Three Types of Money Creation

Haoqian Zhang, Supervised by Prof. Bryan Ford, EPFL

Thanks Basescu Cristina and Marchal Alexis.


CHRISTIAN
BALE
STEVE
CARELL
RYAN
GOSLING
BRAD
PITT
AN ADAM McKAY FILM
THE
BIG
SHORT
THIS IS A TRUE STORY

	Geneva	Beijing	Difference
Rent Per Month	[Edit]	[Edit]	
Apartment (1 bedroom) in City Centre	2,032.61 Fr. (14,557.07 ¥)	1,018.11 Fr. (7,291.47 ¥)	-49.91 %
Apartment (1 bedroom) Outside of Centre	1,544.58 Fr. (11,061.94 ¥)	621.80 Fr. (4,453.16 ¥)	-59.74 %
Apartment (3 bedrooms) in City Centre	3,575.93 Fr. (25,609.94 ¥)	2,125.27 Fr. (15,220.69 ¥)	-40.57 %
Apartment (3 bedrooms) Outside of Centre	2,836.96 Fr. (20,317.62 ¥)	1,328.65 Fr. (9,515.46 ¥)	-53.17 %
Buy Apartment Price	[Edit]	[Edit]	
Price per Square Meter to Buy Apartment in City Centre	12,818.18 Fr. (91,800.82 ¥)	14,309.30 Fr. (102,479.88 ¥)	+11.63 %
Price per Square Meter to Buy Apartment Outside of Centre	9,458.33 Fr. (67,738.37 ¥)	7,185.59 Fr. (51,461.54 ¥)	-24.03 %
Salaries And Financing	[Edit]	[Edit]	
Average Monthly Net Salary (After Tax)	5,375.55 Fr. (38,498.42 ¥)	1,224.10 Fr. (8,766.69 ¥)	-77.23 %
Mortgage Interest Rate in Percentages (%), Yearly, for 20 Years Fixed-Rate	2.02	5.14	+154.06 %
Last update:	*February 2020*	*February 2020*	
Contributors:	*167*	*196*	
Data from past:	*18 months*	*18 months*	
Currency: CHF			

*Data from numbeo.com


जम्बो गिलास Rs.10/-
बडा गिलास Rs.08/-
छोटा गिलास Rs.06/-
प्लास्टिक गिलास Rs.12/-

GLOBAL REAL HOUSE PRICE INDEX

SOURCE: Bank for International Settlements, European Central Bank, Federal Reserve Bank of Dallas, Savills, and national sources

IMF.org/housing

#HousingWatch

This Talk:

(1) Money Creation in Modern Economy

(2) Cryptocurrency is Different

(3) Currency Issuance Language (CIL)

(4) Community Cryptocurrency

(5) Monetary Policy Language (MPL)

(6) Demurrage Implementation and Application

Outline

1. Proof-of-Credit

   US Dollar, Euro

2. Proof-of-Resource

   Gold, Bitcoin

3. Proof-of-Personhood

   Universal Base Income, Mutual Credit

Outline

1. **Proof-of-Credit**

   US Dollar, Euro

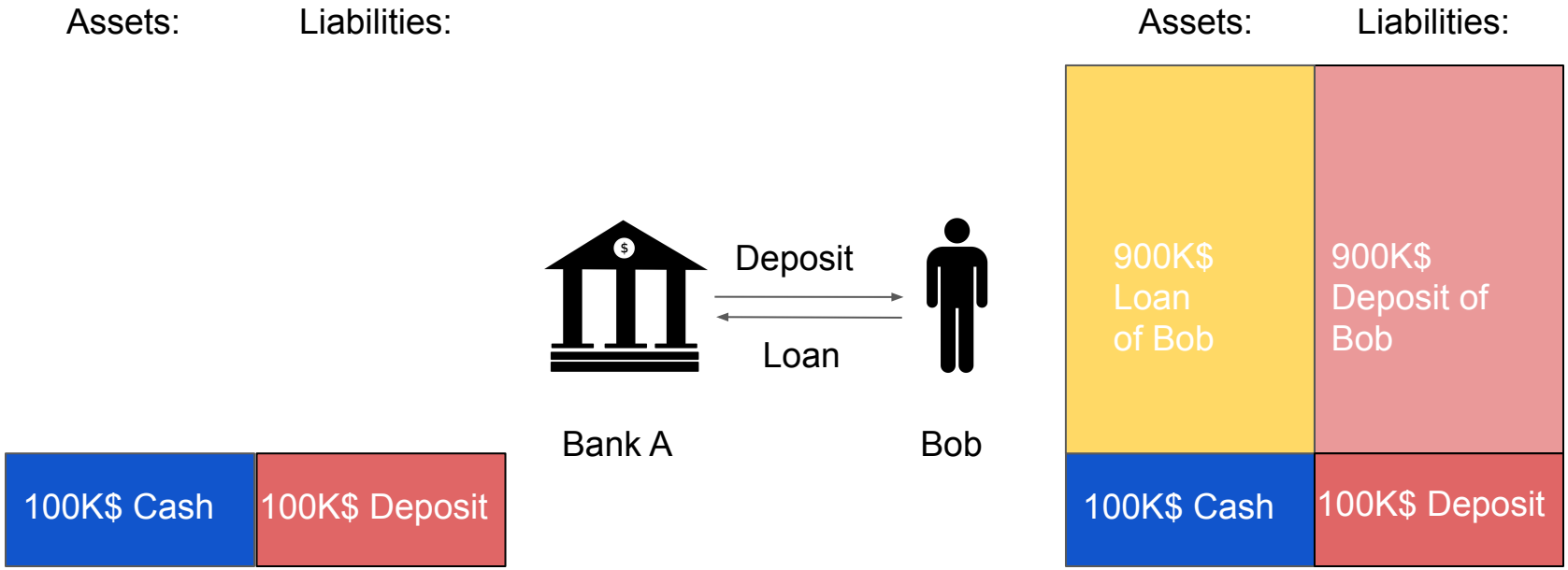
2. Proof-of-Resource

   Gold, Bitcoin

3. Proof-of-Personhood

   Universal Base Income, Mutual Credit

Money Creation in Modern Economy



The Debt-Based Economy

Money Creation	Debt Creation
900K$ Deposit	900K$+

1. Majority of money is created by commercial banks.
2. Money creation relies on lending and borrowing.
3. The amount of debt exceeds the total money supply.

Central Bank

Goal of Central Bank

Inflation and the 2% target

ⓘ We are responsible for keeping inflation (price rises) low and stable.
The Government has set us a target of keeping inflation at 2%

Goal of Central Bank

What is inflation?

Inflation is a measure of how much the prices of goods (such as food or televisions) and services (such as haircuts or train tickets) have gone up over time.

Usually people measure inflation by comparing the cost of things today with how much they cost a year ago. The average increase in prices is known as the inflation rate.

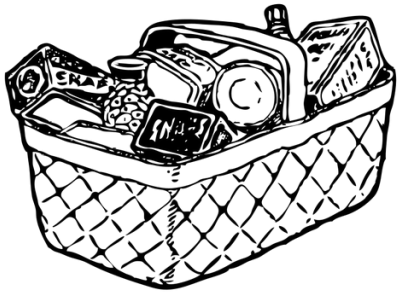
So if inflation is 3%, it means prices are 3% higher (on average) than they were a year ago. For example, if a loaf of bread cost £1 a year ago and now it's £1.03 then its price has risen by 3%.

Use our inflation calculator to find out how prices have changed over the years.

How inflation is measured

Each month, the Office for National Statistics (ONS) collect around 180,000 prices of about 700 items. They use this 'shopping basket' to work out the Consumer Prices Index (CPI). CPI is the measure of inflation we target.

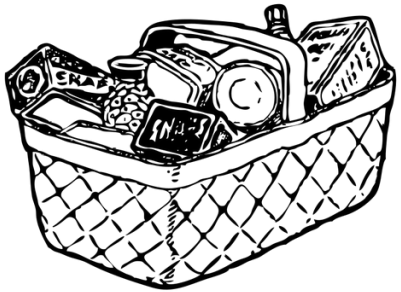
Asset Price Inflation



Goods & Services

Assets

Asset Price Inflation



Goods & Services

Assets

Outline

1. Proof-of-Credit

   US Dollar, Euro

2. **Proof-of-Resource**

   Gold, Bitcoin

3. Proof-of-Personhood

   Universal Base Income, Mutual Credit

Proof-of-Resource

Cryptocurrency

Cryptocurrency is debt-free money

Set/change the currency issuance mechanism

Challenges:

Optimal monetary policy for cryptocurrency.

Encourage real exchange and discourage speculation

Currency Issuance Language

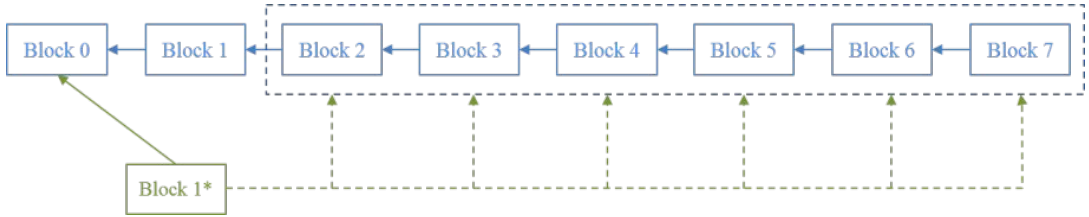
```
{
  "base": "block",
  "period": 1,
  "update": [
    {
      "formula": "50 / (2 ** (Height / 210000))",
      "target": "BlockMiner"
    }
  ]
}
```

Currency Issuance Language

```
{
  "base": "year",
  "period": 1,
  "update": [
    {
      "formula": "50 * 52500 / (2 ** (Year / 4))",
      "target": "BitcoinSupply"
    }
  ]
}
```

Currency Issuance Language

```
{
  "base": "block",
  "period": 1,
  "update": [
    {
      "formula": "BaseReward",
      "target": "BlockMiner"
    },
    {
      "times": "len(UncleBlocks)",
      "formula": "BaseReward*(9-UncleBlocks[i].k)/8",
      "target": "UncleBlocks[i].Miner"
    },
    {
      "condition": "len(UncleBlocks)>0",
      "formula": "len(UncleBlocks)*BaseReward/32",
      "target": "BlockMiner"
    }
  ]
}
```



Block Reward

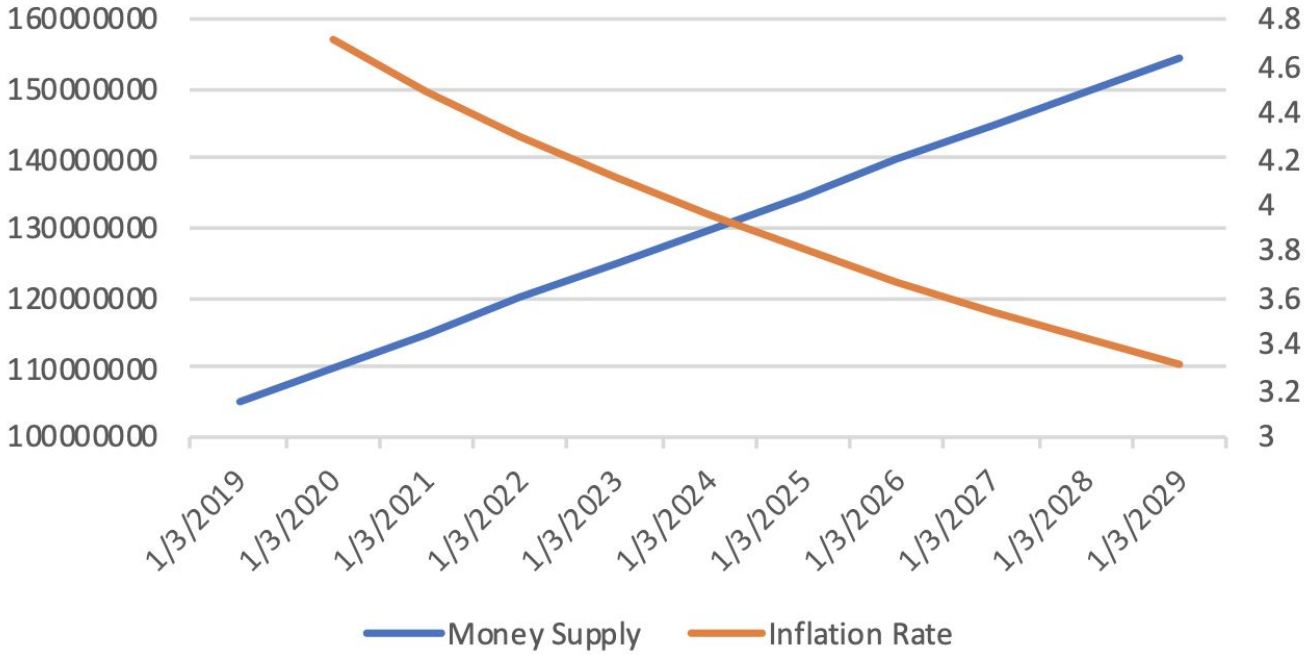
Uncle Reward

Uncle Incl. Reward

Currency Issuance Language

```
{
  "base": "year",
  "period": 1,
  "update": [
    {
      "formula": "BaseReward * DailyBlocks * 365",
      "target": "EtherSupply"
    },
    {
      "formula": "BaseReward * DailyUncles * (9 - UnclesK) / 8 * 365",
      "target": "EtherSupply"
    },
    {
      "formula": "BaseReward / 32 * DailyUncleBlocks * 365",
      "target": "EtherSupply"
    }
  ]
}
```

Ether Supply



Currency Issuance Language

Implementation:

Go Language, using Expr Library

Application:

(1) Plug into different platforms.
(2) Simulation (account level or macro level)
(3) Focusing only on currency issuance.

Limitation:

(1) Not all can be modeled well in this framework
(2) Mechanics and assumptions of blockchains cannot be clearly separated

Outline

1. Proof-of-Credit

   US Dollar, Euro

2. Proof-of-Resource

   Gold, Bitcoin

3. **Proof-of-Personhood**

   Universal Base Income, Mutual Credit

Universal Base Income

1000$/Month

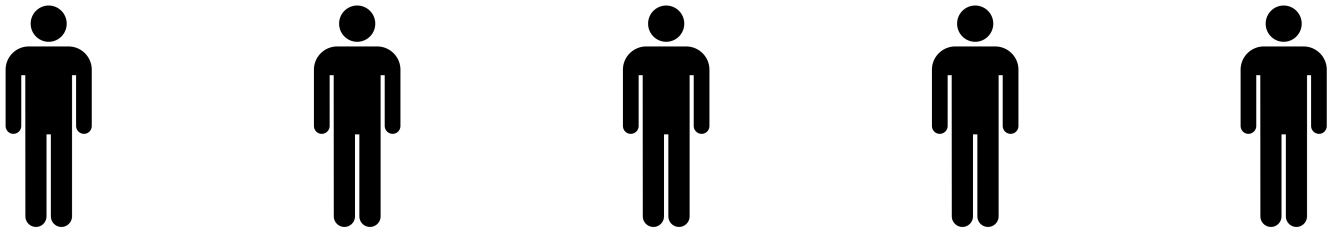
1000$/Month

1000$/Month

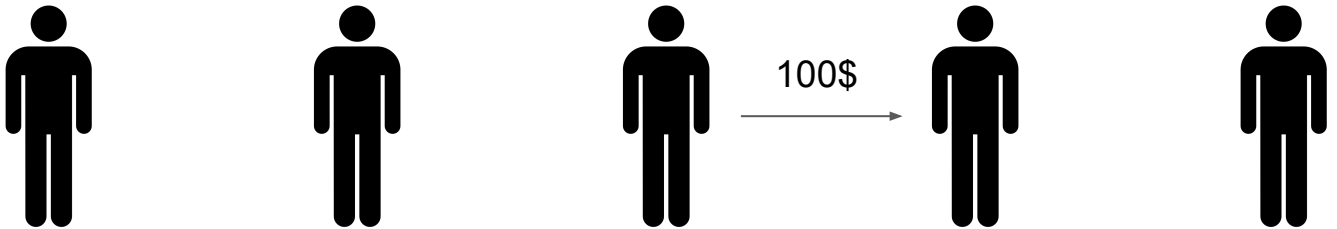
1000$/Month

1000$/Month

Mutual Credit



Mutual Credit



Community Currency

Community Cryptocurrency

Identity Control	Blockchain
Preventing Sybil Attacks	Transparent Deterministic Monetary Policy No Single Point of Failure ...

Monetary Policy Language

(1) Currency Issuance

Initial Distribution, Periodic Creation(block, month...)

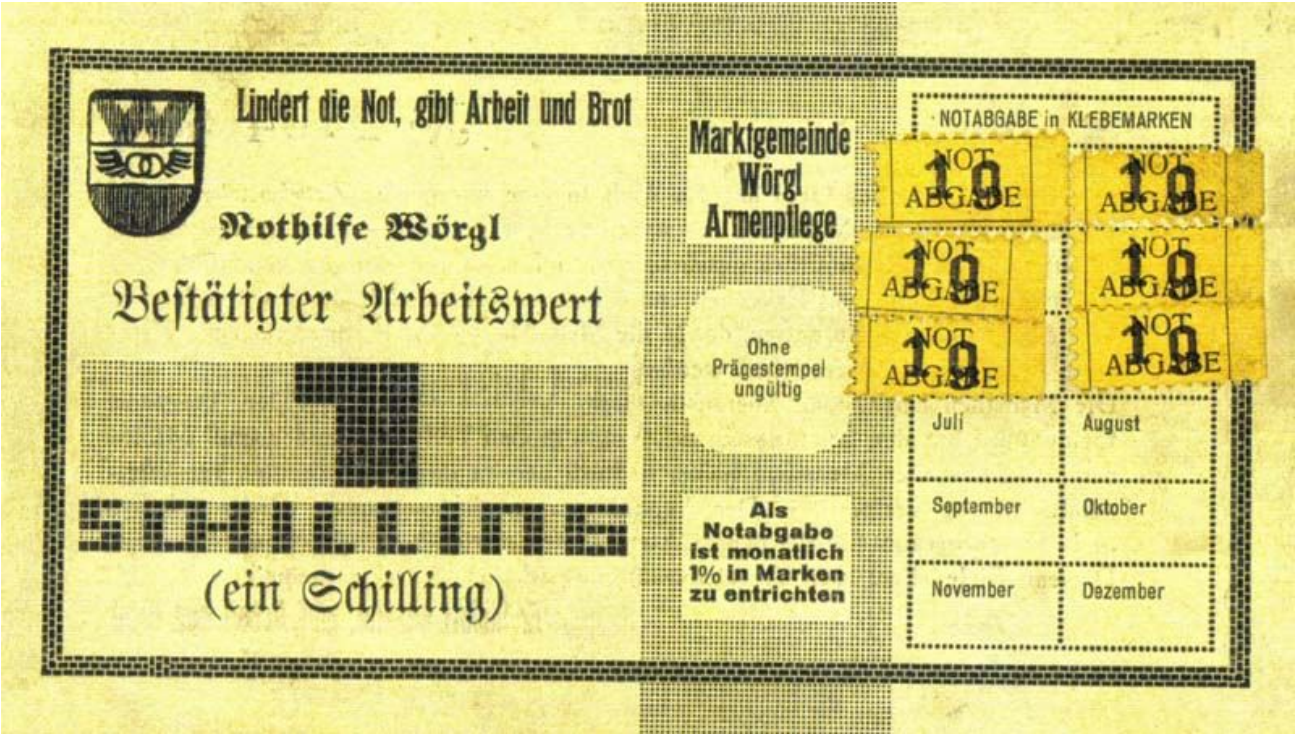
(2) Transaction

Transaction Fee, Condition

(3) Demurrage

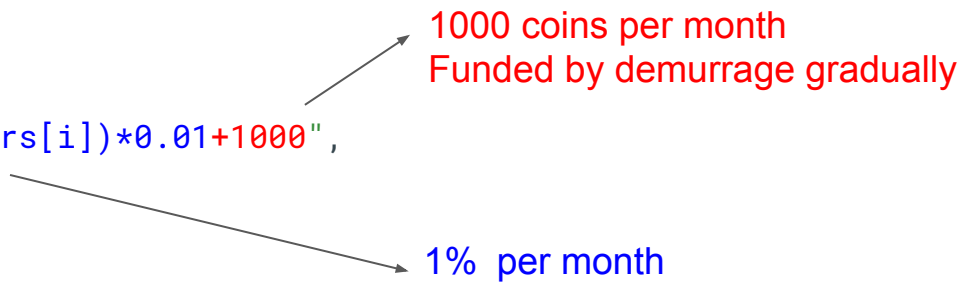
Negative Interest

Demurrage


Lindert die Not, gibt Arbeit und Brot
Nothilfe Wörgl
Bestätigter Arbeitswert
1
SCHILLING
(ein Schilling)
Marktgemeinde
Wörgl
Armenpflege
Ohne
Prägestempel
ungültig
Als
Notabgabe
ist monatlich
1% in Marken
zu entrichten
NOTABGABE in KLEBEMARKEN
NOT ABGABE 1 0
Juli
August
September
Oktober
November
Dezember

Universal Base Income

```
{
  "base": "month",
  "period": 1,
  "update": [
    {
        "times": "len(Members)",
        "formula": "-balance(Members[i])*0.01+1000",
        "target": "Members[i]"
    }
  ]
}
```

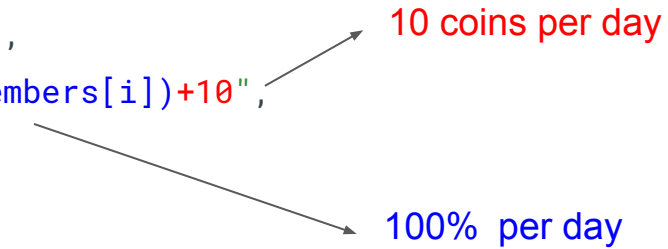


Mutual Credit

```
{
    "condition": "Value>0 && balance(Sender)-Value>=negative_limit(Sender) &&
                  balance(Receiver)+Value<=positive_limit(Receiver)",
    "update": [{
            "formula": "-Value",
            "target": "Sender"
        },
        {
            "formula": "Value",
            "target": "Receiver"
        }
    ]
}
```

Prevent Spamming

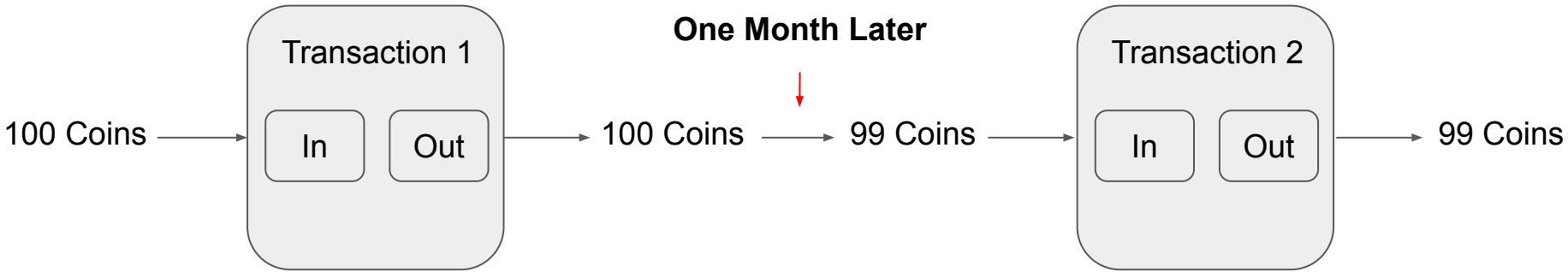
```
"events": [{
    "base": "day",
    "period": 1,
    "update": [{
        "times": "len(Members)",
        "formula": "-balance(Members[i])+10",
        "target": "Members[i]"
    }]
}]
```



Prevent Spamming

```
"transfer": {
   "condition": "Value>=1 && balance(Sender)>=Value",
   "update": [{
     "formula": "-Value",
     "target": "Sender"
   }]
}
```

Demurrage in UTXO



*Demurrage rate is 1% per month

Demurrage in Global Balance Model

Current Date	Address	Value in DB	Timestamp in DB	Real Balance
1 Jan 2020	1BvBMSEYst	100	1 Jan 2020	100 coins
One Month Later:				
1 Feb 2020	1BvBMSEYst	100	1 Jan 2020	99 coins
Immediately Before Receiving or Spending Coins:				
15 Feb 2020	1BvBMSEYst	99	15 Feb 2020	99 coins
Spending 10 coins:				
15 Feb 2020	1BvBMSEYst	89	15 Feb 2020	89 coins

*Demurrage rate is 1% per month

Demurrage in Bitcoin

(1) Encourage spending (disencourage hoarding)

(2) Replace zombie coins gradually

(3) Funding block rewards (e.g. 1% per year for block rewards)

Conclusion & Future Work

Our current monetary system is not perfect.

Cryptocurrency could be an alternative solution.

Formally describing monetary policies is the first step.

Conclusion & Future Work

More Community Cryptocurrency Applications

Extending the Monetary Policy Language

Implementing Community Cryptocurrency in Blockchain

Further Reading

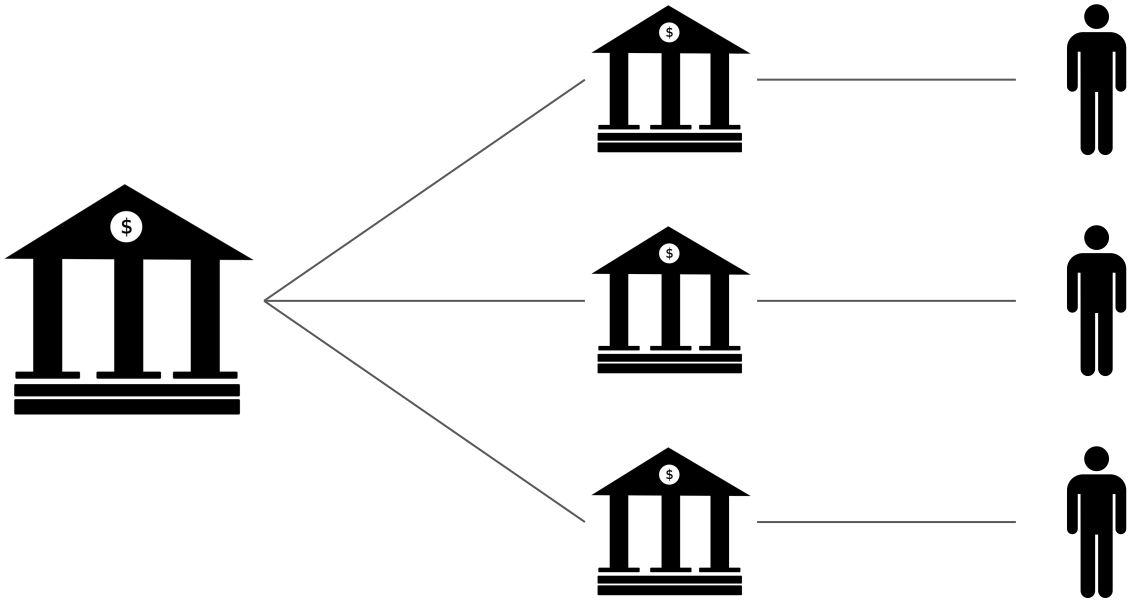
(1) Money creation in the modern economy

By Michael McLeay, Amar Radia and Ryland Thomas, 2014

(2) Can banks individually create money out of nothing? — The theories and the empirical evidence

By Richard A.Werner, 2014

Banking System



Central Bank

Commercial Banks

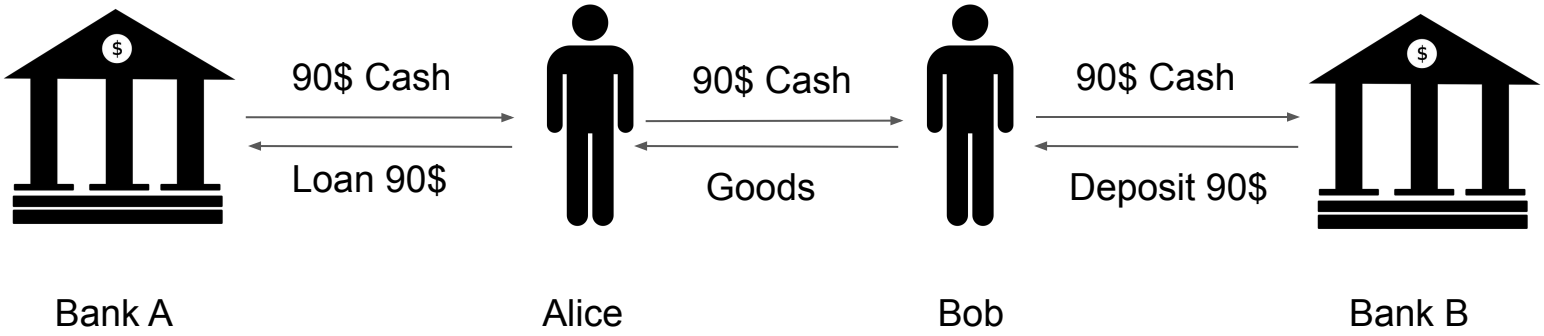
Fractional-Reserve Banking

Money Supply:

100$

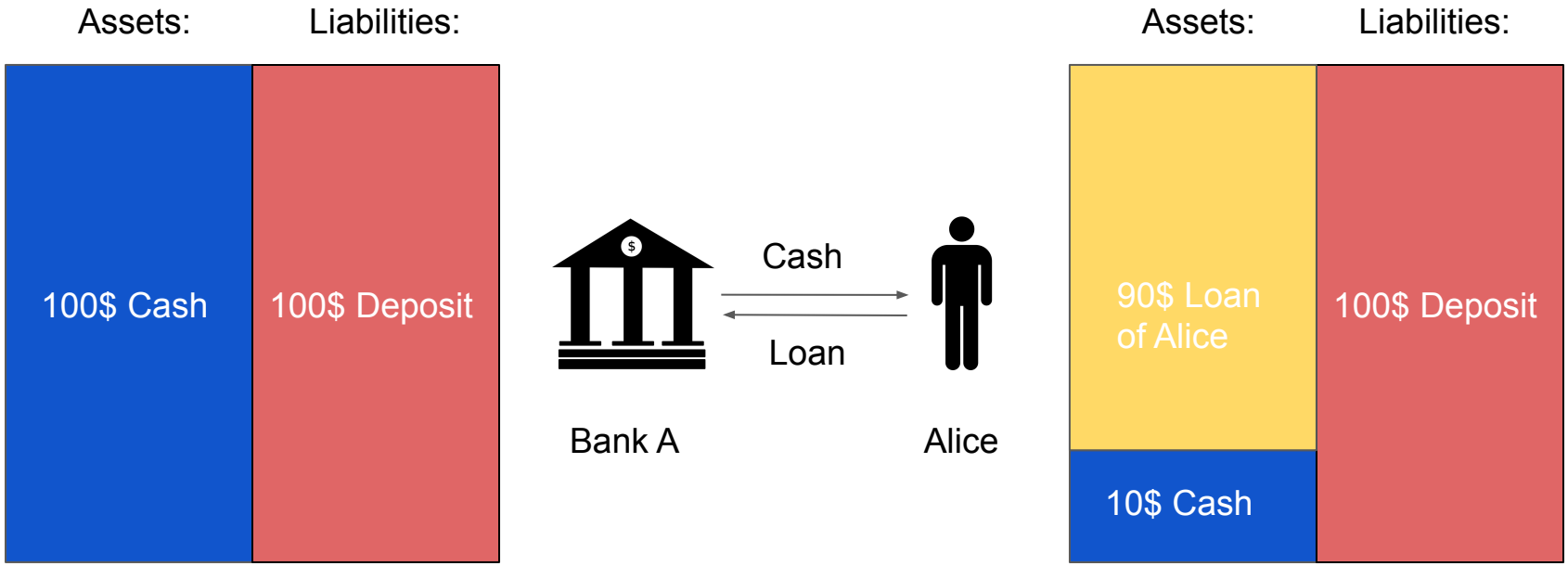
100$

Bank Lending



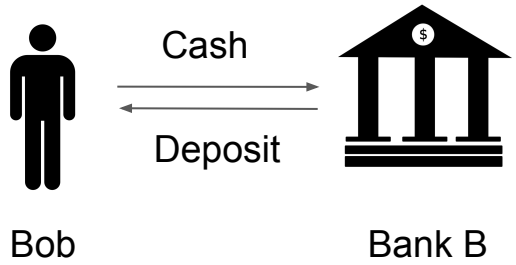
*Assuming Reserve Ratio is 10%

Balance Sheet of Bank A

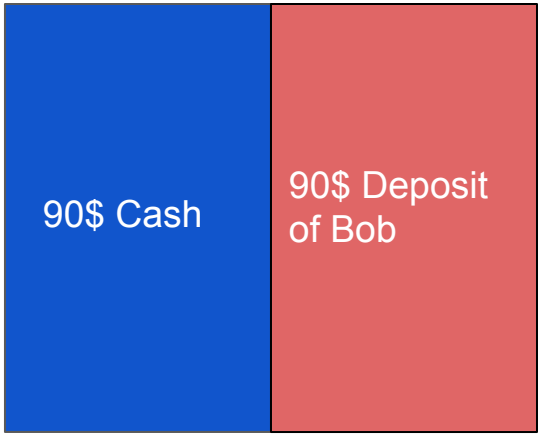


Balance Sheet of Bank B

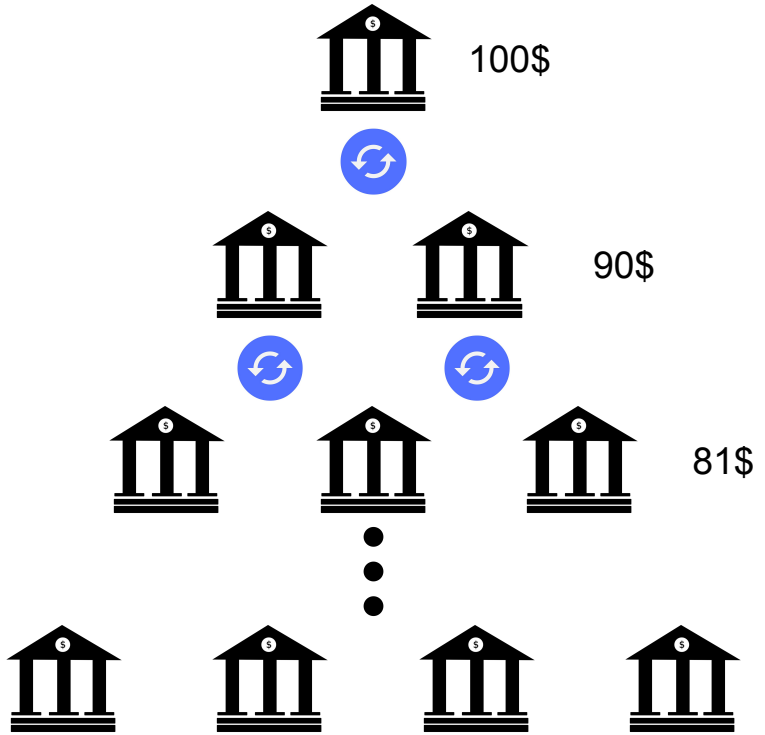
Assets: Liabilities:



Assets: Liabilities:



Money Multiplier



Money Supply:

100$

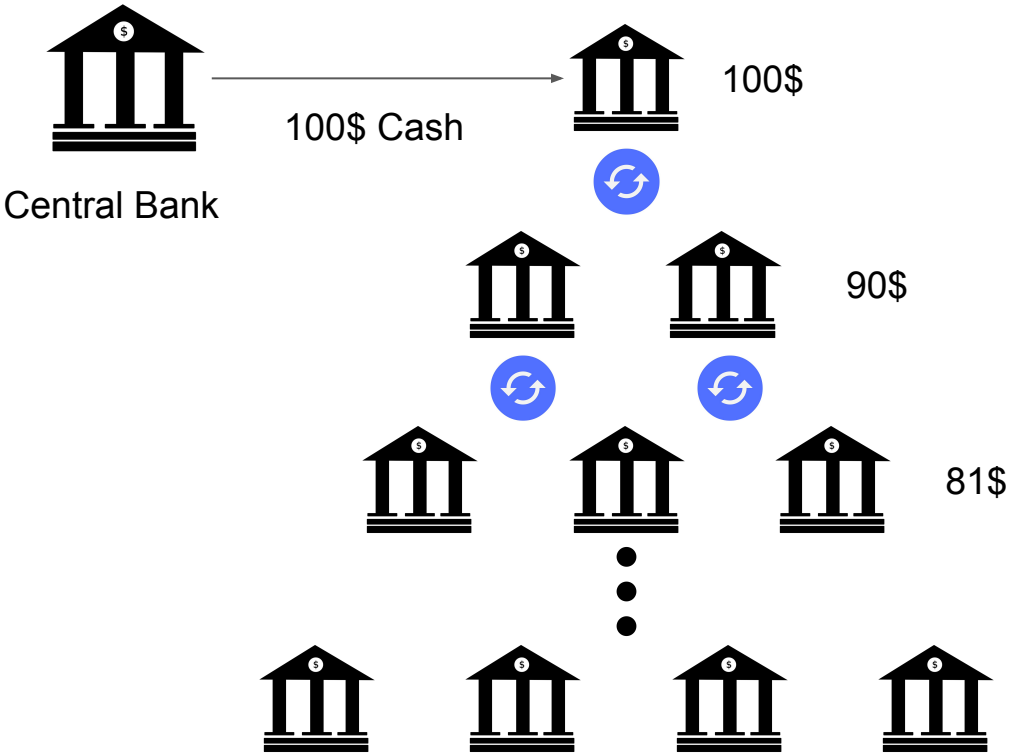
190$

271$

(Up to)1000$

*Assuming Reserve Ratio is 10%

Role of Central Bank



Money Supply:

100$

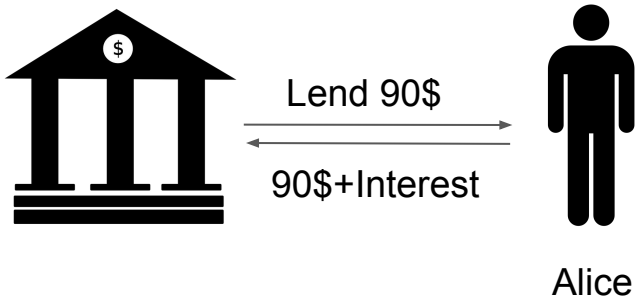
190$

271$

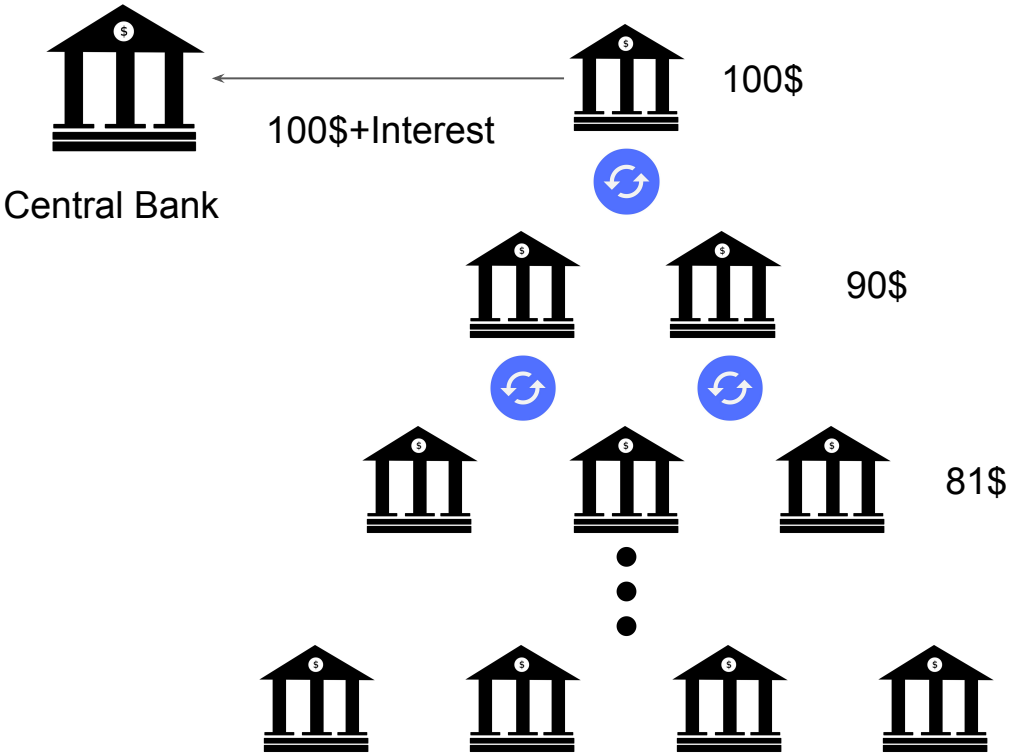
(Up to)1000$

*Assuming Reserve Ratio is 10%

End of the Year



End of the Year



Money Supply:

100$

190$

271$

(Up to)1000$

*Assuming Reserve Ratio is 10%

The Debt-Based Economy

Money Supply:	Debt:
1000$ (100$ Cash + 900$ Deposit)	1000$+

1. Majority of money is created by commercial banks.
2. Money creation relies on lending and borrowing.
3. The amount of debt in the world exceeds the total money supply.

Conventional Theory

Assumed that all money is used for GDP transactions:

$$MV = PQ$$

with constant or stable V

M is money supply. Its unit is dollar.
V is velocity of money. Its unit is per year.
Q is real GDP. Its unit is dollar/year
P is price level. PQ will be the nominal GDP.

The Quantity Theory of Credit (Werner, 1992, 1997)

Money is used for all transactions:

$$MV = PQ$$

M is money supply. Its unit is dollar.
V is velocity of money. Its unit is per year.
QP is the values of all transactions.

$M = M_r + M_f$
Money used for GDP transactions, used for the 'real economy' ('real circulation') (M_r)
Money used for non-GDP transactions ('financial circulation') (M_f)

The Quantity Theory of Credit (Werner, 1992, 1997)

Considering growth of money supply :

$$M_r V_r = P_r Q_r$$

$$M_f V_f = P_f Q_f$$

Assume V_r and V_f is constant or stable:

ΔM_r -> Δnom. GDP (real economy)
ΔM_f -> $\Delta(P_f+Q_f)$ (asset market)

Banks' decisions reshape the economic landscape

The Quantity Theory of Credit (Werner, 1992, 1997)

The allocation of bank credit creation determines what will happen to the economy:

non-GDP credit

Case 1: Financial credit (= credit for transactions that do not contribute to and are not part of GDP) => Result: Asset inflation, bubbles and banking crises

GDP credit

Case 2: Consumption credit => Result: Inflation without growth

Case 3: Investment credit (= credit for the creation of new goods and services or productivity gains that generate income) => Result: Growth without inflation, even at full employment