the investment climate in the region dramatically. The 1980s saw a massive appreciation of the US dollar against the renminbi and yen, making competition increasingly hard for American manufacturers. Following lobbying by US manufacturers, the protectionist policies of the Plaza Accords sought to alter US free-market policy radically. From 1985 to 1987, the US dollar declined by 51% against the yen – creating the incentive for the expansionary monetary policies that led to the Japanese asset price bubble of the late 1980s and the 'Lost Decade' in Japan.

For fledging nations in Southeast Asia, emerging through rapid liberalization, urbanization and industrialization, the ability to attract foreign direct investment was paramount. In this graph, you can see the rising inflows of real foreign direct investment over the period and compare and contrast these changes against other countries used in these notes.

In [143]:
```
%%opts Curve [width=600, height=450]
investment = Indicators(country=selected_countries.iso3c.tolist(),
                        start=pd.to_datetime('1981', yearfirst=True),
                        end=pd.to_datetime('2007', yearfirst=True))\
                        .get_indicator(indicator='BX.KLT.DINV.CD.WD', scale=True)

facet = investment.hvplot.line(x='year', by='country')*line
facet.cols(1)
```

Out[143]:



Indonesia, under Suharto, was a huge proponent of foreign direct investment, and it was generally believed that by controlling the exchange rate risk of foreign investors, they would be able to increase investment, growth and development in the country. In the graph, you can see the scaled real foreign direct investment, and its meteoric rise in Indonesia from the period 1981 to 1997. While we see similar increases in neighboring countries, like Malaysia, it is not nearly as dramatic in its rise and collapse. The primary driver of these differences was around interest rates.

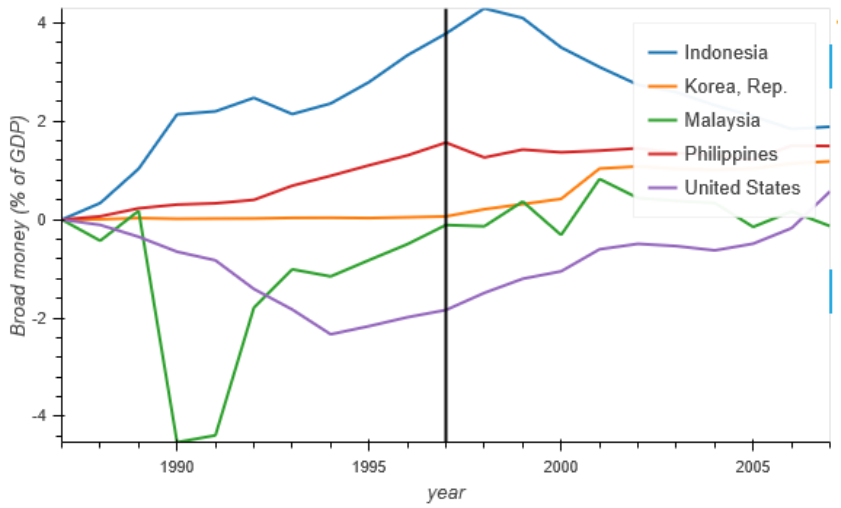
One major attraction for investors, given the fixed exchange rate, were the high real interest rates offered in Indonesia, Malaysia and the Philippines. Investors would borrow in the United States, exchange for Indonesian rupiah, and invest in government and commercial bonds or fixed-income assets, without the uncertainties of exchange rate depreciation when the bond reached maturity.

For the Indonesian government, the ability to maintain the exchange rate was crucial, as when bonds reached maturity investors would want to exchange their rupiah for dollars to realize their investment. This exchange meant the government needed sufficient reserves to allow a transaction to take place without having to alter the exchange rate. Since exchange rates are fixed, the government would need to sell domestic currency and buy foreign currency, thereby raising the money supply, to shift the LM curve back to its original position.

In this graph, we see that while broad money supply declined in the United States, it increased dramatically in Southeast Asia, as well as in South Korea, over the period 1987 to 1997. According to the Liquidity-Money Relationship, to keep interest rates constant, given increasing GDP, real money supply must increase to meet the growing demand for money in the economy. By stabilizing real interest rates and increasing the money supply, banks sought to stabilize the bond markets to protect the investors by controlling exchange rates to maintain economic growth.

In [145]:
```
%%opts Curve [width=600, height=350]
money = Country_Indicators.get_indicator(indicator='FM.LBL.BMNY.GD.ZS')
money.hvplot.line(x='year', by='country')*line
```

Out[145]:

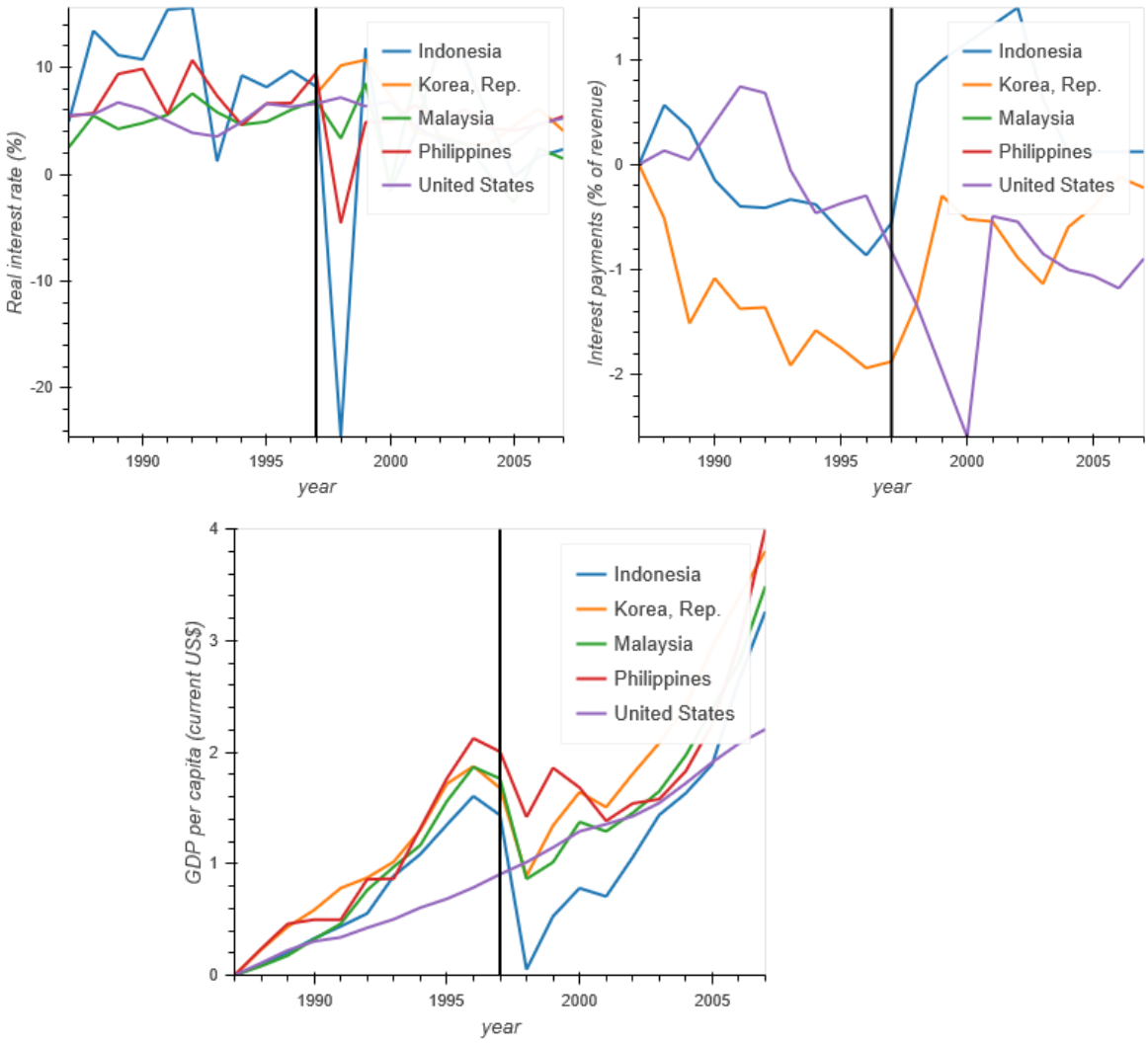


In this graph, you can see the real interest rates in several Asian countries against the United States over the period 1987 to 2007 to analyze the build-up to the crisis. While government interest payments as a percent of revenue appear to decline due to growing real GDP, and growing tax bases, in the region these interest payments quickly revert, sending real interest rates and real GDP crashing.

In [154]:
```
%%opts Curve [width=400, height=350]
interest = Country_Indicators.get_indicator(indicator='FR.INR.RINR', scale=False)
govtinterestpayment = Country_Indicators.get_indicator(indicator='GC.XPN.INTP.RV.ZS', scale=True)
gdp = Country_Indicators.get_indicator(indicator='NY.GDP.PCAP.CD', scale=True)


facet = interest.hvplot.line(x='year', by='country')*line +\
        govtinterestpayment.hvplot.line(x='year', by='country')*line +\
        gdp.hvplot.line(x='year', by='country')*line
facet.cols(3)
```

Out[154]:

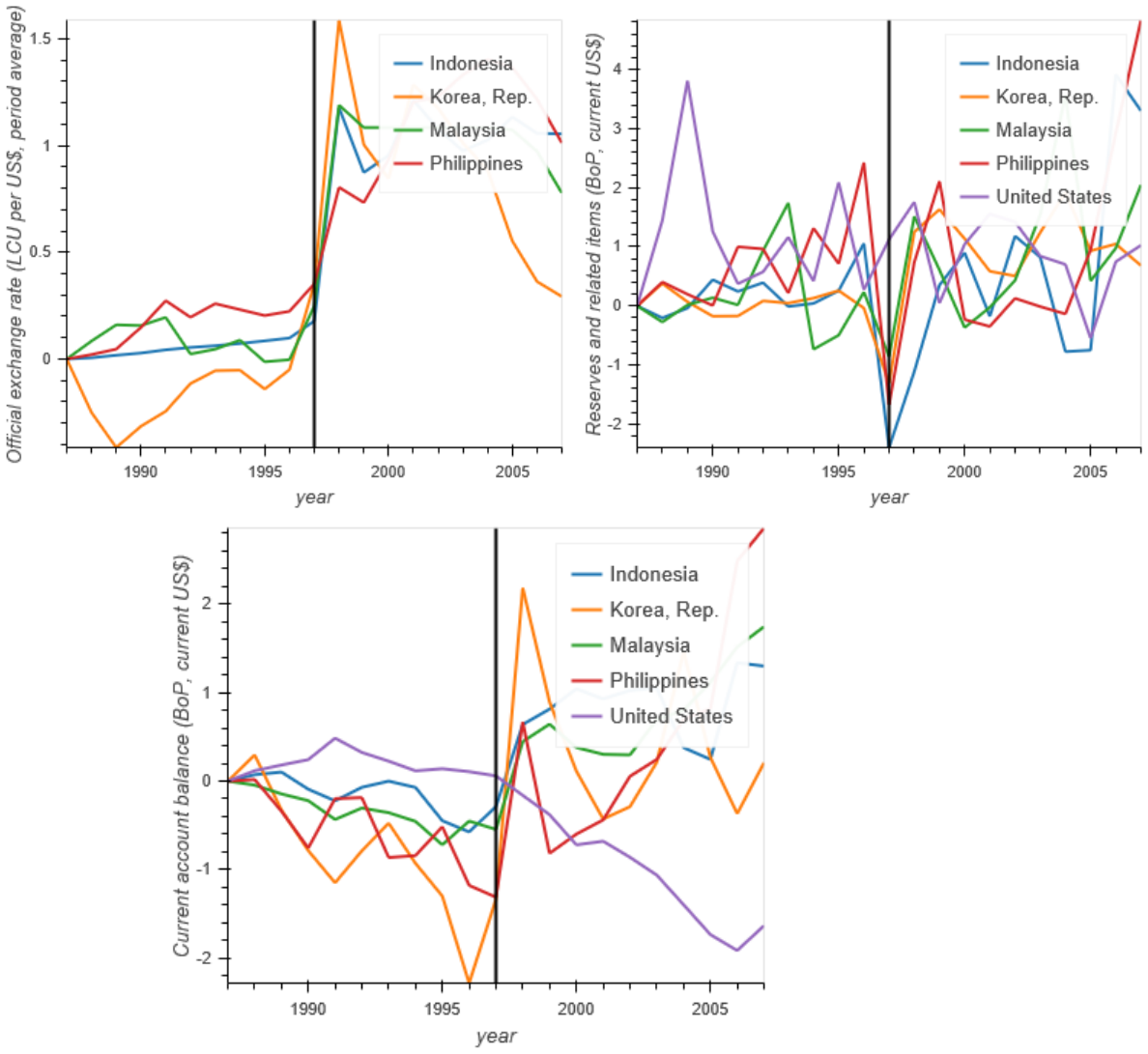


Eventually, without any remaining foreign currency reserves and with dangerously high-interest rates, these Asian nations were forced to let their currencies float. In these graphs, you can observe the official exchange rate, foreign exchange reserves and current account balance for these nations before and after the crisis. While this betrayed much of the investors in the country at the time, it did appear to stabilize the country's monetary system, allowing it to meet the changing needs of the economy at the time.

In [190]:
```
%%opts Curve [width=400, height=350]
exchange = Country_Indicators.get_indicator(indicator='PA.NUS.FCRF').dropna()
reserves = Country_Indicators.get_indicator(indicator='BN.RES.INCL.CD').dropna()
netexports = Country_Indicators.get_indicator(indicator='BN.CAB.XOKA.CD').dropna()

facet = exchange.hvplot.line(x='year', by='country')*line  +\
        reserves.hvplot.line(x='year', by='country')*line  +\
        netexports.hvplot.line(x='year', by='country')*line
facet.cols(3)
```

Out[190]:



Using this data, we are going to try to model these forces using the IS-LM-IP model on real output and exchange rates. Using broad money as an exogenous determinant in the LM Relationship, and real direct foreign investment, real government expenditure and real consumption as exogenous determinants of the IS Relationship, we will analyze how these curves shift to examining their effect

on real output and the exchange rate. Ideally, broad money would be replaced with M0 or M1 money in this model, but as this is not available, we will use M4 money. Using the sliders, you can select a country and move through time to see how well the model tracks the indicator. While this money lacks all possible contributors to economic shifts, it does provide strong levels of explainability to the chaos of markets at the time.

In [68]:
```
# this function prives us our range
#  of real interest rate values
def i(*args, **kwargs):
    i = np.linspace(-6, 6, 100).reshape(-1,1)
    i = i[i!=0]
    return i

# These define our IS-LM-IP equations
def IS(i=i(), Z_1=0, df=True):
    return pd.DataFrame([i, -i+Z_1], index=['Real Interest','Real Output']).T if df else -i+Z_1

def LM(i=i(), Z_2=0, df=True):
    return pd.DataFrame([i, i-Z_2], index=['Real Interest','Real Output']).T if df else i-Z_2

def IP(i=i(), Z_3=0, df=True):
    return pd.DataFrame([i, i-Z_3], index=['Real Interest','Exchange Rate']).T if df else i-Z_3

# This equation is used to find the Price-level and Real Output from our graphs
def findIntersection(fun1,fun2,x0):
    return fsolve(lambda x : fun1(x) - fun2(x),x0)
```

In [184]:
```
## Lets get some data

# z_1
gov = Country_Indicators.get_indicator(indicator='NE.CON.GOVT.CD', scale=False)
cons = Country_Indicators.get_indicator(indicator='NE.CON.TOTL.CD', scale=False)
netexports = Country_Indicators.get_indicator(indicator='BN.CAB.XOKA.CD', scale=False)

Z_1 = gov.loc[:,['year','country']]

Z_1['Z_1']  = pd.DataFrame(gov.drop(columns=['year','country']).iloc[:,0] +\
                    cons.drop(columns=['year','country']).iloc[:,0] -\
                    netexports.drop(columns=['year','country']).iloc[:,0], columns=['Z_1'])
Z_1.loc[:,'Z_1'] = Z_1.groupby('country')['Z_1'].apply(lambda x: (x-x.iloc[0])/iqr(x))

# z_2
money = Country_Indicators.get_indicator(indicator='FM.LBL.BMNY.GD.ZS')

# response variables
exchange = Country_Indicators.get_indicator(indicator='PA.NUS.FCRF').fillna(0)
gdp = Country_Indicators.get_indicator(indicator='NY.GDP.PCAP.CD', detrend=True)

# independent varable
interest = Country_Indicators.get_indicator(indicator='FR.INR.RINR', scale=False)
```

In [186]:
```
# Using this function we will produce our plots
def IS_LM_IP(country='United States', year=1987):
    z_1 = Z_1.loc[(Z_1.year==year)&(Z_1.country==country),:].drop(columns=['year','country']).iloc[0,0]
    z_2= money.loc[(money.year==year)&(money.country==country),:].drop(columns=['year','country']).iloc[0,0]
    z_3=0

    is_eq = IS(i(), Z_1=0)
    lm_eq = LM(i(),Z_2=0)
    ip_eq = IP(i(), Z_3=0)

    is_shock = IS(i(), Z_1=z_1)
    lm_shock = LM(i(), Z_2=z_2)
    ip_shock = IP(i(), Z_3=z_3)

    result = findIntersection(lambda x: LM(i=x, Z_2=z_2, df=False), lambda x: IS(i=x, Z_1=z_1, df=False), 0.0)
    result = result + 1e-4 if result==0 else result

    is_lm_plot = hv.Curve(lm_eq, vdims='Real Interest',kdims='Real Output').options(alpha=0.2, color='#1BB3F5') *\
            hv.Curve(is_eq, vdims='Real Interest',kdims='Real Output').options(alpha=0.2, color='orange') *\
            hv.Curve(lm_shock, vdims='Real Interest',kdims='Real Output', label='LM').options(color='#1BB3F5') *\
            hv.Curve(is_shock, vdims='Real Interest',kdims='Real Output', label='IS').options(alpha=1, color='orange') *\
            hv.VLine(LM(i=result[0], Z_2=z_2, df=False)).options(color='black', alpha=0.2, line_width=1) *\
            hv.HLine(result[0]).options(color='black', alpha=0.2, line_width=1)

    ip_plot = hv.Curve(ip_eq, vdims='Real Interest',kdims='Exchange Rate').options(alpha=0.2, color='#33CC00') *\
            hv.Curve(ip_shock, vdims='Real Interest',kdims='Exchange Rate', label='IP').options(color='#33CC00') *\
            hv.VLine(IP(i=result[0], Z_3=z_3, df=False)).options(color='black', alpha=0.2, line_width=1) *\
            hv.HLine(result[0]).options(color='black', alpha=0.2, line_width=1)

    exchange_plot = exchange.loc[exchange.country==country].hvplot.line(x='year', by='country') *\
    hv.VLine(year) * pd.DataFrame([[year,0.5*IP(i=result[0], Z_3=z_3, df=False)]],
                                  columns=['year','Exchange Rate']).hvplot.scatter(x='year', color='red')

    gdp_plot = gdp.loc[gdp.country==country].hvplot.line(x='year', by='country') *\
    hv.VLine(year) * pd.DataFrame([[year,0.5*LM(i=result[0], Z_2=z_2, df=False)]],
                                   columns=['year','Real GDP']).hvplot.scatter(x='year', color='red')

    facet = is_lm_plot + ip_plot + gdp_plot + exchange_plot

    return facet.cols(2)
```

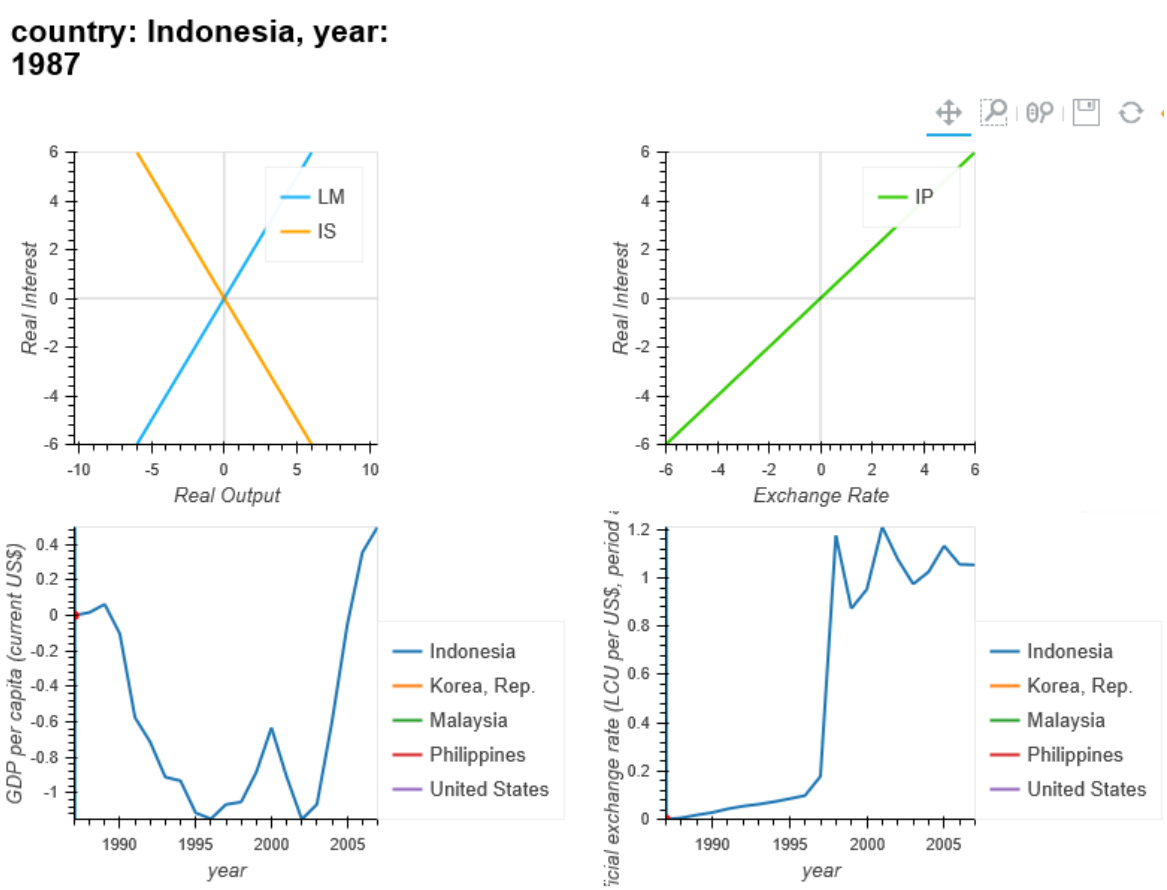
In [187]:
```
is_lm_ip_dict = {(c,y):IS_LM_IP(c,y)
                 for c in countries.loc[countries.iso3c.isin(Country_Indicators.country),'name'].tolist()
                 for y in range(Country_Indicators.start.year,Country_Indicators.end.year)}

hmap = hv.HoloMap(is_lm_ip_dict, kdims=['country', 'year']).collate()
```

In [188]:
```
%%opts Curve [width=400, height=250]

hmap
```

Out[188]:



It is important to note in the movement of the IP curve are anticipated real interest rates and exchange rates. These two variables serve to shift the IP curve but are not directly observed in the model. In order to use this model in practice, we would need to accurately calibrate the coefficients on our variables and determine the elasticity of the variables.

Unit 4: Slowed Growth in Asia

Beginning in July 1997, the currencies of several Asian economies collapsed under a heavy load of speculative attacks. With economies riding high on easy credit and unscrupulous lending practices, the financial sectors of various Asian states were at a high risk of collapsing. The context of poorly regulated banks and ongoing government nepotism, corruption and mismanagement set the stage for a serious halt to the economic growth that had been the norm during the mid-to-late 20th century. The crisis came to a head in May 1997, starting in Thailand, and continued well into 1999, with some currencies falling as much as 40% and many countries defaulting on international loans.

Crisis time

Despite massive growth, the Thai economy was on a precipice as its budget deficit continued to increase. The currency market, while tied to the US dollar, was hit with heavy speculative attacks on the 14th and 15th of May 1997. Currency speculation relies on the mass selling and purchasing of currencies in the hope that prices will fluctuate in the investor's favor. A speculative 'attack' operates where speculators and investors dump currency from countries whose exchange rate is tied to other currencies, normally larger countries with stronger exchange rates (commonly the US dollar, the UK pound sterling or the European Union's Euro). In this case, the affected country needs to hold heavy amounts of their own currency or the currency they are tied to in reserve to counteract against the speculation. Failure to do this will result in the currency being delinked, causing an inevitable devaluation that will plunge the currency downwards. As a result, growth slows, inflation rises, and a larger economic crisis develops.

In the case of Thailand in 1997, because national debt was so high and currency reserves were comparatively low, the government was unable to meet the onslaught by currency speculators. Despite assurances by the government that they would not devalue the baht (Thailand's currency), by early July they were forced to delink from the dollar and float the baht. This decision caused serious uncertainty for the regional currencies, as most currencies were tied elsewhere rather than determined by the market. The result of this for the Thai economy was devastating: the value of the baht sank, volume in the Thai exchange market plunged to almost zero, and companies and banks collapsed. The most notable example – Finance One, at the time the largest financial institution in Thailand – collapsed, causing a ripple effect across the other major investment and stock exchanges in Asia.

In July 1997, the Indonesian rupiah underwent a similar attack to that experienced by the baht. The government, hoping to prevent similar collapses, attempted to float the rupiah, but the currency continued to fall and by September hit record lows. As in Thailand, companies and banks collapsed and unemployment skyrocketed. In Malaysia, the ringgit was traded heavily in the weeks following the Thai collapse and suffered similar devaluation. The Philippine peso, the South Korean won and the Hong Kong dollar – which had been valued higher than the dollar for over a decade – all faced heavy speculative attacks in the aftermath of Thailand. Only Hong Kong was able to retain the currency link with the US dollar, but it still suffered losses for an extended period on the Hong Kong Stock Exchange. This did, however, coincide with the transfer of Hong Kong from Britain to China. Overall, the crisis plunged several economies into chaos as national debt ratios to gross domestic product (GDP) rose and growth rates fell to almost nothing. After years of development and booming economies, the region now faced economic stagnation on a grand scale and the aftershocks were felt across the global economy.

The fix

Citing the massive fall in stocks and fear of the crisis becoming 'contagious', the International Monetary Fund (IMF) decided to step in and try to rectify the crisis. As national debt in Thailand, Indonesia, Malaysia and South Korea was becoming increasingly burdensome, the IMF proposed bailout programs to boost the economies. Around 110 billion US dollars was dedicated to help uplift the major currencies and stock markets and to prevent the spread of the speculative crisis. Critically, the IMF was granted the power to define fiscal and monetary policies for the program's recipients. Political and economic pressures were placed on the incumbent governments, generating mixed results.

In the instance of Thailand, the government collapsed under pressure from voters and the private sector. The succeeding government, at the prompting of the IMF, cut the deficit as much as possible by removing all extraneous government spending and raising taxes across the board. Indonesia had the most prolific economic and political changes. Due to the declining economy and the extensive problems with the Indonesian banking sector, several large companies went bankrupt and inflation rose, causing increased unemployment and reduced GDP. The economic reform package introduced by the IMF, while able to prevent further damage to the currency, caused austerity measures that prompted major socio-political unrest.

Meanwhile, in Indonesia successive protests against the government of Suharto and serious unrest across the country led to his resignation in May 1998, resulting in several years of political and economic turbulence. The Philippines had a similarly rocky path: with the crunch hitting both business and government, protests and unrest continued until the early 2000s as government scandals and mismanagement were revealed. Hong Kong, in an attempt to withstand speculative attacks, bought up as much currency as possible and invested in major financial corporations, reaping impressive profits in the aftermath of the crisis. Finally, in South Korea, the bailout package led to the closure of banks, investment firms and other financial institutions, but reform in the banking sector allowed the government to break notable monopolies that had caused the crisis in the first place.

By the end of 1999, most of the region had begun to recover economically. GDP and growth rates, after suffering temporarily, slowly increased, with many citing it as a 'miracle' of economic recovery. Currencies were permanently delinked from the US dollar, however, and the political and social turbulence left scars in the respective countries. The Asian crisis was largely the result of poor economic and financial decisions that persisted due to the increasing levels of unchecked investor confidence. What is critical to learn from the module is that the decisions made by several governments over a long period of time were identifiably risky. There was no time spent on developing long-term fiscal strategies that could have protected the currencies from attacks and kept the growth consistent in times of financial uncertainty.

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