THE DYNAMICS OF THE VELOCITY OF MONEY IN THE DIGITAL ECONOMY

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OBJECTIVE AND METHODOLOGY

The objective of this study is to simulate and calibrate the velocity of money in the Czech economy based on available data on payment methods, population demographics, and the sectoral structure of the economy.

THE MODEL INTEGRATES

MICRO-LEVEL DATA

on individual payment preferences (disaggregated by age, education level, municipality size, and gender

MACROECONOMIC AGGREGATES

M1,
M2,
M3,
GDP,
CPI

CENTRAL IDENTITY

$M \times V = P \times Y$
where V denotes the velocity of money, P the price level, Y the real output, and M the money supply.

DATA SOURCES

Domain	Sources
Payment Methods	Czech National Bank (ČNB), European Central Bank (ECB), Visa, MasterCard, Kantar and Czech Banking Association (ČBA) studies
Price Level	Czech Statistical Office (ČSÚ): Consumer Price Index (CPI), GDP deflator
GDP and Consumption	ČSÚ, ČNB: National accounts, sectoral breakdown
Monetary Aggregates	ČNB: M0, M1, M2, M3 (annual data 2000-2025)

DEFINITION OF KEY PARAMETERS

Parameter	Definition	Sources and Justification
Friction	The degree of psychological or practical effort associated with the use of a given payment method.	Estimates based on data from Visa, ČBA, and ECB (e.g., surveys on reasons for choosing specific payment methods).
Availability	The probability that a particular payment method can be used at a given time and place.	Infrastructure availability by municipality size, terminal penetration; based on ČBA and ČSÚ data.
Habitual Weight	The degree of preference with which an individual (or demographic group) selects a payment method when multiple options are available.	Estimates by demographic group derived from Kantar, Visa, ČBA datasets and aggregated survey data.
Delay	The number of days between payment and the reuse of the same money in the economy ("transactional dormancy").	ECB, Bundesbank, ČBA, Visa: typical circulation time for cash, transfers, and clearing operations.

POPULATION STRUCTURE (KANTAR DATA)

The population typology was constructed based on a combination of the following attributes:

- Gender: male, female
- Age groups: 18-29, 30-44, 45-59, 60+
- Education: primary & lower secondary / secondary without diploma, secondary with diploma, tertiary (university or higher vocational education)
- Municipality size: six categories ranging from <1,000 inhabitants to Prague

This resulted in 216 unique population segments, each assigned:

- a probability weight representing its share within the population, and
- an estimated population size, based on a reference population of 8 million.

PAYMENT METHOD PARAMETERS

Method	Friction	Availability	Habitual Weight (by group)	Delay (days)
Cash	0.30	1.00	0.10–1.00	2.5
Bank Transfer	0.50	0.80	0.05–0.40	0.5
Physical Card	0.15	0.40–1.00	0.10–0.80	1.0
Mobile Payment	0.10	0.20–0.90	0.05–0.50	1.0
QR Code	0.20	0.20–0.60	0.01–0.20	0.1

SIMULATION OF 8 BILLION B2C TRANSACTIONS (1,000 PER CAPITA)

- Payment method selection was simulated according to the probability weights derived from the population typology.
- Each method contributed to the overall transactional delay proportionally to its usage share.
- The average transactional delay across all methods was estimated at 1.60 days.

0.62

PROXY VELOCITY OF MONEY

MATHEMATICAL MODEL OF SIMULATING THE VELOCITY OF MONEY

SELECTION OF PAYMENT METHOD PER DEMOGRAPHIC GROUP

For each demographic group g and each payment method i, we define the raw score of method i for group g as:

$$s_{g,i} = z_{g,i} \cdot d_{g,i} \cdot f_{g,i}$$

Where:

- $z_{g,i}$: habitual weight (preference)
- $d_{g,i}$: availability of the method
- $f_{g,i}$: friction (perceived difficulty or resistance to using the method)

The normalized probability of method i being selected by group g is then:

$$p_{g,i} = \frac{s_{g,i}}{\sum_j s_{g,j}}$$

ESTIMATING THE AVERAGE PAYMENT DELAY

We simulate N_g payments for each group g, using the probabilities $p_{g,i,}$ and derive the population-level usage share of method i, denoted P_i.

The average transactional delay is computed as:

$$\bar{T} = \sum_i P_i \cdot t_i$$

Where:

- t_i: typical delay in days for method i

PROXY VELOCITY OF MONEY

The proxy velocity of money based on payment delay is:

$$V_{\text{proxy}} = \frac{1}{\bar{T}}$$

EXTENSION TO MULTIPLE CIRCULATION LAYERS

For each circulation layer $k \in \{\text{B2C}, \text{B2B}, \text{Government} \rightarrow \text{Households}\}$, define:

- T_k: average transactional delay in layer k
- Q_k: number of transactions in layer k

The overall average delay across the economy is:

$$\bar{T}_{\text{total}} = \frac{\sum_k Q_k \cdot T_k}{\sum_k Q_k}$$

VELOCITY CALIBRATED BY MONEY VOLUME (M2)

For each layer k, compute the annualized velocity:

$$V_k = \frac{365}{T_k}$$

The turnover (transaction volume) in each layer is:

$$\text{Turnover}_k = V_k \cdot \text{Volume}_k$$

Finally, the aggregate money velocity based on M2 is:

$$V_{M2} = \frac{\sum_k \text{Turnover}_k}{M2}$$

CALIBRATION BASED ON ACTUAL M0 AND M2 DATA

- Share of cash (M0) in M2: 12.7%
- After recalibrating method shares to align with this monetary structure:
- Average transactional delay decreased to 1.11 days
- For comparison, the empirical M2 velocity in 2020 was 1.084

0.898

CORRESPONDING PROXY VELOCITY OF MONEY

DYNAMIC EVOLUTION OF PROXY VELOCITY (2000–2025)

Year	Average Transactional Delay (days)	Proxy Velocity (V)
2000	2.41	0.415
2005	2.25	0.445
2010	2.00	0.500
2015	1.76	0.569
2020	1.51	0.661
2025	1.11	0.898

This trend illustrates a **gradual acceleration in the velocity of money** over time, primarily driven by the **digitization of payment systems** and the **declining average delay between transactions.**

EXTENSION: LAYERED CIRCULATION STRUCTURE

Additional transactional layers were introduced to reflect the broader economic circulation:

- **B2C (Business-to-Consumer)**:
  - 1,000 transactions per capita annually
  - Average delay: 1.11 days
- **B2B (Business-to-Business)**:
  - Assumed to be 5× the volume of B2C transactions
  - Average delay: 14 days
- **Wages and Social Transfers**:
  - 12 transactions per capita annually
  - Average delay: 30 days

Weighted average delay: 11.89 days

0.084

TOTAL PROXY VELOCITY.
ANNUALIZED: ≈ 30.7 CIRCULATION CYCLES PER YEAR

CALIBRATION BY MONETARY VOLUME (CZSO)

Layer	Transaction Volume (CZK bn)	Average Delay (days)	Layer Velocity (annual)
B2C (Household Consumption)	2,542	1.114	327.6
B2B (Intermediate Consumption)	3,869	14	26.1
Wages & Transfers	2,338	30	12.2

- **Total Annual Turnover:**
  963.1×10^9 CZK
- **Money Supply (M2, 2020):**
  $5,255.2$ CZK bn

FINAL MODELED VELOCITY OF MONEY (2020)

Approximately **0.183 cycles per monetary unit per year**, when modeled with full-layer calibration.

This reflects a s**ignificantly slower effective circulation** compared to GDP-based M2 velocity (≈1.08), highlighting the difference between monetary velocity in accounting terms and real transaction-level flow velocity.

0.1832

MODELED VELOCITY OF MONEY

CONCLUSION

The model successfully captures **real shifts in population payment behavior** and **structural differences across economic sectors**.

When aggregating all transactional layers, the results indicate that the **actual circulation of money is substantially more dynamic** than suggested by the traditional GDP-to-money supply ratio (GDP/M).

This framework is **applicable for forecasting the impacts of fintech adoption**, payment system digitalization, and structural changes within the economy.

THANK YOU!