An Analysis of the Effects of US Monetary Policy on Assets Prices: A Markov Switching Approach with Commodities

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Abstract

Commodities have always been front and center in any economy through the process of production, consumption and distribution of goods and services. As such, regardless of the level of development of an economy – developing, frontier, emerging, or developed – changes in their prices carry a wide range of implications both domestically and globally. This study examines the effects of US monetary policy on commodity prices. Specifically, it empirically assesses how the form of policy regime, conventional or unconventional, implemented by US monetary authorities affects these prices using a two-state Markov switching methodology with yearly data spanning the 1995-2022 period. Findings highlight that commodity prices are sensitive to monetary policy irrespective of the regime. Moreover, it is found that conventional monetary policy practices appear more impactful than unconventional ones.

Keywords: Commodity price, Markov switching, Monetary policy.

JEL Classification: E52, E58.

I- Introduction

Monetary policy along with its implementation has undergone unparalleled changes since the 2007-2008 financial crisis. The sheer scope of these changes across the globe, both quantitatively and qualitatively, has led some scholars to argue that long-held paradigms and teachings pertaining to monetary policy have been recast. Furthermore, the COVID-19 pandemic, by exposing systemic fragilities in even the most advanced economies, has reinforced this stylized fact.

In March of 2020, the Fed's balance sheet topped $4.6 trillion for the first time in history, with some analysts even projecting that this figure would more than double to reach $10 trillion by year's end.[1] In the wake of the COVID-19 outbreak, the Federal Reserve (Fed) unambiguously laid out a *do-whatever-it-takes* approach to allay market turbulences and prop up economic growth. In this new context, a host of legitimate questions may be raised regarding the repercussions of such massive shifts in central banks' actions on asset prices. Indeed, most asset prices have experienced swings like a roller coaster ride, which has in turn notably affected the wealth of economic agents.

The pertinence of the current work is two-fold. First, asset prices underpin the wealth of economic agents and performances of economies. Considering that wealth is essential in determining living standards in a society, understanding the drivers of asset prices in general and commodity prices in particular still carries contemporary relevance in economic policy formulation in the US and beyond. Second, changes in US money supply directly affect the creation of riches in foreign countries via the commodity pricing channel. The ramifications of these changes shape income distribution and overall investment levels especially in commodity-dependent economies, which are mostly developing, frontier or emerging.

Assets take a variety of forms in an economy. Among others, they can be financial instruments or securities (stocks, bonds, derivatives, etc.), commodities (gold, diamond, silver, copper, oil, wheat, cocoa, coffee, etc...), or real estate (buildings, lands, etc.). In an attempt to provide a comprehensive understanding of the impacts of monetary policy over time, this paper zooms in on commodities. With that backdrop, this investigation is in practice concerned with assessing the extent of impacts of different policy choices pursued by the Fed, whether conventional or unconventional, on commodity prices.

The structure of the paper revolves around four pillars. Next, a global review of the literature as it pertains to monetary policy and assets prices is conducted. A presentation of the methodology is in order with the third pillar, whereas results and policy implications are highlighted through the fourth. At last, a fifth pillar is used to make concluding remarks.

[1] To add more perspective to the monumental changes that occurred, the trend shows a sharp increase starting in February of 2020. Available at https://www.federalreserve.gov/monetarypolicy/bst_recenttrends.htm).

II- Literature Review

Many scholars from a broad spectrum of the field have chimed in on the issue of monetary policy and its interaction with asset prices. This interaction has been investigated in both developed and developing nations for a variety of assets.

Henderson (2018) endeavors to understand how US monetary policy impacts prices in the agricultural commodity market. He typically argues that monetary policy, through the interest rate channel, does affect commodity prices. For instance, higher interest rates depress prices, whereas lower interest rates exert an upward pressure on them. However, he remains cautious on the magnitude of these impacts, for it depends on some other factors such as the relationship between US and international interest rates, economic growth − specifically in developing countries – inflation, and exchange rates.

It is well-known that expectations are crucial in macroeconomics. Chen et al. (2015) examine the nexus between monetary policy and asset prices by introducing a process capturing the process of expectations formation. They focus on the use of monetary policy as a stabilizing tool used by authorities to respond to movements in assets prices. Their analysis incorporates a DSGE model applied to the US economy. After defining a range of calibration for parameters, evidence is found that there exists an optimal set of policy choices by the central bank to control fluctuations in asset prices. On the other hand, market bubbles can generate significant economy-wide risks. Thus, understanding how monetary policy influences them has elicited research interest. Gali and Gambetti (2015), among others, shed light on this phenomenon using a time-varying coefficients VAR. They find empirical evidence of persistent price increases as a result of contractionary monetary policy, while acknowledging that such a finding is "at odds" with "conventionally "admitted explanations in the literature. Paul (2020) also explores the effects of US monetary policy on both asset prices and the real economy. He considers a structural monetary policy shock with a VAR approach that accommodates high-frequency surprises. Results indicate that stock and house prices exhibit relatively lower reactions than output.

Other than asset prices, it is noteworthy that a factor such as liquidity can play an important role when trying to figure out the effects of monetary policy. Benigno and Nistico (2017) innovate by building a model including different categories of assets, namely, safe and "pseudo-safe," with varying liquidity. In a nutshell, two main results emanate from the study. Firstly, interest rate spreads go up as the liquidity of "pseudo-safe" assets slumps following a shock. Secondly, expansionary monetary policy can guard interest rates against fluctuations when there is a liquidity shock.

Beyond the US, the world's second largest economy, China, has drawn some interest from scholars Zhang and Huang (2017). They target the asset price – specifically, bond price – transmission channel of monetary policy. It is empirically determined that monetary policy drives fluctuations in bond yields. However, the bond market exerts limited impacts on the real economy. In the short run, bond yields show conclusive transmission effects on macro variables – for instance, consumption, investment, and the price level – but not in the long run.

In addition, Ha (2021) looks into the spillover effects of US monetary policy in other parts of the world. To capture these effects, the author considers five economies, namely, Australia, Canada, New Zealand, South Korea, and the United Kingdom, in an open-economy SVAR framework using data from 2000 to 2017. A few interesting findings are derived from the study, but most importantly, it establishes that US monetary policy remains more impactful on foreign financial markets than domestic monetary policies and other shocks taking place in those economies. The author explains that the main transmission channels of US monetary policy are global financial sentiments, US asset prices, and exchange rates.

III- Methodology and Data

1- Methodology

Time series modelling posits that the characteristics ─ means and variance ─ of a series should typically be immutable for regression analysis purposes. However, real-world micro- and macro-economic data seldom, if at all, behave in accordance with that assumption. Markov switching modelling proves to be a powerful tool addressing this shortcoming. It is one of the most utilized regime-changing models in economics and finance. It is a nonlinear method that can accommodate complex, dynamic, and different behavioral patterns of time-series under a variety of states or regimes. The current research work favors it to probe the impacts of monetary policy on commodity prices because of this key feature. Moreover, consequential shifts in monetary policy have occurred in the US and the world in the aftermath of systemic shocks such as the 2007-2008 financial crisis and the COVID-19 pandemic.

The theoretical framework in this study is adapted from the landmark work by Hamilton (1989).[2] At time t, suppose that A_t is a random variable, capturing asset prices, namely, commodity prices, whose value is derived from a process that depends on an unobserved (discrete) state variable S_t. There are three regressors ─ accounting for monetary policy (MON), output (OUT), and exchange rate (ER) ─ at time t-1. For simplification's sake, two unobserved states, 1 or 2, are considered. State 1 is characterized by unconventional monetary policy, whereas periods of conventional monetary policy practices are captured by state 2. In that environment,

$$A_t = \alpha_{s_t} + \beta_{1s_t} MON_{t-1} + \beta_{2s_t} OUT_{t-1} + \beta_{3s_t} ER_{t-1} + \mu_t \quad (1),$$

where β's and μ respectively represent coefficients and the error term, with $\mu_t \sim N(0, \sigma_{s_t}^2)$. Furthermore, α_{s_t} is the intercept and $\sigma_{s_t}^2$ denotes the variance. The transition process from one state to another follows a first-order Markov chain with the probabilities:

$p_t = P(s_t = 1 | s_{t-1} = 1, R_{t-1}) = p(R_{t-1})$, (2)
$1 - p_t = P(s_t = 2 | s_{t-1} = 2, R_{t-1}) = 1 - p(R_{t-1})$, (3)
$q_t = P(s_t = 2 | s_{t-1} = 2, R_{t-1}) = q(R_{t-1})$, (4)
$1 - q_t = P(s_t = 1 | s_{t-1} = 2, R_{t-1}) = 1 - q(R_{t-1})$, (5)

where R_{t-1} is a given vector of variables fully known and available at t-1, which affects transmission probabilities between states, i.e., 1 to 2 or 2 to 1. Equation (1) is estimated using the maximum likelihood technique, and probabilities p_t, $1 - p_t$, q_t, and $1 - q_{t-1}$ are derived. The transition matrix of probabilities can therefore be written in this form:

$$p_t = \begin{pmatrix} p_{t_{11}} & p_{t_{12}} \\ p_{t_{21}} & p_{t_{22}} \end{pmatrix} = \begin{pmatrix} p(R_{t-1}) & 1 - q(R_{t-1}) \\ 1 - p(R_{t-1}) & q(R_{t-1}) \end{pmatrix} \quad (6)$$

2- Data

The empirical work is carried out with data sourced from the *UNCTADStat*, a statistical database produced by the United Nations Conference on Trade and Development (UNCTAD), and the World Bank Group's *World Development Indicators (WDI)*. Various data limitations as well as reliability concerns have constrained the period of interest to 1995-2022. Four series are included in the study: (i) commodity price index (I_c), (ii) broad money (M2), (iii) output (RGDP), and (iv) real effective exchange rate (REER).

IV- Results and Policy Implications

1- Results

Exhibit 1 reports the main statistical characteristics of the four series in the dataset.

Exhibit 1 – Descriptive Statistics

	I_c	M2	RGDP	REER
Mean	105.2607	1.31E+13	1.62E+13	110.5791
Median	103.15	1.26E+13	1.64E+13	111.6208
Maximum	207.5	3.11E+13	2.09E+13	126.5669
Minimum	38.4	4.65E+12	1.11E+13	95.00847
Std. Dev.	49.62482	6.69E+12	2.74E+12	9.092518
Observations	28	28	28	28

To justify the use of the Markov switching estimation method, it is imperative to establish nonlinearity. Specifically, this study looks closely at monetary policy and its impacts on commodity prices. In that regard, three sets of tests are performed. First, a BDS (Brock, Dechert and Scheinkman, 1987) nonparametric test is conducted and summarized in Exhibit 2. It suggests nonlinear serial dependence in the distribution of series, as the null hypothesis is rejected through multiple dimension thresholds. Second, an ANOVA-test for inequality is performed on the mean. Null hypothesis is rejected, which shows stark statistical differences in the means using different sample categories within the series (Exhibit 3). Third, unit root tests compiled in Exhibit 4 show that there is a unit

[2] A comprehensive discussion of Markov-switching is available in the literature. See also Gulen et al. (2011), and Merabet (2021), among others, for further discussions.

root using Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) techniques. These statistical tests point to nonlinearity and the likely existence of more than one regime in the M2 series making it empirically relevant to adopt a Markov-Switching process.

Exhibit 2 – BDS Test of Nonlinearity

Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.174098	0.007898	22.04413	0
3	0.291152	0.011398	25.54443	0
4	0.38121	0.012328	30.9221	0
5	0.41405	0.011678	35.4565	0
6	0.427282	0.010242	41.71828	0

Exhibit 3 – ANOVA Test

Method		df	value	Prob.
Anova F-test		(4, 23)	82.46005	0
Analysis of Variance				
Source of Variation		**df**	**Sum of Sq.**	**Mean Sq.**
Between		4	6.643075	1.660769
Within		23	0.463227	0.02014
Total		27	7.106302	0.263196

Exhibit 4 – Unit Root Tests (with Constant and Trend)

	t-Statistic	Prob.	1% level	5% level	10% level
ADF	-2.43963	0.3525	-4.35607	-3.59503	-3.23346
PP	-1.56029	0.7819	-4.33933	-3.58753	-3.22923

Markov switching estimation results are documented in Exhibit 5. Expansionary monetary policy, whether unconventional (State 1) or conventional (State 2), appears to be statistically significant putting an upward on commodity prices. Indeed, with the US accounting for about a quarter of the world economy, increasing liquidity in the country generally prompts monetary authorities in other major economies in both developed and developing worlds to follow suit.[3] With the resulting low interest rates, a relatively stronger demand for all types of commodities (food; agricultural raw materials; minerals, ores and metals; and, fuels) occurs amid positive outlooks, bullish markets and output growth. Findings reveal as well that elasticities of commodity prices with respect to US monetary policy are higher during conventional rather than unconventional regimes. An increase of about 1.8 percent in commodity prices is to be expected in the former regime, and about 1.6 percent in the latter, when broad money is expanded by one percent.

The signs of other regressors come out as expected. An appreciation in the US dollar causes a downward pressure on prices regardless of the monetary policy regime. Such a finding can be corroborated by the stylized fact that commodity prices are typically priced or traded in Us dollars. Furthermore, as aforenoted, due to its immense relative size, economic growth in the US unsurprisingly pushes up commodity prices. Indeed, the US economy's "appetite" for commodities ─ only rivaled by China's ─ constitutes a major factor moving the needle of prices up.

[3] In nominal terms, according to 2022 data from the *World Development Indicators (WDI),*the World Bank Group, US GDP hovered around $25.5 trillion, while world GDP neared $100 trillion.

Exhibit 5 – Estimation Results of Markov Switching Model with 2 States (Dependent Variable: Commodity Price)[4]

	State 1	**State 2**
α	-0.135996** (0.0341)	-0.109621 (0.1507)
β1	1.579555*** (0.0132)	1.800146*** (0.0142)
β2	4.860238*** (0.0125)	2.795382 (0.1899)
β3	-3.083984*** (0.0008)	-3.978598*** (0.0004)
σ^2	0.02042441	0.026840597

Another takeaway from the Markov switching estimations pertains to the transition probability matrix and expected durations of regimes showcased in exhibits 6 and 7. On the one hand, the probabilities of remaining in the regime of origin are about 60% and 80% for unconventional and conventional monetary practices, respectively. However, these probabilities are relatively lower when transitioning from one state to another. Case in point, the likelihood of transitioning from unconventional to conventional monetary practices stands at 41% against 20% the other way around. Furthermore, standard deviations associated with these transition probabilities turn out to be reasonably low.

Exhibit 6 – Matrix of Transition Probabilities

Mean

	1	**2**
1	0.586941	0.413059
2	0.203616	0.796384

Standard Deviation

	1	**2**
1	3.39E-07	3.39E-07
2	0.000285	0.000285

On the other hand, the expected duration in a regime of conventional monetary policy is about 4.9 years compared to 2.4 years in a regime of unconventional monetary policy. For completeness' sake, the paper provides in the Appendix the corresponding estimates of probabilities of being in either regime throughout the timeframe considered. They are presented graphically in exhibits 8, 9, and 10 using the one-step-ahead, filtered, and smoothed methods, respectively.

Exhibit 7 – Expected Duration

	1	**2**
Mean	2.420964	4.911218
Std. Dev.	1.99E-06	0.006861

2- Policy Implications

The implications of the study's findings can be discussed at three levels. First, they connote the fact that revenues in commodity-dependent developing countries in particular hinge upon US monetary authorities' decisions. To mitigate the negative effects of US contractionary monetary policy on commodity prices ─ and therefore revenues ─ these countries could pursue the creation or expansion of stabilization mechanisms, namely, special funds. These funds could be bankrolled by a preset fraction of potential excess or windfall in revenues at times of expansionary monetary policy in the US. Some oil-rich countries, such as Saudi Arabia, Kuwait, and United Arab Emirates (UAE), among others, have established sovereign wealth funds that globally serve similar purposes. Second, a diversification away from commodities by these countries could provide a solid economic bumper to not only shocks emanating from external factors such as policy moves by US monetary authorities, but also pave the way for sustained growth. For instance, the United Arab Emirates (UAE) in general, and Dubai in particular, has successfully completed such a process of diversification by building up almost from scratch, its hospitality and financial industries, among others. Third, at the microeconomic level, businesses would gain in being proactive to US monetary policy, as it could seriously impact their costs, through input prices, hence their bottom line.

[4] Variables are all in logarithmic forms. *, **, and *** denote significance at the 1%, 5%, and 10%, respectively; p-values are in parentheses.

These three levels do not represent per se a reinvention of the economic wheel, but they could provide a roadmap to contemplate for many developing countries in their continued quest for effective homegrown paradigms toward sustained economic development.

V- Conclusion

Empirical evidence has been found that commodity prices remain sensitive to US monetary policy practices regardless of the regime. This sensitivity is more pronounced under a regime of conventional monetary policy than it is for an unconventional. Overall, stakeholders across the globe ─ ranging from countries and central banks to corporations cannot overlook the monetary policy decisions of US monetary authorities, as their global economic impacts are noticeable via asset prices in general and commodity prices in particular. It's worth a note that an extension of this investigation to include a breakdown of commodities into different categories along with quarterly data could create a more comprehensive framework for understanding these impacts.

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Appendix

Exhibit 8 – Regime Probabilities (One-step-ahead)

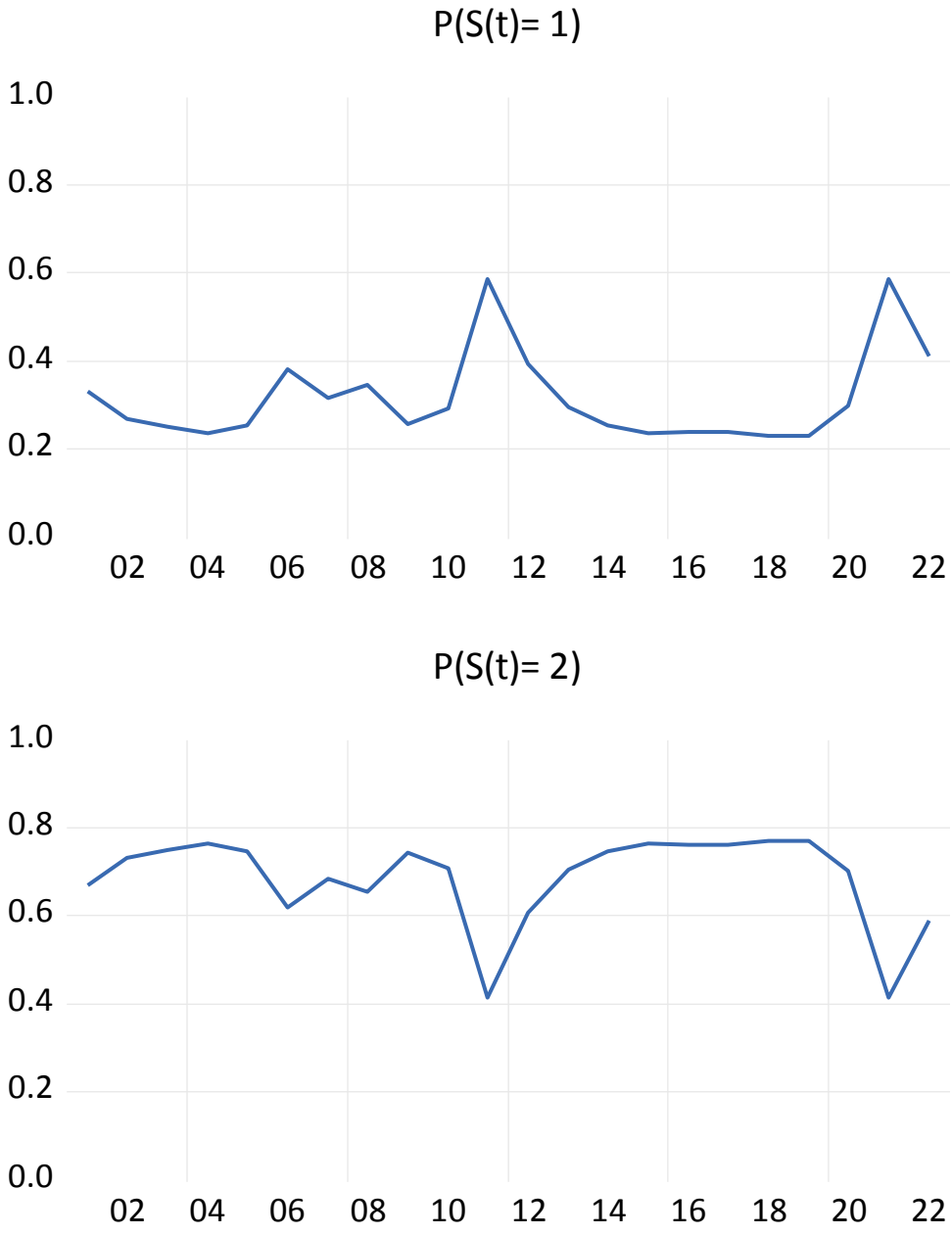

Exhibit 9 – Regime Probabilities (Filtered)

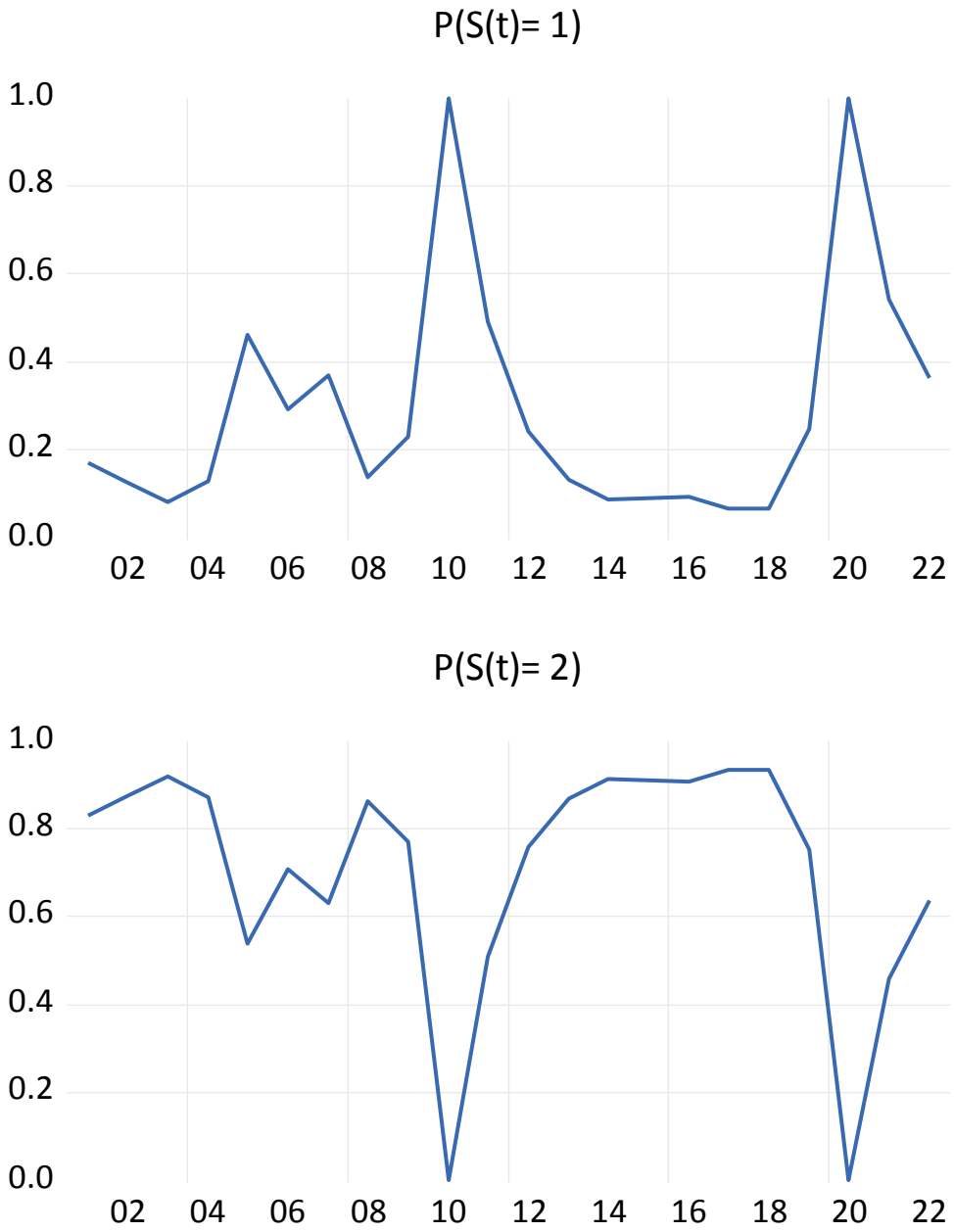

Exhibit 10 – Regime Probabilities (Smoothed)