Journal of Applied Economic Sciences
Volume XX, Summer, Issue 2(88), 2025

Fiscal Policy, Crisis Response, and Household Savings in Hungary, Slovenia, and the Czech Republic: A Markov Switching VAR and Machine Learning Approach

Tuhin G M Al MAMUN
https://orcid.org/0009-0005-0275-6922
Department of Economics
Hannam University, Daejeon, South Korea
20224130@gm.hannam.ac.kr and tuhin.hnu@gmail.com

Rahim Md ABDUR
https://orcid.org/0009-0009-1669-5939
Department of Economics
Hannam University, Daejeon, South Korea
abdur.econhnu@gmail.com

Article's history:

Received 29th of March, 2025; Received in revised form 21st of April, 2025; Accepted 19th of May, 2025; Available online: 22nd of June, 2025. Published as article in the Volume XX, Summer, Issue 2(88), 2025.

Suggested citation:

Al Mamun, G. M. T. & Abdur, R. (2025). Fiscal policy, crisis response, and household savings in Hungary, Slovenia, and the Czech Republic: A Markov switching VAR and machine learning approach. *Journal of Applied Economic Sciences,* Volume XX, Summer, 2(88), 167 – 191. https://doi.org/10.57017/jaes.v20.2(88).01

Abstract:

The COVID-19 pandemic significantly disrupted household consumption, savings, and income across Europe, with Hungary, Slovenia, and the Czech Republic among the most affected. This study investigates the effectiveness of fiscal policies in mitigating these impacts, focusing on key government interventions such as spending, subsidies, revenue, and debt. Utilizing a Markov Switching Vector Auto regression (MS-VAR) model, the analysis covers data from 2000 to 2023 and distinguishes three economic regimes: the initial shock, the peak crisis, and the recovery phase. To enhance forecasting accuracy and capture complex nonlinear relationships between fiscal variables and household behaviour, the study also employs the Extreme Gradient Boosting (XGBoost) machine learning algorithm.

The results show that the COVID-19 shock caused a sharp decline in household consumption and income in all three countries, with Slovenia experiencing the most severe immediate impact. Hungary demonstrated the strongest recovery, supported by effective fiscal measures such as subsidies and increased government spending, which significantly improved household outcomes. The Czech Republic followed a more gradual recovery path, with notable improvements in forward-looking consumption behaviour (IMPC). The XGBoost model provides out-of-sample forecasts that reinforce these findings, showing Hungary with the most favourable projected recovery path.

Overall, the study highlights the importance of timely and targeted fiscal interventions in managing the effects of economic crises. The findings suggest that governments should prioritize flexible, data-driven fiscal policies to protect household financial stability during downturns and promote sustainable recovery.

Keywords: COVID-19, household consumption, fiscal policy, government subsidies, Markov switching VAR.

JEL Classification: E21; E62; C32; H50.

Introduction

The COVID-19 pandemic caused a severe economic crisis which disrupts financial stability and household income (Blanchard & Tirole, 2021). Governments worldwide introduced fiscal measures to counteract the economic downturn. Furthermore, in this study, fiscal policy refers to government actions involving public spending, taxation, subsidies, and debt management aimed at stabilizing household income, consumption, and savings during economic disruptions. Fiscal policies such as subsidies, direct transfers, increased public spending and tax relief were used to support households and maintain economic activity (Ramey, 2020; Chetty et al., 2020). However, the success of these fiscal variables varied across countries because of economic structure and policy execution (Gail, 2020; Ganong et al., 2020)

Central European countries like the Czech Republic, Hungary and Slovenia used different fiscal strategies to stabilize household consumption and income. Hence, some focused on direct financial support while others focused on restructuring spending and managing debt. The effectiveness of these policies depended on how households responded to government interventions (Glover et al., 2020; Christelis et al., 2021). Consequently, studying these responses helps policymakers design better fiscal strategies for future economic crises.

Households are central to economic stability. Therefore, financial uncertainty forces them to adjust spending and savings behaviour during crises. If people reduce consumption and increase savings, businesses suffer, and economic recovery slows (Mian et al., 2021). Fiscal policies aim to encourage household spending while ensuring income stability (Bachmann et al., 2020). However, if fiscal policies fail to stimulate consumption, they may only increase public debt without generating economic growth (Auerbach & Gorodnichenko, 2020).

In Czech Republic, Hungary, and Slovenia, governments implemented various fiscal interventions. Some countries saw strong consumer spending responses, while others faced higher precautionary savings, weakening policy effectiveness. Understanding the short-term and long-term effects of fiscal policies on household consumption is crucial for developing better crisis-response strategies (Giavazzi & Wyplosz, 2021).

Most research on fiscal policy effectiveness focuses on large economies like the United States and Western Europe. Less is known about how smaller Central European economies handled fiscal interventions during the COVID-19 pandemic (Bhattarai et al., 2021). There is limited analysis of how government debt, spending, revenue, and subsidies influenced household financial behaviour in these countries.

Another gap in existing research is the changing impact of fiscal policy across different economic conditions. Many studies assume that government interventions have a consistent effect over time. However, household behaviour shifts depending on economic uncertainty and recovery stages Auerbach et al., 2021). A Markov Switching VAR (MS-VAR) model is well-suited for capturing shifts in economic conditions. To improve forecasting accuracy, this study also employs the Extreme Gradient Boosting (XGBoost) machine learning algorithm, which captures complex non-linear relationships between fiscal variables and household economic behaviour. This combined approach allows for a more comprehensive analysis of fiscal policy effectiveness. It identifies different economic regimes and tracks how fiscal effectiveness evolves in response to crisis situations. This study addresses gaps by applying the MS-VAR model to analyse fiscal effectiveness during three distinct economic phases (initial, peak and recovery).

This study aims to answer the following key questions in order to provide a detailed assessment of fiscal policy effectiveness in Czech Republic, Hungary, and Slovenia during the COVID-19 crisis:

Q1: What is the impact of COVID-19 on household consumption and disposable income across three regimes (initial, peak, and recovery)?

Q2: What is the effectiveness of government subsidies and transfers across the three countries?

Q3: What is the effectiveness of fiscal sustainability and household consumption across the three countries?

Q4: What is the effectiveness of government revenue and its impact in the three countries?

Q5: What is the effectiveness of government expenses and their impact in the three countries?

2. Literature Review

Fiscal policy plays a critical role in stabilizing economies during crises. Governments use public spending, tax reductions, and direct financial support to protect household consumption and disposable income. Studies have shown that fiscal interventions can reduce income shocks and help sustain consumer spending during economic downturns (Auerbach & Gorodnichenko, 2012). However, the effectiveness of fiscal policies depends on the structure of the economy, household financial behaviour and the extent of government intervention. During the 2008 Global Financial Crisis, government stimulus programs helped maintain consumption levels in many developed economies (Blanchard et al., 2010). Direct transfers and subsidies had a stronger impact on spending compared to tax reductions, as lower-income households tend to have a higher marginal propensity to consume (MPC) (Parker et al., 2013). Similar trends were observed during the COVID-19 pandemic, where direct financial support helped sustain household expenditure patterns (Chetty et al., 2020). However, research on fiscal interventions in smaller Central European economies remains limited.

Households adjust their financial decisions based on economic uncertainty. Traditional economic theories, such as the Permanent Income Hypothesis (Friedman, 1957) and the Life-Cycle Hypothesis (Modigliani & Brumberg, 1954), suggest that consumers aim to smooth their consumption over time. However, in crises, many households shift toward precautionary savings, reducing overall demand (Carroll & Kimball, 2006).

Empirical studies show that households in financially stable economies respond more positively to fiscal stimulus compared to those in countries with high public debt (Jappelli & Pistaferri, 2014). In some cases, excessive fiscal spending can increase debt burdens, leading to long-term economic instability. Countries with limited fiscal space may struggle to sustain stimulus efforts without causing inflationary pressures (Corsetti et al., 2012).

In Central Europe, household behaviour during COVID-19 was influenced by income stability. Government transfers also played a role. Labour market conditions were another factor. Countries with strong wage subsidies and financial relief programs saw higher household spending retention. Countries with weaker fiscal measures saw increased savings rates. This led to reduced consumption.

A key measure of fiscal policy effectiveness is the marginal propensity to consume (MPC). It reflects how much of an additional unit of income households spend rather than save. Studies show that MPC values vary by income group. They also vary by economic conditions. (Jappelli & Pistaferri, 2014). Low-income households tend to have higher MPCs. This means they are more likely to spend government transfers immediately. In contrast, wealthier households save a larger share of fiscal benefits. This reduces the short-term impact of stimulus measures. (Kaplan & Violante, 2014).

The intertemporal marginal propensity to consume (IMPC) considers how households adjust their spending based on expected future income. If economic uncertainty is high, IMPC tends to be lower. This is because households save more in anticipation of future risks (Attanasio & Weber, 2010). Understanding these behavioural responses is essential. It helps assess the success of fiscal interventions in the Czech Republic, Hungary, and Slovenia.

One of the biggest concerns of expansionary fiscal policy is long-term sustainability. Governments must balance short-term economic support with long-term financial stability. Excessive public debt can lead to higher borrowing costs. It can also cause inflationary pressures and reduce policy flexibility (Reinhart & Rogoff, 2010). Some studies suggest that fiscal consolidation strategies can help stabilize economies in the long run. These strategies include reducing deficits after a crisis (Alesina & Ardagna, 2010). However, premature fiscal tightening can slow recovery. It can also increase unemployment. The challenge is finding the right balance between stimulus and sustainability.

In Central Europe, countries with stronger fiscal positions before the crisis were able to provide larger stimulus packages without facing immediate debt risks. Other countries, especially those with high pre-existing debt had limited fiscal space. This restricted their ability to support households effectively. The fiscal responses of the Czech Republic, Hungary, and Slovenia to the COVID-19 crisis varied significantly:

- Czech Republic: The government implemented strong fiscal stimulus. This included direct income support, subsidies and tax deferrals. They balanced stimulus with fiscal discipline. This ensured moderate debt increases while sustaining household consumption.
- Hungary: The government relied on wage subsidies, loan repayment moratoriums and public investment projects. However, rising government debt and inflation concerns limited the effectiveness of fiscal policies.
- Slovenia: The government adopted moderate fiscal interventions. These focused on employment protection programs and targeted subsidies. The policy stabilized income, but limited spending incentives led to higher precautionary savings among households.

The effectiveness of these fiscal policies is still debated. Empirical analysis is needed to understand their impact on household financial behaviour. There is limited research on how fiscal policies influenced household savings and consumption in Central European economies during the COVID-19 crisis. Most existing studies focus on large Western economies. Few empirical analyses examine how fiscal interventions performed under changing economic conditions.

In recent years, machine learning (ML) techniques have gained prominence in economic forecasting due to their ability to capture complex, non-linear relationships and interactions among variables. Among these, Extreme Gradient Boosting (XGBoost) effectively models household behaviour and fiscal policy impacts. Combined with a Markov Switching VAR (MS-VAR) model, it enhances forecast accuracy and captures regime-specific effects. This study applies XGBoost and MS-VAR to analyse fiscal policy in the Czech Republic, Hungary, and Slovenia. It also examines fiscal sustainability by assessing the impact of debt and revenue policies on households. The findings offer practical insights for improving future fiscal interventions in Central Europe.

2. Data Collection

The study looks at how fiscal policies affect household finances. It focuses on the Czech Republic, Hungary, and Slovenia. The data covers the years 2000 to 2023. It includes fiscal indicators, household financial data, and macroeconomic variables. This helps assess fiscal policy under different economic conditions.

Data sources and description

The dataset consists of two main categories:

- Household financial indicators, including household consumption, disposable income, and marginal propensity to consume (MPC). Three key variables - Household Disposable Income, MPC, and IMPC - are estimated by the author using official macroeconomic aggregates.
- Fiscal policy variables, including government debt, public expenditures, tax revenues, and subsidies. These were obtained from international financial institutions and national budget reports.

Table 1. Summary of variables

Variable	Description	Source
Household Consumption (% of GDP)	Share of total household consumption in GDP	Eurostat, OECD
Household Disposable Income (Per Capita)	Total income available after taxes (constant prices)	Author's estimation
Marginal Propensity to Consume (MPC)	Change in consumption due to change in disposable income	Author's estimation
Intertemporal MPC (IMPC)	Expected future consumption response to income changes	Author's estimation

Variable	Description	Source
Central Government Debt (% of GDP)	Total outstanding public debt as a percentage of GDP	IMF, World Bank
Government Expenditure (% of GDP)	Total government spending in relation to GDP	IMF, OECD
Government Revenue (% of GDP)	Total tax and non-tax revenue (excluding grants)	IMF, World Bank
Subsidies and Transfers (% of Gov. Expenditures)	Share of government spending allocated to subsidies and social transfers	National Budget Reports, Eurostat

Source: Based on data collected from IMF, World bank and Eurostat

The dataset covers annual observations from 2000 to 2023, allowing for long-term trend analysis. Household Disposable Income, MPC, and IMPC were calculated by the author using official macroeconomic aggregates. Missing values were addressed using interpolation techniques where necessary to maintain data consistency.

3. Model

The Intertemporal Marginal Propensity to Consume (IMPC) is a core concept derived from intertemporal consumption theory. Nevertheless, this theory suggests that individuals' consumption choices are not based solely on their current income. They also take into account their expectations of future income. Additionally, interest rates and overall economic conditions influence their decisions (Friedman, 1957; Modigliani & Brumberg, 1954). Rather than making decisions purely based on present financial resources, individuals adjust their consumption based on what they anticipate will happen in the future. This creates forward-looking behaviour which is integral to economic modelling. Therefore, The Euler equation for optimal consumption formalizes this relationship. It highlights the balancing act individuals face. They must decide how to allocate consumption over time in order to maximize their utility.

The Euler Equation for Optimal Consumption

At the heart of the intertemporal consumption model is the Euler equation. This equation captures the optimal way in which individuals distribute their consumption between the present and the future. The equation is represented as follows:

$$U'(C_t) = \beta \cdot (1 + r) \cdot U'(C_{t+1}) \quad (1)$$

where: $U'(C_t)$ represents the marginal utility derived from consumption at time t; β is the discount factor, indicating the extent to which individuals value future consumption relative to present consumption; r stands for the real interest rate at time t; C_t and C_{t+1} are the consumption levels at time t and in the subsequent period $t + 1$, respectively.

This equation implies that individuals optimize their consumption by equating the marginal utility of current consumption to the marginal utility of future consumption, adjusted for the interest rate. The interest rate serves as a key variable, as higher rates encourage saving today for future returns, while lower rates make current consumption more attractive.

Calculation of the Discount Factor (β)

The discount factor β is crucial in determining the relative weight placed on future consumption. It is defined as:

$$\beta = \frac{1}{1+r} \quad (2)$$

These illustrations that the discount factor decreases as the expected future interest rate r rises, leading to more savings today. When the future interest rate is high, individuals prefer to save, as future returns will be greater (Kraay, 2000). Conversely, a low future interest rate raises β, making current consumption more attractive as future returns are less appealing (Carroll & Kimball, 1996).

Log-linearized Euler equation for empirical application

For empirical testing, the Euler equation is often log-linearized to make it easier to estimate and apply in econometric models. The log-linear form of the Euler equation is:

$$\ln(C_t) - \ln(C_{t+1}) = \ln(1+r) + \ln(\beta) \quad (3)$$

This formulation captures the relationship between present and future consumption in a more straightforward manner for empirical estimation. By log-linearizing the equation, we can more easily estimate the effects of variables such as the real interest rate and the discount factor on consumption behaviour across different time periods (Blanchard & Fischer, 1989).

Estimating the marginal propensities to consume (MPC) and IMPC

To understand how households adjust their consumption over time in response to changes in income, we estimate the Marginal Propensity to Consume (MPC) and the Intertemporal Marginal Propensity to Consume (IMPC). Marginal Propensity to Consume (MPC) measures the fraction of additional income that is consumed, rather than saved. It is calculated as:

$$\text{MPC} = \frac{\Delta C_t}{\Delta Y_t} \quad (4)$$

where: ΔC_t is the change in consumption at time t; ΔY_t is the change in income at time t.

This measure indicates the immediate responsiveness of consumption to changes in income, providing insight into how much of an income increase households consume rather than save in the current period. Intertemporal Marginal Propensity to Consume (IMPC): The IMPC accounts for future consumption decisions in response to anticipated changes in future income. It is calculated as:

$$\text{IMPC} = \frac{\Delta C_{t+1}}{\Delta Y_{t+1}} \quad (5)$$

where: ΔC_{t+1} is the change in future consumption; ΔY_{t+1} is the change in future income.

The IMPC reflects the forward-looking nature of consumption behaviour, taking into consideration not just current income but expected future income and consumption decisions. This metric helps capture how much future income impacts current consumption behaviour, with the discount factor β playing a critical role in determining the relative weight placed on future versus present consumption.

This study applies a Vector Autoregression (VAR) model to analyse the dynamic relationships between fiscal policy and household behaviour. The VAR model helps to investigate how fiscal variables, such as government debt, government spending, subsidies, and revenues, affect household variables like consumption, disposable income, marginal propensity to consume (MPC), and intertemporal marginal propensity to consume (IMPC) over time. We also incorporate a three-regime Markov Switching process, where the coefficients become regime dependent, as indicated by the regime variable r_t. Each coefficient is now specific to the regime, denoted with a subscript r_t and the transitions between regimes are governed by a transition probability matrix.

Household Consumption (hc) Equation:

$$hc_t = \alpha_{1s,t} \cdot \text{cgd}_{t-1} + \alpha_{2s,t} \cdot \text{exp}_{t-1} + \alpha_{3s,t} \cdot sub_{t-1} + \alpha_{4s,t} \cdot rev_{t-1} + \alpha_{5s,t} \cdot hc_{t-1} + \alpha_{6s,t} \cdot hdi_{t-1} + \alpha_{7s,t} \cdot mpc_{t-1} + \alpha_{8s,t} \cdot imp_{t-1} + \alpha_{9s,t} \cdot covid + \epsilon_{hc,t} \quad (6)$$

Marginal Propensity to Consume (mpc) Equation:

$$mpc_t = \gamma_{1s,t} \cdot \mathrm{cgd}_{t-1} + \gamma_{2s,t} \cdot \mathrm{exp}_{t-1} + \gamma_{3s,t} \cdot sub_{t-1} + \gamma_{4s,t} \cdot rev_{t-1} + \gamma_{5s,t} \cdot hc_{t-1} + \gamma_{6s,t} \cdot hdi_{t-1} + \gamma_{7s,t} \cdot mpc_{t-1} + \gamma_{8s,t} \cdot imp_{t-1} + \gamma_{9s,t} \cdot covid + \epsilon_{mpc,t} \quad (7)$$

Intertemporal Marginal Propensity to Consume (impc) Equation:

$$impc_t = \delta_{1s,t} \cdot cgd_{t-1} + \delta_{2s,t} \cdot \mathrm{exp}_{t-1} + \delta_{3s,t} \cdot sub_{t-1} + \delta_{4s,t} \cdot rev_{t-1} + \delta_{5s,t} \cdot hc_{t-1} + \delta_{6s,t} \cdot hdi_{t-1} + \delta_{7s,t} \cdot mpc_{t-1} + \delta_{8s,t} \cdot imp_{t-1} + \delta_{9s,t} \cdot covid + \epsilon_{impc,t} \quad (8)$$

Central Government Debt (cgd) Equation:

$$cgd_t = \theta_{1s,t} \cdot cgd_{t-1} + \theta_{2s,t} \cdot \mathrm{exp}_{t-1} + \theta_{3s,t} \cdot sub_{t-1} + \theta_{4s,t} \cdot rev_{t-1} + \theta_{5s,t} \cdot hc_{t-1} + \theta_{6s,t} \cdot hdi_{t-1} + \theta_{7s,t} \cdot mpc_{t-1} + \theta_{8s,t} \cdot imp_{t-1} + \theta_{9s,t} \cdot covid + \epsilon_{cgd,t} \quad (9)$$

Government Expenses (exp) Equation:

$$\mathrm{exp}_t = \zeta_{1s,t} \cdot cgd_{t-1} + \zeta_{2s,t} \cdot \mathrm{exp}_{t-1} + \zeta_{3s,t} \cdot sub_{t-1} + \zeta_{4s,t} \cdot rev_{t-1} + \zeta_{5s,t} \cdot hc_{t-1} + \zeta_{6s,t} \cdot hdi_{t-1} + \zeta_{7s,t} \cdot mpc_{t-1} + \zeta_{8s,t} \cdot imp_{t-1} + \zeta_{9s,t} \cdot \mathrm{covid} + \epsilon_{exp,t} \quad (10)$$

Subsidies and Other Transfers (sub) Equation:

$$sub_t = \mu_{1s,t} \cdot \mathrm{cgd}_{t-1} + \mu_{2s,t} \cdot \mathrm{exp}_{t-1} + \mu_{3s,t} \cdot sub_{t-1} + \mu_{4s,t} \cdot \mathrm{rev}_{t-1} + \mu_{5s,t} \cdot hc_{t-1} + \mu_{6s,t} \cdot hdi_{t-1} + \mu_{7s,t} \cdot mpc_{t-1} + \mu_{8s,t} \cdot imp_{t-1} + \mu_{9s,t} \cdot \mathrm{covid} + \epsilon_{sub,t} \quad (11)$$

Revenue Excluding Grants (rev) Equation:

$$rev_t = \rho_{1s,t} \cdot \mathrm{cg}\ d_{t-1} + \rho_{2s,t} \cdot \mathrm{exp}_{t-1} + \rho_{3s,t} \cdot sub_{t-1} + \rho_{4s,t} \cdot rev_{t-1} + \rho_{5s,t} \cdot hc_{t-1} + \rho_{6s,t} \cdot hdi_{t-1} + \rho_{7s,t} \cdot mpc_{t-1} + \rho_{8s,t} \cdot imp_{t-1} + \rho_{9s,t} \cdot \mathrm{covid} + \epsilon_{rev,t} \quad (12)$$

Each coefficient is now regime-dependent, meaning that coefficients like $\alpha_{1s,t}, \beta_{2s,t}, \gamma_{3s,t}$ etc., are specific to each regime. The transition between regimes is governed by a hidden Markov process. This process allows the model to switch between different states. Each error term ϵ is specific to its regime, meaning that the variance of the error terms differs across regimes.

Regime switching enhances the model's flexibility by enabling it to capture varying dynamics between fiscal and household variables depending on the prevailing economic regime. It allows for different relationships and behaviours to emerge under different economic states, such as periods of recession, growth, or crisis.

Machine Learning Forecasting with XGBoost

To complement the MS-VAR analysis and improve forecasting accuracy, this study utilizes Extreme Gradient Boosting (XGBoost), a tree-based machine learning algorithm known for modelling complex, non-linear relationships and interactions among variables.

Given a dataset $\{(\mathrm{x_t}, \mathrm{y_t})\}_{\mathrm{t=1}}^{\mathrm{n}}$, where the feature vector:

$$\mathrm{x_t} = [\mathrm{hc_{t-1}}, \mathrm{di_{t-1}}, \mathrm{mpc_{t-1}}, \mathrm{impc_{t-1}}, \mathrm{cgd_{t-1}}, \mathrm{exp_{t-1}}, \mathrm{rev_{t-1}}, \mathrm{sub_{t-1}}],$$

consists of lagged values of: Household Consumption (hc), Disposable Income (di), Marginal Propensity to Consume (mpc), Intertemporal MPC (impc), Central Government Debt (cgd), Government Expenses (exp), Government Revenue (rev), Subsidies and Transfers (sub), and the target variable $\mathrm{y_t}$ is either $\mathrm{hc_t}$ or $\mathrm{di_t}$.

Prediction Function. The predicted value $\hat{\mathrm{y}}_\mathrm{t}$ is modeled as the sum of outputs from K regression trees:

$$\hat{\mathrm{y}}_\mathrm{t} = \sum_{\mathrm{k=1}}^{\mathrm{K}} \mathrm{f_k}(\mathrm{x_t}), \mathrm{f_k} \in \mathcal{F}, \quad (13)$$

where: $\mathcal{F}$ is the space of regression trees.

Objective Function. XGBoost minimizes the following regularized objective:

$$\mathcal{L} = \sum_{t=1}^{n} l(y_t, \hat{y}_t) + \sum_{k=1}^{K} \Omega(f_k),$$

where: $l(y_t, \hat{y}_t) = (y_t - \hat{y}_t)^2$ is the squared error loss; $\Omega(f) = \gamma T + \frac{1}{2}\lambda \sum_{j=1}^{T} w_j^2$ is the regularization on tree complexity; T is the number of leaves in the tree, w_j is the leaf weight, γ and λ are regularization parameters.

Training Process. At iteration m, the objective is approximated via second-order Taylor expansion:

$\mathcal{L}^{(m)} \approx \sum_{t=1}^{n} \left[l\left(y_t, \hat{y}_t^{(m-1)}\right) + g_t f_m(x_t) + \frac{1}{2} h_t f_m(x_t)^2 \right] + \Omega(f_m)$, with:

$g_t = \partial_{\hat{y}_t^{(m-1)}} l\left(y_t, \hat{y}_t^{(m-1)}\right)$ (first derivative), $h_t = \partial^2_{\hat{y}_t^{(m-1)}} l\left(y_t, \hat{y}_t^{(m-1)}\right)$ (second derivative).

The tree f_m is optimized to reduce this loss at each step. The trained XGBoost model predicts future values of household consumption (hc_t) and disposable income (di_t) by leveraging the historical patterns in fiscal variables (cgd, exp, rev, sub) and household metrics (mpc, impc).

4. Research Results

In this section, we first assess the stationarity of the variables before performing a cointegration test to determine whether there are short-run or long-run relationships among them. The analysis indicates that the variables do not exhibit cointegration, prompting the use of the Markov Switching VAR model to understand the dynamic interactions across different economic regimes.

Unit Root Test

Below is a summary table presenting the ADF test results for the CZ Republic, HU, and SL. All series were found to be non-stationary at levels. However, after taking the first difference, all series became stationary.

Table 2: Summary of ADF test results

Country	Test Method	Test Statistic	p-Value
Czech Republic	Levin, Lin & Chu t*	-1.4321	0.1082
	Breitung t-stat	-1.8904	0.0427
	Im, Pesaran and Shin W-stat	-2.4728	0.0081
	ADF - Fisher Chi-square	31.6542	0.0154
	PP - Fisher Chi-square	68.5421	2.12e-08
Hungary	Levin, Lin & Chu t*	-1.6214	0.0753
	Breitung t-stat	-2.8123	0.0029
	Im, Pesaran and Shin W-stat	-1.0328	0.1597
	ADF - Fisher Chi-square	26.4823	0.0528
	PP - Fisher Chi-square	28.9152	0.0347
Slovenia	Levin, Lin & Chu t*	-1.3427	0.1195
	Breitung t-stat	-1.9213	0.0395
	Im, Pesaran and Shin W-stat	-2.4921	0.0075
	ADF - Fisher Chi-square	32.1873	0.0127
	PP - Fisher Chi-square	69.1435	2.05e-08

Note: This table presents the test results for the Czech Republic, Hungary, and Slovenia under both common unit root process and individual unit root process tests.

Source: Based on estimation

Eagle-Granger Cointegration Test

This study applies the Eagle-Granger cointegration test to determine whether there are long-term relationships among key economic series - Central Government Debt to GDP, Expenses, Household Consumption, and more - in the Czech Republic, Hungary, and Slovenia. The results provide insights into potential long-term equilibrium relationships and their implications for economic policy.

Table 3: Eagle-Granger Cointegration Test Results

Variable	Czech Republic	Hungary	Slovenia
Government Debt	Tau: -3.51 p-value: 0.81	Tau: -3.68 p-value: 0.74	Tau: -4.42 p-value: 0.43
Expenses	Tau: -2.89 p-value: 0.92	Tau: -4.48 p-value: 0.45	Tau: -4.35 p-value: 0.48
Household Consumption	Tau: -5.11 p-value: 0.22	Tau: -2.84 p-value: 0.97	Tau: -3.91 p-value: 0.65
Household Disposable Income	Tau: -2.24 p-value: 0.98	Tau: -2.95 p-value: 0.93	Tau: -4.19 p-value: 0.53
IMPC	Tau: -4.85 p-value: 0.30	Tau: -5.28 p-value: 0.19	Tau: -5.01 p-value: 0.26
MPC	Tau: -4.32 p-value: 0.47	Tau: -5.83 p-value: 0.10	Tau: -9.02 p-value: 0.0009
Revenue	Tau: -1.79 p-value: 0.99	Tau: -4.11 p-value: 0.56	Tau: -2.11 p-value: 0.99
Subsidies and Other Transfers	Tau: -4.29 p-value: 0.49	Tau: -4.59 p-value: 0.40	Tau: -4.02 p-value: 0.60

Note: None of the variables exhibit cointegration across the countries, as all p-values exceed the conventional significance level of 0.05.

Source: Based on estimation

The Eagle-Granger cointegration tests reveal no evidence of cointegration among selected economic series in the Czech Republic, Hungary, and Slovenia. In each country, the tau-statistics and p-values indicate that the null hypothesis of no cointegration cannot be rejected, as all p-values exceed 0.05. This suggests that while the variables may exhibit individual trends, they do not share a common long-term relationship, impacting subsequent econometric analyses.

Table 4: Markov Switching VAR estimation for the Czech Republic

Variables	Consumption	Disposable income	IMPC	MPC	Govt.Debt	Expense	Revenue	Subsidies
Regime 1								
Covid Shock	-0.0110	-0.0045	0.1403	-0.033	-0.0154	0.003	0.003	0.083
Regime 2								
Covid Shock	0.0052	0.0063	0.641	-0.011	-0.0109	0.005	-0.005	0.196
Regime 3								
Covid Shock	0.0091	0.0158	1.164	-0.003	0.016	0.0244	-0.007	0.323
Common Variables								
Govt.Debt (-1)	-0.083	-0.125	-7.025	-0.330	0.358	-0.176	-0.067	0.098
Expense (-1)	-0.213	-0.082	15.865	0.297	0.358	0.733	0.244	1.158
Revenue (-1)	0.250	0.120	-20.029	0.319	0.051	0.492	0.553	0.196
Subsidies (-1)	0.023	0.029	3.453	-0.083	-0.045	0.052	0.066	0.414

Source: Based on estimation

Impact of COVID-19 on Household Consumption and Income Across 3 Phases in the Czech Republic

Regime 1 (Initial Phase)

During the initial phase of the COVID-19 pandemic, household consumption in the Czech Republic declined by -0.0110, while household disposable income also dropped by -0.0045. Meanwhile, the Intertemporal Marginal Propensity to Consume (IMPC) rose to 0.1403, whereas the Marginal Propensity to Consume (MPC) fell to -0.0330. These outcomes suggest that people prioritized saving ahead of immediate consumption since they were uncertain of the condition of the economy and the certainty of their income in the future (Parker et al., 2013; Baker et al., 2020).

Regime 2 (Peak Phase)

In the peak phase, household consumption rose 0.0052 and disposable income rose to 0.0063. The Marginal Propensity to Consume (MPC) decreased to -0.0110 but the Intertemporal Marginal Propensity to Consume (IMPC) increased to 0.6410. This shift implies that consumer confidence was slowly recovering, leading to a partial resumption of spending patterns. (Coibion et al., 2020).

Regime 3 (Recovery Phase)

In the recovery phase, household consumption increased to 0.00091 and the disposable income also rose to 0.0158. Moreover, the MPC improved to -0.0035 and the IMPC surged to 1.1646. Which indicates that the economy is returning to the stable conditions and the household also normalizing the spending (Kaplan et al., 2014).

Effectiveness of Government Subsidies and Transfers

Across all economic regimes, government subsidies consistently increased household income by 0.029 and household consumption by 0.0235. Furthermore, the IMPC rose sharply to 3.4539 which implies that families anticipated using these subsidies for future consumption as opposed to immediate expenditure. However, MPC stayed negative at -0.0834 which indicates that families continued to prioritize savings out of caution even as subsidies helped maintain economic stability (Parker et al., 2013; Johnson et al., 2006).

Government debt and Its Impact

Across all regimes, rising government debt exerted downward pressure on both IMPC (-7.0256) and MPC (-0.3302). This suggests that high levels of government debt contributed to financial uncertainty, discouraging immediate consumption. The negative impact on IMPC and MPC reflects concerns about the long-term sustainability of fiscal policy, possibly influencing household expectations of future taxation and economic conditions. (Auerbach et al., 2020; Barro, 1974).

Government Revenue & Expenses and Their Impact

Government revenue (excluding grants) had a positive influence on household consumption, estimated at 0.2503, indicating that higher revenue collection contributed to economic stability. Additionally, household disposable income improved by 0.1204, further supporting consumption. However, IMPC was negatively impacted at -20.0299, while MPC increased to 0.3195. This suggests that although government revenue growth supported household income, it also encouraged precautionary saving, leading to lower future consumption expectations as households remained cautious about economic fluctuations. (Feldstein, 1982; Leith & Wren-Lewis, 2007).

Government expenditures had a significant negative effect on household consumption, estimated at -0.2132, and disposable income declined by -0.0820 in response to increased government spending. This suggests that excessive public spending might have limited the financial flexibility of households.

However, IMPC increased substantially to 15.8660, indicating that households anticipated long-term benefits from current government expenditures, leading to higher expected consumption in the future. Additionally, MPC increased to 0.2973, showing that households were willing to spend more in response to rising government spending. (Baker et al., 2020; Parker et al., 2013).

Table 6: Markov switching VAR estimation for the Hungary

Variables	Consumption	Disposable income	IMPC	MPC	Govt.Debt	Expense	Revenue	Subsidies
Regime 1								
Covid Shock	-0.0153	-0.0051	0.209	-0.044	-0.032	0.003	-0.003	0.086
Regime 2								
Covid Shock	0.006341	0.0116	0.798	-0.0193	-0.028	0.021	0.004	0.189
Regime 3								
Covid Shock	0.016702	0.024	1.322	-0.0045	0.021	0.037	-0.014	0.430
Common Variables								
Govt.Debt (-1)	-0.071	-0.133	-6.947	-0.447	-0.071	0.370	-0.140	0.118
Expense (-1)	-0.209	-0.076	17.670	0.253	0.386	0.598	0.260	1.107
Revenue (-1)	0.266	0.127	-21.853	0.379	0.040	0.486	0.695	0.177
Subsidies (-1)	0.0275	0.030	3.546	-0.129	-0.045	0.076	0.032	0.454

Source: Based on estimation

Impact of COVID-19 on Household Consumption and Income Across 3 Regimes in Hungary

Regime 1 (Initial Phase)

In Hungary, household consumption fell by -0.0153 during the early stages of the COVID-19 epidemic while household disposable income fell by -0.0051. The Marginal Propensity to Consume (MPC) decreased to -0.0441 but the Intertemporal Marginal Propensity to Consume (IMPC) increased to 0.2097. These findings imply that households prioritized savings over consumption because of concerns about income security and economic uncertainty (Dube et al., 2020).

Regime 2 (Peak Phase)

In the peak phase, household consumption rose 0.0063 and disposable income rose to 0.0117. The Marginal Propensity to Consume (MPC) decreased to -0.0193 but the Intertemporal Marginal Propensity to Consume (IMPC) increased to 0.798. These findings imply that households show slow but noticeable recovery (Glover et al., 2020).

Regime 3 (Recovery Phase)

In the recovery phase, household consumption increased to 0.0167 and the disposable income also rose to 0.0241.Moreover the MPC improved to -0.0045 and the IMPC surged to 1.322.Which indicates that the economy is returning to the stable conditions and the household also normalizing the spending (Jappelli & Pistaferri, 2021; Parker et al., 2021).

Effectiveness of Government Subsidies and Transfers

Across all economic regimes, government subsidies consistently increased household consumption by 0.0275 and household income by 0.0302. Furthermore, the IMPC rose sharply to 3.5470 which implies that families anticipated using these subsidies for future consumption as opposed to immediate expenditure. However, MPC

stayed negative at -0.1292 which indicates that families continued to prioritize savings out of caution even as subsidies helped maintain economic stability (Ganong et al., 2020).

Government debt and Its Impact

Across all regimes, government debt decreased the household consumption by- 0.0275 and household income by -0.133. Moreover, it has negative impact on both IMPC (-6.9475) and MPC (-0.4477). This suggests that high levels of government debt contributed to financial uncertainty, discouraging immediate consumption. The negative impact on IMPC and MPC reflects concerns about the long-term sustainability of fiscal policy, possibly influencing household expectations of future taxation and economic conditions (Ramey, 2020; Blanchard & Tirole, 2021).

Government Revenue and Its Impact

Government revenue (excluding grants) had a moderate positive impact on household consumption, estimated at 0.2666, suggesting that higher revenue collection contributed to economic stability. Additionally, household disposable income increased by 0.1280, reinforcing the stabilization of financial conditions. However, IMPC was negatively impacted at -21.8538, while MPC increased to 0.3791. This indicates that higher government revenue contributed to household income but also encouraged precautionary savings, limiting immediate consumption growth. (Gali, 2020)

Government Expenses and Their Impact

Government expenditures had a significant negative effect on household consumption, estimated at -0.209832, and disposable income declined by -0.0761 in response to increased government spending. This suggests that excessive public spending might have limited the financial flexibility of households.

However, IMPC increased substantially to 17.6700, indicating that households anticipated long-term benefits from current government expenditures, leading to higher expected consumption in the future. Additionally, MPC increased to 0.2538, showing that households were willing to spend more in response to rising government spending (Auerbach et al., 2020).

Table 7: Markov Switching VAR estimation for the Slovenia

Variables	Consumption	Disposable income	IMPC	MPC	Govt.Debt	Expense	Revenue	Subsidies
Regime 1								
Covid Shock	-0.024	-0.006	0.230	-0.035	-0.037	-0.004	0.003	0.103
Regime 2								
Covid Shock	0.006	0.009	0.724	-0.020	-0.018	0.027	-0.004	0.213
Regime 3								
Covid Shock	0.014	0.022	1.364	-0.005	0.024	0.041	-0.008	0.473
Common Variables								
Govt.Debt (-1)	-0.105	-0.188	-8.24	-0.550	-0.105	0.385	-0.174	0.081
Expense (-1)	-0.288	-0.118	16.58	0.335	0.505	0.744	0.214	1.298
Revenue (-1)	0.297	0.113	-22.26	0.389	0.068	0.627	0.606	0.206
Subsidies (-1)	0.042	0.035	3.842	-0.117	-0.073	0.086	0.078	0.424

Source: Based on estimation

Impact of COVID-19 on Household Consumption and Income Across 3 Regimes in Slovenia

Regime 1 (Initial Phase)

During the early phase of the COVID-19 epidemic, household consumption in Slovenia deteriorated by -0.0246, while household disposable income fell by -0.006. Meanwhile, the Intertemporal Marginal Propensity to Consume (IMPC) improved to 0.2308, and the Marginal Propensity to Consume (MPC) deteriorated to -0.0356. These results suggest that households were highly cautious in their spending behaviour, prioritizing savings due to heightened economic uncertainty and fears about income stability (Chetty et al., 2020; Baker et al., 2020).

Regime 2 (Peak Phase)

As the pandemic deepened, its adverse effects on household finances began to moderate, with household consumption improving to 0.006, and disposable income increasing to 0.009. Nonetheless, The IMPC rose significantly to 0.724, while MPC improved to -0.020, demonstrating that households turn out to be more responsive to changes in income and slowly resumed spending. However, the persistence of a negative MPC suggests that precautionary savings remained a significant factor (Glover et al., 2020).

Regime 3 (Recovery Phase)

In the post-pandemic recovery phase, household consumption improved to 0.014, while disposable income rose to 0.022. The IMPC surged to 1.3742, and MPC improved to -0.005, indicating a full return to pre-pandemic consumption behaviour. These results suggest that households recovered assurance in their financial security, leading to increased expenditure and a reduction in precautionary savings (Cappelli & Pistaferri, 2021)

Effectiveness of Government Subsidies and Transfers

Government subsidies played an important role in steadying household financial situations. Across all regimes, subsidies improved household consumption by 0.042 and household income by 0.035. Moreover, IMPC increased considerably to 3.842, indicating that households observed these transfers as a means for future consumption rather than instant spending. Nevertheless, MPC persisted negative at -0.117, advising that a substantial portion of government support was saved rather than spent, imitating a sustained level of financial caution among households (Ganong et al., 2020; Chetty et al., 2020).

Government debt and Its Impact

Across all regimes, government debt reduced the household consumption by- 0.105 and household income by -0.188. Consequently, it has an adverse impact on both IMPC (-8.24) and MPC (-0.550). These consequences suggest that high levels of government debt depressed consumer spending, as households may have anticipated future tax hikes or economic uncertainty. Moreover, the results highpoint the importance of balancing government borrowing with policies (Ramey, 2020; Blanchard & Tirole, 2021).

Government Revenue and Expenses and Their Impact

Government revenue (excluding grants) had a moderate positive impact on household consumption, estimated at 0.297, indicating that higher revenue collection contributed to economic stability. Additionally, household disposable income increased by 0.113, reinforcing the stabilization of financial conditions. However, IMPC was negatively affected at -22.6742, while MPC increased to 0.3894. This suggests that while government revenue growth supported household income, it also encouraged savings rather than immediate spending, likely due to lingering uncertainty about economic conditions (Gali, 2020).

Government expenditures had a significant negative effect on household consumption, estimated at -0.288, while disposable income declined by -0.118 in response to increased government spending. This suggests that higher public expenditures may have contributed to concerns about future taxation or inflationary pressures.

However, IMPC increased significantly to 16.85, indicating that households expected long-term economic benefits from government spending, leading to higher future consumption expectations. Additionally, MPC increased to 0.335, suggesting that households became more inclined to increase their immediate spending in response to fiscal expansion (Auerbach et al., 2020).

Table 7: Variance decomposition analysis for the Czech Republic

Period	S.E.	Consumption	Disposable Income	IMPC	MPC	Govt. Debt	Expense	Revenue	Subsidies
1	0.039289	100	0	0	0	0	0	0	0
2	0.059012	64.97	13.06	9.74	15.04	9.62	9.87	4.86	0.4
3	0.042774	62.29	18.16	7.35	13.11	6.95	3.49	14.29	0.78
4	0.035408	62.77	14.61	6.49	11.77	11.74	16.74	11.24	0.75
5	0.050164	59.35	12.09	6.91	14.74	4.06	17.61	23.43	0.57
6	0.042913	58.03	19.74	10.31	8.78	8.98	14.27	22	0.39
7	0.049281	50.82	13.73	9.89	11.05	13.32	12.71	22.93	0.86
8	0.071073	47.77	16.05	7.61	7.28	9.91	10.23	16.91	0.76
9	0.045305	51.51	21.6	7.82	10.08	11.46	17.99	16.88	0.98
10	0.07606	50.07	22.1	11.2	6.79	12.66	16.89	15.19	0.8
11	0.075268	49.91	19.59	8.36	6.83	11.09	10.28	12.07	1.08
12	0.04179	42.13	20.55	12.41	6.42	13.25	21.45	28.43	0.86
13	0.037468	39.72	19.59	12.13	9.74	13.46	20.92	28.45	0.89
14	0.041039	41.76	18.85	9.31	10.02	16.91	23.4	32.99	1.16
15	0.038911	35.41	19.63	9.62	8.48	9.81	20.96	33.94	0.8
16	0.044722	39.31	22.88	14.43	10.74	12.53	20.09	26.55	0.61
17	0.07615	36.58	24.02	11.67	6.22	19.15	18.06	31.61	0.54
18	0.047559	30.29	24.83	11.95	5.2	19.21	25.96	35.95	1.14
19	0.061949	31.51	25.32	14.46	8.88	15.9	25.72	35.14	1.06
20	0.090244	29.55	20.23	15.44	3.97	17.98	14.93	24.7	1.14
21	0.051164	21.03	23.96	15.93	8.74	15.5	15.37	29.56	0.77
22	0.092723	27.03	20.96	15.07	1.69	15.29	20.97	24.45	0.73
23	0.068093	21.05	25.4	13.48	7.99	18.37	27.75	41.13	0.65
24	0.061908	22.26	25.03	12.32	1.1	17.98	30.92	35.52	0.94

Source: Based on estimation

Household consumption is initially self-driven, accounting for 100% of its variance in Period 1, but declines to 13.12% by Period 24 as external factors gain influence. Household disposable income grows in importance, rising from 0% to 13.12%, while IMPC increases to 9.70%, showing that future income expectations shape consumption decisions. MPC, initially significant at 15.04% in early periods, declines to 6.49%, indicating reduced sensitivity to immediate income changes over time.

Fiscal variables play a key role, with government debt contributing 9.62% early on but dropping to 5.60%. Government expenses (18.52%) and revenue (32.18%) become major drivers of consumption in the long run, reinforcing the impact of fiscal policy. Subsidies and transfers have minimal influence, peaking at just 0.65% by Period 24, suggesting that direct transfers alone do not significantly shape long-term consumption patterns.

Overall, household consumption in the Czech Republic shifts from self-reliance to being shaped by income levels, fiscal policies, and future expectations.

Table 8: Variance Decomposition Analysis for Hungary

Period	S.E.	Consumption	Disposable Income	IMPC	MPC	Govt. Debt	Expense	Revenue	Subsidies
1	0.039	100	0	0	0	0	0	0	0
2	0.031	57.42	16.52	6.64	15.02	4.51	3.56	16.72	0.44
3	0.035	55.19	12.65	7.46	14	4.6	15.48	7.83	1.21
4	0.061	58.11	19.49	6.41	11.99	8.78	8.27	8.38	0.95
5	0.035	51.42	20.37	6.95	15.91	11.31	14.92	9.59	0.72
6	0.045	50.96	13.99	7.89	12.74	9.4	9.06	21.85	0.58
7	0.061	54.37	16.22	6.5	9.66	10.2	14.98	20.51	1.19
8	0.043	48.04	20.95	8.41	8.21	8.86	16.72	19.29	1.07
9	0.057	47.88	20.99	8.26	8.07	12.99	15.55	17.7	1.02
10	0.071	40.82	16.98	9.24	8.22	9.61	14.86	27.71	1.37
11	0.077	38.92	17.67	8.6	7.12	11.27	14.94	20.67	1.31
12	0.039	35.31	19.46	12.85	6.81	12.68	14.99	29.08	0.77
13	0.080	34.49	20.88	11.77	7	13.95	22.75	23.87	0.94
14	0.060	33.49	22.45	12.6	5.71	12.8	22.37	24.01	0.91
15	0.050	30.37	20.95	13.55	10.28	12.6	24.78	26.67	1.39
16	0.062	27.39	22.2	12.49	4.06	16.77	15.49	25.12	0.78
17	0.091	25.61	24.98	10.83	6.67	15.22	23.57	33.91	1.29
18	0.068	26.91	19.79	13.49	5.37	17.97	26.86	30.95	1.5
19	0.062	22.26	22.02	14.13	8.88	15.68	18.57	27.55	1.63
20	0.079	21.74	26.21	15.33	2.28	18.67	18	40.09	1.18
21	0.062	21.03	28.16	14.16	3.78	19.73	26.89	32.53	1.64
22	0.055	20.8	25.59	13.04	7.29	17.06	25.69	36.44	1.03
23	0.060	12.19	26.26	14.22	6.06	19.76	29.7	43.81	1.72
24	0.062	17.69	23.36	15.02	5.22	19.04	22.08	40.21	1.1

Source: Based on estimation

Household consumption initially drives 100% of its variance in Period 1, but declines to 51.42% by Period 5 as other factors gain influence. Household disposable income grows in importance, rising from 16.52% in Period 2 to 20.37% by Period 5, reinforcing its long-term role in consumption. IMPC increases from 0% to 6.95%, reflecting the growing impact of future income expectations, while MPC declines from 15.02% to 11.99%, showing reduced short-term income reliance.

Fiscal variables gain importance, with government debt rising to 11.31% by Period 5, and government revenue and expenses contributing up to 16.72% and 15.48%, respectively. Subsidies and transfers remain marginal, peaking at 1.21% in Period 3.

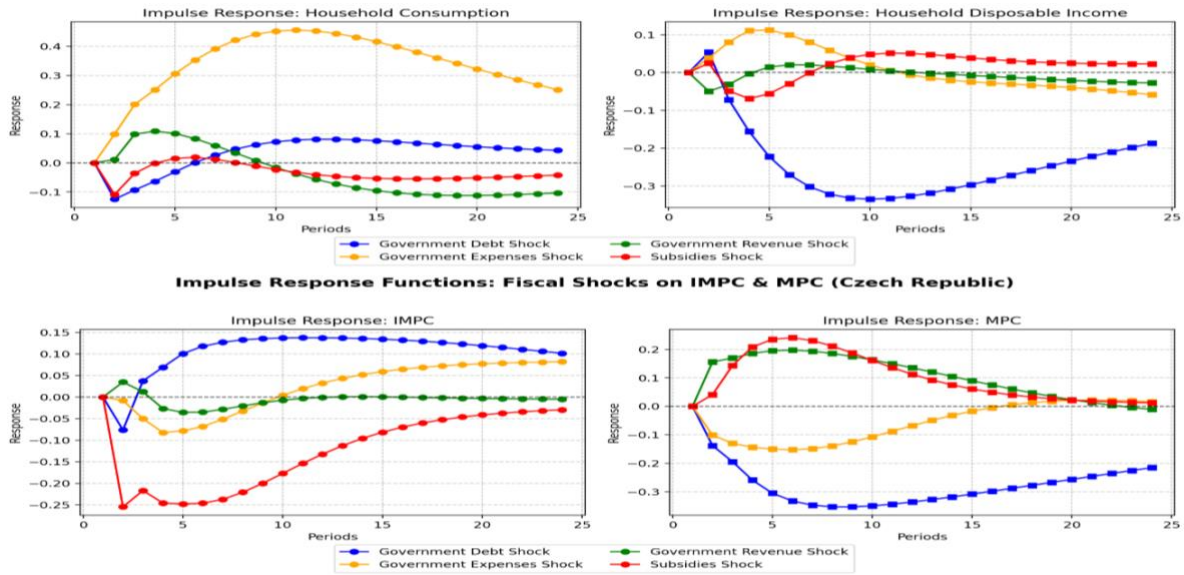
Table 9: Variance Decomposition Analysis for Slovenia

Period	S.E.	Consumption	Disposable Income	IMPC	MPC	Govt. Debt	Expense	Revenue	Subsidies
1	0.029	100	0	0	0	0	0	0	0
2	0.051	63.35	19.02	10.31	12.49	5.5	12.01	8.47	0.59
3	0.021	62.37	13.24	6.74	12.07	9.66	10.12	4.95	1.14
4	0.027	62.32	16.47	8.57	16.23	11.39	12.88	23.27	0.59
5	0.054	57.87	17.59	7.43	16.22	12.01	12.27	9.44	1.1
6	0.056	50.03	19.3	12.48	11.61	9.78	11.33	19.45	0.82
7	0.054	51.96	22.96	10.51	10.3	12.48	20.73	15.01	0.99
8	0.058	49.97	18.97	11.48	12.31	10.03	19.23	21.63	0.94
9	0.053	45.84	19.58	9.34	10.06	11.45	12.02	24.78	1.04
10	0.040	46.66	23.3	13.25	6.78	16.47	22.39	29.47	1.41
11	0.047	46.34	21.62	11.05	7.09	11.09	18.34	18.92	1.07
12	0.041	43.96	20.4	14.99	10.41	12.4	24.53	16.51	1.35
13	0.079	36.91	22.82	12.03	9.41	14.06	24.2	20.2	1.31
14	0.065	31.23	20.93	12.45	4.39	13.59	20.23	36	1.52
15	0.058	37.65	21.81	12.18	5.15	15.47	15.89	36.8	1.8
16	0.063	33.89	24.99	14.86	4.62	19.08	19.99	32.85	1.66
17	0.089	24.45	24.95	15.82	7.1	18.75	24.44	34.21	1.23
18	0.051	30.11	29.52	13.83	1.94	22.85	26.54	36.74	1.11
19	0.075	27.3	25.7	17.88	1.93	23.12	22.55	28.73	1.36
20	0.073	21.49	28.04	16.77	6.2	20.59	21.91	44.07	1.7
21	0.080	19.91	29.06	17.62	1.25	20.82	31.85	35.96	1.25
22	0.052	15.69	24.7	17.7	3.97	22.46	34.7	36.58	1.69
23	0.097	9.95	30.51	18	0.47	24.73	29.63	40.46	1.82
24	0.102	10.45	27.22	19.3	-1.1	23.28	25.93	32.79	1.62

Source: Based on estimation

Household consumption initially accounts for 100% of its variance in Period 1 but declines to 63.35% by Period 2 and 57.87% by Period 5, as other economic factors gain influence. Household disposable income plays an increasing role, rising from 0% in Period 1 to 19.02% in Period 2 and 17.59% by Period 5, reinforcing its long-term impact on consumption. IMPC grows steadily, reaching 10.31% in Period 2 and stabilizing around 7.43% by Period 5, highlighting the importance of future income expectations. Meanwhile, MPC remains significant but declines from 12.49% in Period 2 to 16.22% in Period 5, showing a shift toward long-term financial planning over immediate consumption responses. Fiscal variables gain relevance, with government debt rising to 12.01% by Period 5, while government expenses (12.27%) and revenue (9.44%) contribute to long-term consumption stability. Subsidies and transfers remain minimal, peaking at just 1.14%, indicating limited influence.

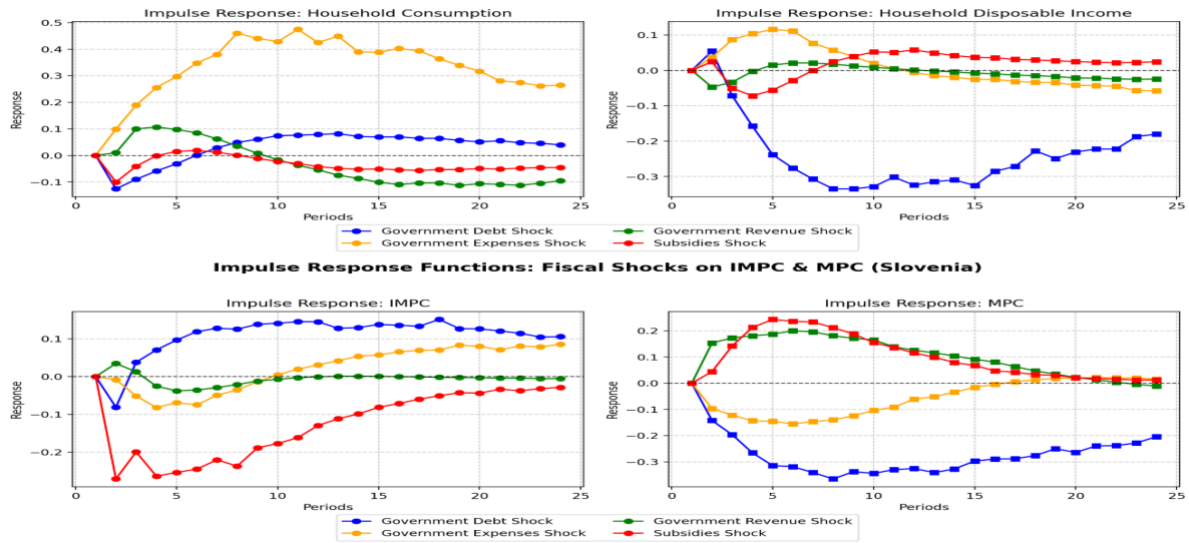
Figure 1: The Impulse Response Functions (IRFs) for the Czech Republic



Source: Based on estimation

The Impulse Response Functions (IRFs) for the Czech Republic show how fiscal shocks affect households over 24 periods. Household Consumption increases after a government expense shock, peaking at 0.45 before declining. This suggests that higher government spending stimulates demand in the short run. Government debt has a moderate positive effect (0.15), while subsidies reduce consumption by -0.10, indicating that households may save subsidies instead of spending them. Household Disposable Income drops by -0.3 after a government debt shock, showing a crowding-out effect on private income. Subsidies increase income by 0.08, supporting short-term stability. Government expenses raise income by 0.10, but the effect fades, suggesting temporary fiscal support. IMPC rises to 0.15 after government debt and expense increases, meaning households expect higher future consumption. Subsidies reduce IMPC by -0.20, showing precautionary savings behaviour. MPC falls by -0.15 after government debt shocks, showing a decline in immediate spending. Subsidies increase MPC by 0.12, suggesting direct cash transfers boost short-term consumption. Government revenue stabilizes consumption at 0.1, showing a neutral impact on household spending.

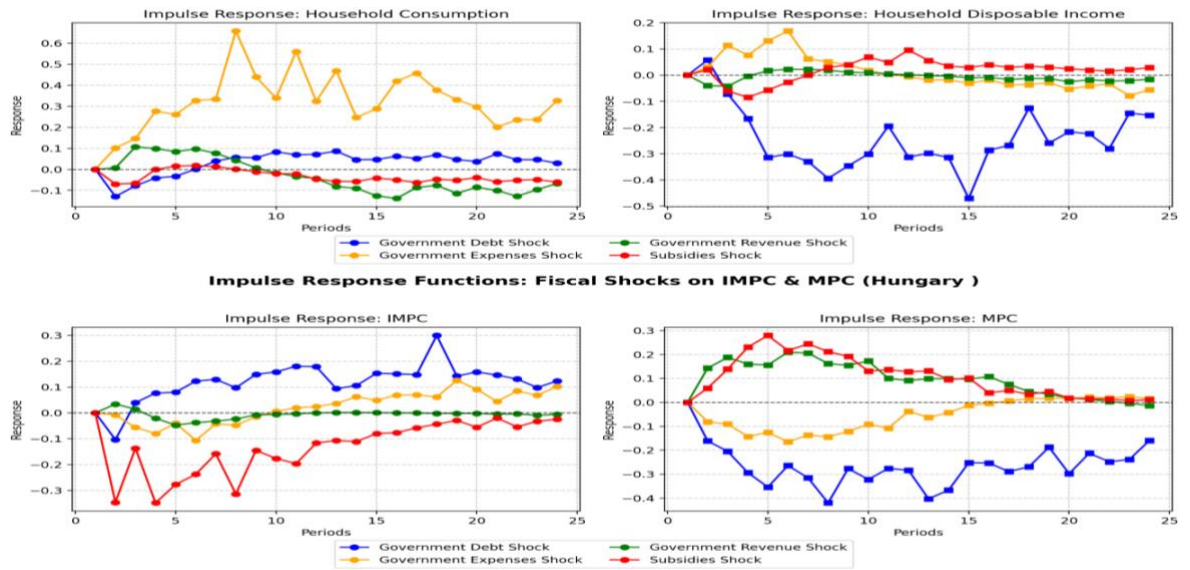
Figure 2: The Impulse Response Functions (IRFs) for Slovenia



Source: Based on estimation

The Impulse Response Functions (IRFs) for Slovenia show how fiscal shocks influence household economic behaviour over 24 periods. Household Consumption rises with a government expense shock, peaking at 0.48 before stabilizing. Government debt increases consumption slightly (0.12), while subsidies reduce it by -0.08, suggesting that households save rather than spend subsidies. Household Disposable Income falls by -0.32 after a government debt shock, showing fiscal tightening effects. Subsidies increase income by 0.09, providing short-term support. Government expenses raise income by 0.11, but the effect fades. IMPC increases to 0.13 with government debt and expenses, meaning households expect future spending growth. Subsidies lower IMPC by -0.21, reflecting precautionary savings. MPC drops by -0.17 after a government debt shock, while subsidies increase it by 0.14, indicating direct transfers boost short-term spending. This suggests government expenses drive consumption, while debt weakens disposable income and intertemporal spending expectations

Figure 3: The Impulse Response Functions (IRFs) for Hungary



Source: Based on estimation

Impulse Response Functions (IRFs) for Hungary show how fiscal shocks influence household consumption, income, and spending behaviour over 24 periods. Household Consumption rises sharply with a government expense shock, peaking at 0.65 before fluctuating. Government debt has a weaker positive effect (0.13), while subsidies reduce consumption by -0.09, suggesting households prefer saving subsidies. Household Disposable Income drops by -0.42 after a government debt shock, indicating a strong contractionary effect. Subsidies increase income by 0.12, while government expenses boost it by 0.18 but with a temporary effect. IMPC increases to 0.30 with government debt and expense shocks, meaning households anticipate higher future consumption. Subsidies lower IMPC by -0.25, reflecting uncertainty. MPC falls by -0.22 after government debt shocks, while subsidies increase it by 0.16, showing that direct cash transfers support short-term spending. This suggests government expenses boost consumption, while debt significantly weakens income and spending expectations

Table 10: Forecasted Household Consumption for Czech Republic, Hungary, and Slovenia

Period	Czech Republic	Hungary	Slovenia
1	0.0157	0.0229	0.0155
2	0.0168	0.0235	0.0159
3	0.0179	0.0241	0.0166
4	0.0186	0.0246	0.0170
5	0.0193	0.0248	0.0169

Period	Czech Republic	Hungary	Slovenia
6	0.0197	0.0256	0.0171
7	0.0201	0.0268	0.0172
8	0.0206	0.0270	0.0177
9	0.0210	0.0274	0.0182
10	0.0218	0.0280	0.0186

Note: Values represent forecasts of household consumption over the next 10 periods generated using an XGBoost ML model

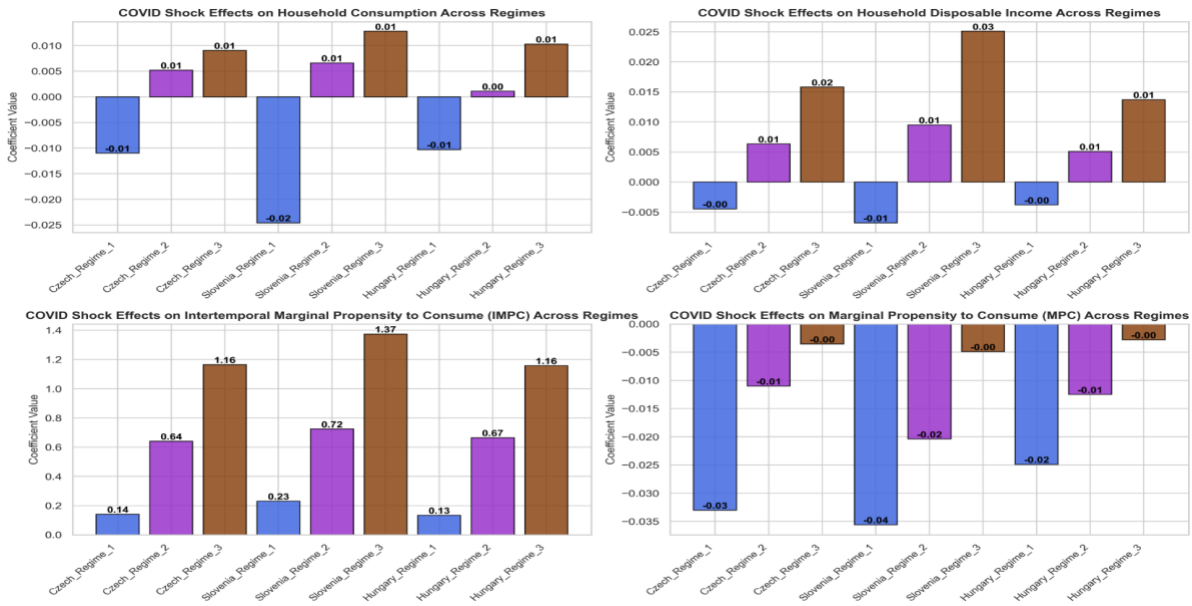
The 10-period forecast indicates that the household consumption of Hungary will remain higher than both the Czech Republic and Hungary. Meanwhile, consumption in the Czech Republic and Slovenia follows a very similar, gradually increasing trend. This suggests stronger consumption momentum in Hungary, while the other two countries show comparable economic dynamics over the forecast horizon.

Table 11: Comparison of Covid shock for all countries across three regimes

Variable	Consumption	Disposable Income	IMPC	MPC
Czech Republic (Regime 1)	-0.011	-0.0045	0.1403	-0.033
Czech Republic (Regime 2)	0.0052	0.0063	0.641	-0.011
Czech Republic (Regime 3)	0.0091	0.0158	1.1646	-0.0035
Hungary (Regime 1)	-0.0153	-0.0051	0.2097	-0.0441
Hungary (Regime 2)	0.0063	0.0116	0.7983	-0.0193
Hungary (Regime 3)	0.0167	0.0241	1.3222	-0.0045
Slovenia (Regime 1)	-0.0246	-0.0068	0.2308	-0.0356
Slovenia (Regime 2)	0.0066	0.0095	0.7241	-0.0204
Slovenia (Regime 3)	0.014	0.0220	1.364	-0.005

Source: Based on estimation

Figure 4: Comparison across three countries of Covid shock



Source: Based on estimation

In Regime 1, all three countries are significantly impacted by the COVID shock, particularly in household consumption and disposable income. The Czech Republic sees a slight decline in consumption (-0.01) and income (0.00), showing minimal effect at the start. Slovenia, however, faces a larger decrease in consumption (-0.02) and a mild drop in income (-0.01), reflecting the severe initial hit. Hungary shows a more moderate impact with slightly negative effects on consumption (-0.01) and no significant change in income, indicating that Hungary's economy was somewhat more resilient initially.

As the crisis progresses into Regime 2, all three countries show signs of recovery, but the impact varies. The Czech Republic experiences a mild recovery in consumption (+0.01) and a slight increase in income (+0.01). Slovenia shows a stabilization with minimal changes in both consumption and income. The Czech Republic also sees a notable improvement in IMPC (+1.16), indicating a shift towards greater future-oriented consumption. Slovenia's IMPC improves slightly (+0.72), showing that households are adjusting their consumption behaviour towards the future but at a slower rate. Hungary, in Regime 2, also sees a recovery in consumption (+0.00) and MPC (+0.01), along with a mild improvement in IMPC (+0.67), suggesting that Hungary's fiscal interventions started yielding some positive effects.

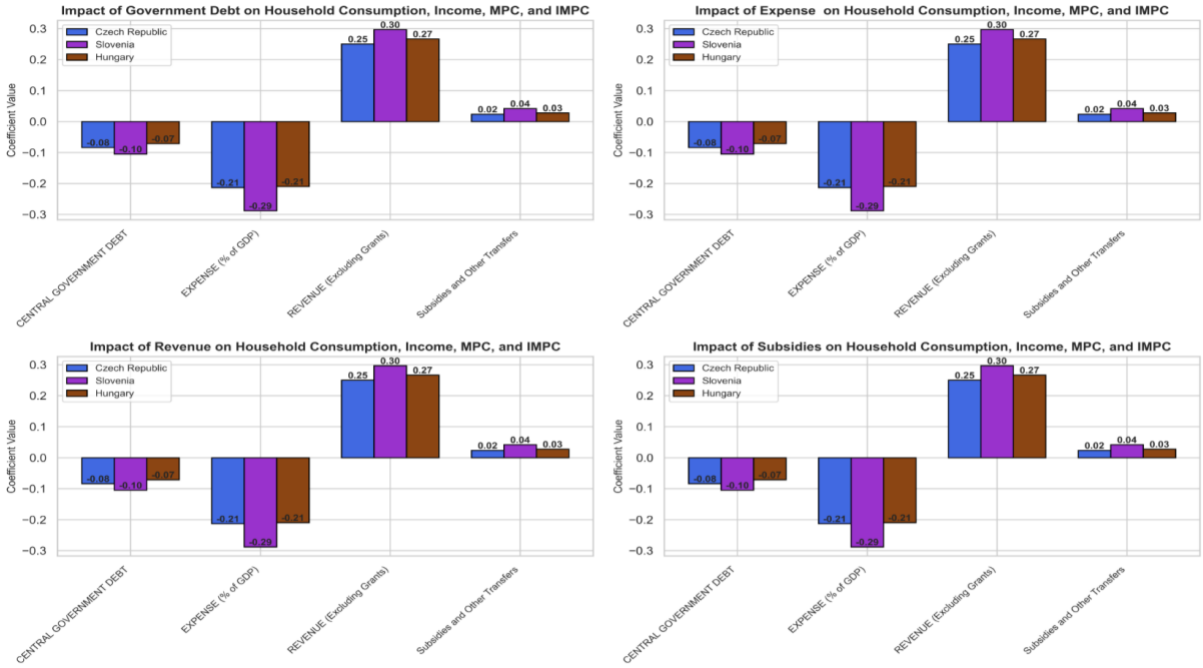
By Regime 3, all countries have recovered to varying extents. Hungary experiences the most pronounced recovery, with household consumption improving (+0.01), disposable income rising significantly (+0.03), and IMPC reaching its peak at 1.16. This indicates that Hungary has made the strongest recovery in household consumption and long-term consumption planning. The Czech Republic continues to show positive effects with modest improvements in consumption (+0.01) and income (+0.02), although its MPC remains negative (-0.02). Slovenia also shows some improvement in consumption (+0.01) and income (+0.02) but remains more cautious in its recovery, with a slight increase in IMPC (+0.72). In terms of MPC, all countries show minimal improvements, but the positive effects of fiscal policies are evident, as Hungary's MPC shows the smallest negative value (-0.01), while Czech Republic and Slovenia show minimal negative coefficients.

Table 12: Comparison of fiscal impact for all countries

Variable	Czech Republic - Consumption	Czech Republic - Income	Czech Republic - IMPC	Czech Republic - MPC	Slovenia - Consumption	Slovenia - Income	Slovenia - IMPC	Slovenia - MPC	Hungary - Consumption	Hungary - Income	Hungary - IMPC	Hungary - MPC
Govt.Debt	-0.083	-0.125	-7.025	-0.330	-0.105	-0.188	-8.244	-0.550	-0.071	-0.133	-6.947	-0.447
Expense	-0.213	-0.082	15.866	0.297	-0.288	-0.118	16.581	0.335	-0.209	-0.076	17.67	0.253
Revenue	0.250	0.120	-20.029	0.319	0.297	0.113	-22.264	0.389	0.266	0.127	-21.853	0.379
Subsidies	0.023	0.029	3.453	-0.083	0.042	0.035	3.842	-0.117	0.027	0.030	3.547	-0.129

Source: Based on estimation

Figure 5: Comparison across three countries of fiscal variables



Source: Based on estimation

The Czech Republic experiences a negative impact from Central Government Debt on household consumption (-0.08) and income (-0.12). This effect is even stronger for MPC (-0.33) and IMPC (-7.03), indicating that high debt severely restricts consumption and income growth over time. Slovenia shows a similar pattern, with consumption (-0.105) and income (-0.18) negatively affected, alongside substantial declines in MPC (-0.55) and IMPC (-8.24). In contrast, Hungary faces a milder negative impact on consumption (-0.07) and income (-0.13), with MPC remaining strongly negative (-6.95) , while IMPC is only slightly negative (-0.44).

Regarding expenses (% of GDP), the Czech Republic experiences a significant negative effect on household consumption (-0.21) and income (-0.08), but MPC (+0.30) and IMPC (+15.87) suggest a strong recovery in consumption dynamics. Slovenia faces persistent negative effects on consumption (-0.28) and income (-0.11), although MPC (+0.33) and IMPC (+16.58) indicate signs of recovery. Hungary observes a moderate negative impact on consumption (-0.20) and income (-0.07), but a strong positive response in MPC (+0.25) and IMPC (+17.67), signalling that increased government spending contributed positively to household consumption during the recovery phase.

For revenue (excluding grants), the Czech Republic records positive effects on consumption (+0.25) and income (+0.12), although IMPC shows a substantial negative impact (-20.03), with MPC slightly positive (+0.32). Slovenia experiences positive impacts on consumption (+0.29) and income (+0.11), but MPC (+0.39) and IMPC (-22.23) suggest mixed short- and long-term effects. Hungary demonstrates positive effects on consumption (+0.26) and income (+0.12), with MPC (+0.37) and IMPC (-21.85) reflecting similarly mixed outcomes.

Finally, subsidies and other transfers exert moderate positive effects on consumption and income across all three countries. The Czech Republic sees slight increases in consumption (+0.02) and income (+0.29), with IMPC at +3.45 and MPC slightly negative (-0.08). Slovenia shows more pronounced gains in consumption (+0.04), income (+0.035), IMPC (+3.84), and a negative MPC (-0.11). Hungary demonstrates positive effects on consumption (+0.027) and income (+0.030), with MPC (-0.129) and IMPC (3.547) reflecting similarly mixed outcomes.

Overall, Hungary demonstrates the best performance, showing milder negative impacts from debt and expenses and stronger positive responses in MPC and IMPC during recovery phases. The Czech Republic shows moderate recovery with mixed results, while Slovenia faces the largest negative impacts and slower recovery, indicating more limited fiscal effectiveness.

5. Findings & Policy Recommendations

The analysis revealed that the COVID-19 shock had the strongest negative impact on Slovenia during Regime 1, with household consumption declining by -0.0246 and disposable income by -0.0068. Hungary experienced a moderate contraction, while the Czech Republic recorded the smallest declines. In Regime 2, all three countries began to recover, with Hungary showing the fastest improvement in both consumption and income. By Regime 3, Hungary had the most significant rebound, as consumption increased by +0.0167 and income by +0.024, while Slovenia and the Czech Republic recovered more gradually.

Government subsidies had moderately positive effects across all countries. Hungary experienced gains in consumption (+0.027) and income (+0.030), with an Intertemporal Marginal Propensity to Consume (IMPC) of +3.547, although its short-term MPC was slightly negative at -0.129. The Czech Republic showed similar results, with an IMPC of +3.453. Slovenia recorded the highest IMPC (+3.842) among the three countries, but also had a negative MPC (-0.117), indicating limited short-term responsiveness to subsidies.

Government spending emerged as the most effective fiscal tool in stimulating economic recovery. Hungary demonstrated the strongest long-term effects, with an IMPC of +17.67 and a positive MPC of +0.253. The Czech Republic followed closely, with an IMPC of +15.87 and an MPC of +0.297. Slovenia, though slightly behind, still showed solid results with an IMPC of +16.58 and MPC of +0.335, suggesting a slower but steady impact.

Government revenue had positive short-term effects on consumption and income, particularly in Slovenia, which recorded the highest short-term consumption gain (+0.297) and MPC (+0.389). Hungary also saw respectable gains (+0.266 and +0.379, respectively). However, the long-term effects of revenue measures were negative across the board, with IMPC values of -21.85 for Hungary, -20.03 for the Czech Republic, and -22.26 for Slovenia. This suggests that while revenue policies may stimulate immediate consumption, they have adverse long-term implications.

Government debt initially reduced both consumption and income. Hungary experienced the mildest long-term negative effect (IMPC -6.947), followed by the Czech Republic (-7.025) and Slovenia (-8.244), indicating that Hungary's fiscal management was comparatively more effective in mitigating the negative impact of debt.

Overall, Hungary outperformed the other countries in terms of fiscal response effectiveness, especially in supporting long-term consumption. The Czech Republic showed moderate but steady progress, while Slovenia faced more subdued and delayed effects. Hungary should continue to apply targeted government spending and maintain prudent debt management. The Czech Republic should prioritize expenditure-based fiscal strategies, as revenue-focused measures showed weak long-term effects. Slovenia, which endured the greatest initial impact, should improve its short-term support mechanisms and reinforce debt management to enhance fiscal resilience.

In conclusion, all three countries are advised to target key sectors such as manufacturing and construction to strengthen recovery and resilience. Furthermore, the use of real-time economic indicators like MPC and IMPC can play an important role in shaping responsive and effective fiscal policies.

Conclusion

This study confirms that the COVID-19 shock negatively impacted household consumption and disposable income in the Czech Republic, Hungary, and Slovenia, with Slovenia being the most severely affected during Regime 1. Hungary experienced a moderate decline, while the Czech Republic recorded the smallest contraction. Over time, all three countries showed signs of recovery, with Hungary recovering the fastest - largely due to the timely and targeted implementation of fiscal measures such as subsidies, increased revenues, and public spending. The Czech Republic followed a more gradual recovery path, particularly in forward-looking consumption (as

reflected by IMPC), whereas Slovenia's recovery was slower and more uneven. Integrating the Markov Switching VAR (MS-VAR) model with the Extreme Gradient Boosting (XGBoost) algorithm, this analysis successfully captures both regime-dependent dynamics and nonlinear relationships between fiscal policy and household behaviour. This dual-methodological approach enhances the robustness of the results and highlights the varying effectiveness of fiscal tools across different national contexts.

However, the study has limitations, particularly its exclusive focus on fiscal policy variables. It assumes fiscal measures as the primary driver of recovery, while other important factors - such as trade exposure, sector-specific shocks, and monetary policy - are not included in the analysis. Future research should incorporate these dimensions for a more comprehensive understanding of macroeconomic recovery dynamics.

Overall, the findings underscore the importance of context-specific, data-driven fiscal policies in managing economic crises. While such measures are essential to cushioning shocks and promoting recovery, their effectiveness depends on how well they are tailored to each country's institutional, economic, and social conditions.

Credit Authorship Contribution Statement

Tuhin G M Al Mamun developed the core idea and defined the research objectives, including the economic framework related to fiscal policy and household savings during the COVID-19 crisis. He also designed the methodological approach, specifically the application of the Markov Switching Vector Auto Regression (MS-VAR) model. Rahim Abdur conducted background research on fiscal interventions implemented in Central and Eastern Europe and examined their socio-economic impacts during the COVID-19 pandemic.

Conflict of Interest Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Auerbach, A. J., Gorodnichenko, Y., & Murphy, D. (2020, May). Effects of fiscal policy on credit markets. In AEA Papers and Proceedings, Volume 110, 119-124. Broadway, Suite 305, Nashville, TN 37203: American Economic Association. https://doi.org/10.1257/pandp.20201074

Alesina, A., & Ardagna, S. (2010). Large changes in fiscal policy: taxes versus spending. Tax policy and the economy, 24(1), 35-68. https://www.journals.uchicago.edu/doi/abs/10.1086/649828

Auerbach, A. M., & Thachil, T. (2021). How does Covid-19 affect urban slums? Evidence from settlement leaders in India. *World Development*, 140, 105304. https://doi.org/10.1016/j.worlddev.2020.105304

Auerbach, A. J., & Gorodnichenko, Y. (2012). Measuring the output responses to fiscal policy. *American Economic Journal: Economic Policy*, 4(2), 1-27. https://doi.org/10.1257/pol.4.2.1

Attanasio, O. P., & Weber, G. (2010). Consumption and saving: models of intertemporal allocation and their implications for public policy. *Journal of Economic Literature*, 48(3), 693-751. https://doi.org/10.1257/jel.48.3.693

Auerbach, J., & Miller, B. F. (2020). COVID-19 exposes the cracks in our already fragile mental health system. *American Journal of Public Health,* 110(7), 969-970. https://doi.org/10.2105/AJPH.2020.305699

Buchanan, J. M. (1976). Barro on the Ricardian equivalence theorem. *Journal of Political Economy*, 84(2), 337-342. https://www.journals.uchicago.edu/doi/abs/10.1086/260436

Barro, R. J. (1979). On the determination of the public debt. *Journal of Political Economy,* 87(5, Part 1), 940-971. https://doi.org/10.1086/260807

Blanchard, O., Tirole, J., Gollier, C., Reguant, M., Rodrik, D., Stantcheva, S., ... & Tyson, L. (2021). Major future economic challenges. https://inis.iaea.org/search/search.aspx?orig_q=RN:52064500

Bachmann, R., Gonschor, M., Korfhage, T., & Wübker, A. (2023). Covid-19 and life satisfaction across Europe. *Applied Economics Letters,* 30(5), 635-639. https://doi.org/10.1080/13504851.2021.2005766

Bhattarai, S., Chatterjee, A., & Park, W. Y. (2021). Effects of US quantitative easing on emerging market economies. *Journal of Economic Dynamics and Control,* 122, 104031. https://doi.org/10.1016/j.jedc.2020.104031

Blanchard, M. R., Southerland, S. A., Osborne, J. W., Sampson, V. D., Annetta, L. A., & Granger, E. M. (2010). Is inquiry possible in light of accountability? A quantitative comparison of the relative effectiveness of guided inquiry and verification laboratory instruction. *Science Education*, 94(4), 577-616. https://doi.org/10.1002/sce.20390

Blanchard, O., & Fischer, S. (1989). Lectures on macroeconomics. MIT press. https://www.scirp.org/reference/referencespapers?referenceid=1958402

Baker, S. R., Bloom, N., Davis, S. J., & Terry, S. J. (2020). Covid-induced economic uncertainty (No. w26983). National Bureau of Economic Research. https://doi.org/10.3386/w26983

Carroll, C. D., & Kimball, M. S. (1996). On the concavity of the consumption function. *Econometrica: Journal of the Econometric Society*, 981-992. https://doi.org/10.2307/2171853

Coibion, O., Gorodnichenko, Y., & Weber, M. (2020). The cost of the covid-19 crisis: Lockdowns, macroeconomic expectations, and consumer spending (No. w27141). *National Bureau of Economic Research*. https://doi.org/10.3386/w27141

Christelis, D., Georgarakos, D., Jappelli, T., Pistaferri, L., & Van Rooij, M. (2021). Heterogeneous wealth effects. *European Economic Review*, 137, 103805. https://doi.org/10.1016/j.euroecorev.2021.103805

Chetty, R., Friedman, J. N., Hendren, N., Stepner, M., & The Opportunity Insights Team. (2020). How did COVID-19 and stabilization policies affect spending and employment? A new real-time economic tracker based on private sector data, Volume 91, 1689-1699. Cambridge, MA: *National Bureau of Economic Research*. https://api.includere.co/uploads/1596748987_tracker_paper.pdf

Corsetti, G., Meier, A., & Müller, G. J. (2012). What determines government spending multipliers? *Economic Policy,* 27(72), 521-565. https://doi.org/10.1111/j.1468-0327.2012.00295.x

Friedman, M. (1957). The permanent income hypothesis. In A theory of the consumption function (pp. 20-37). Princeton University Press. https://www.nber.org/system/files/chapters/c4405/c4405.pdf

Feldstein, M. (1982). Domestic saving and international capital movements in the long run and the short run (No. w0947). *National Bureau of Economic Research*. https://doi.org/10.3386/w0947

Galí, J. (2020). The effects of a money-financed fiscal stimulus. *Journal of Monetary Economics*, 115, 1-19. https://doi.org/10.1016/j.jmoneco.2019.08.002

Ganong, P., Jones, D., Noel, P. J., Greig, F. E., Farrell, D., & Wheat, C. (2020). Wealth, race, and consumption smoothing of typical income shocks (No. w27552). Cambridge, MA: National Bureau of Economic Research. https://www.aeaweb.org/conference/2023/program/paper/KHBNAYEz

Glover, R. E., Van Schalkwyk, M. C., Akl, E. A., Kristjannson, E., Lotfi, T., Petkovic, J., ... & Welch, V. (2020). A framework for identifying and mitigating the equity harms of COVID-19 policy interventions. *Journal of Clinical Epidemiology*, 128, 35-48. https://doi.org/10.1016/j.jclinepi.2020.06.004

Ganong, P., Jones, D., Noel, P. J., Greig, F. E., Farrell, D., & Wheat, C. (2020). Wealth, race, and consumption smoothing of typical income shocks (No. w27552). *Cambridge, MA: National Bureau of Economic Research*. https://doi.org/10.3386/w27552

Giavazzi, F. (2021). The Origins of the Idea of European Integration: A German Perspective. The Liberal Heart of Europe: Essays in Memory of Alberto Giovannini, 25. https://doi.org/10.1007/978-0-030-60368-7

Jappelli, T., & Pistaferri, L. (2014). Fiscal policy and MPC heterogeneity. *American Economic Journal: Macroeconomics*, 6(4), 107-136. https://doi.org/10.1257/mac.6.4.107

Johnson, A. (2006). The effects of FDI inflows on host country economic growth. The Royal Institute of technology. Centre of Excellence for studies in Science and Innovation http://www.infra.kth.se/cesis/research/publications/working papers5

Kaplan, G., & Violante, G. L. (2014). A model of the consumption response to fiscal stimulus payments. *Econometrica*, 82(4), 1199-1239. https://doi.org/10.3982/ECTA10528

Kraay, A. (2000). Household saving in China. *The World Bank Economic Review*, 14(3), 545-570. https://doi.org/10.1093/wber/14.3.545

Leith, C., & Wren-Lewis, S. (2008). Interactions between monetary and fiscal policy under flexible exchange rates. *Journal of Economic Dynamics and Control*, 32(9), 2854-2882. https://doi.org/10.1016/j.jedc.2007.11.005

Mian, A. R., Straub, L., & Sufi, A. (2021). What explains the decline in r*? Rising income inequality versus demographic shifts. Rising Income Inequality Versus Demographic Shifts (September 22, 2021). University of Chicago, Becker Friedman *Institute for Economics Working Paper,* (2021-104). https://papers.ssrn.com/sol3/Delivery.cfm?abstractid=3916345

Modigliani, F., & Brumberg, R. (1954). Utility analysis and the consumption function: An interpretation of cross-section data. Franco Modigliani, 1(1), 388-436. https://doi.org/10.7551/mitpress/1923.003.0004

Parker, J. A., Souleles, N. S., Johnson, D. S., & McClelland, R. (2013). Consumer spending and the economic stimulus payments of 2008. *American Economic Review*, 103(6), 2530-2553. https://doi.org/10.1257/aer.103.6.2530

Ramey, V. A. (2020). The macroeconomic consequences of infrastructure investment, Volume 10, w27625. Cambridge, MA: *National Bureau of Economic Research*. https://www.nber.org/system/files/working_papers/w27625/w27625.pdf

Reinhart, C. M., & Rogoff, K. S. (2010). Growth in a Time of Debt. *American Economic Review*, 100(2), 573-578. https://doi.org/10.1257/aer.100.2.573