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FPAS Mark II Monetary-Policy-Relevant Output Gaps

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ABSTRACT

This paper is the second in a series exploring ways of conducting current macroeconomic analysis using the MPMOD framework. The preceding paper in this series laid the groundwork for this approach, delving into the historical narrative of the US economy in the context of MPMOD and fleshed out important analytical ideas during the time of COVID and COVID-related shocks. This paper provides an update of the MPMOD results with almost all variables updated to 2022 with an accompanying 10-year projection starting in 2023. We also provide the basis of a Case A (Hard Landing) and Case B scenario (Soft Landing) and think critically about the timing that will be relevant for policymakers as the US economy heads into 2023, with a combination of strong disinflationary forces in some sectors (goods and commodities) and persistent, if not accelerating, inflation in others (service and shelter).

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I. INTRODUCTION

This paper updates the results for MPMOD within the context of the COVID-19 pandemic and the associated evolving outlooks for the US economy. It focuses on the monetary-policy-relevant output gap, while the financial-cycle gap is covered in a sister paper.[2] The distinction is highly relevant for policymaking and is closely related to the "leaning against the wind" (LAW) debate; a deeper discussion about the debate can be found in Laxton and others (2019).

This paper continues a series of research papers that are meant to build upon the analytical ecosystem of the Forecasting and Policy Analysis System (FPAS) Mark II framework, a policymaking and analytical framework for a new age of central bank policy and communications that is better prepared to deal with heightened uncertainty during periods such as the COVID pandemic.[3] The highly expansionary fiscal and monetary policies during the pandemic were critiqued by many at the time, including Olivier Blanchard and Lawrence Summers, who referred to this as the "worst economic policy of the past 40 years."[4] The primary concern articulated by Blanchard, Summers, and others was the failure to recognize that the massive fiscal stimulus and the resulting aggregate demand was already pushing up against aggregate supply, which was translating into higher inflation. In addition, "bad luck" shocks including the Russia-Ukraine conflict and China's "zero-covid" response to further waves of the virus, have led to the emergence of stagflationary risks that represent a major concern—and source of uncertainty—for policymakers, perhaps unlike anything seen in the West since the Great Inflation of the 1970s.

Why did the major central banks miss this inflationary wave so badly? One of the reasons was that the central banks of advanced countries treated their credibility as given, and therefore saw little risks of de-anchoring inflation expectations because of overheating economies.[5] In this paper, following Evans (2022)[6] we argue that another reason for overstimulation was the failure to recognize the important role that bottlenecks played in reducing aggregate supply, which should have reduced estimates of the true magnitude of deficient demand. In other words, the absolute size of the monetary-policy-relevant output gap was vastly overestimated, signaling a need for a large stimulus.

There is no doubt that the pandemic rendered any real-time measure of unobservables, such as potential output, highly uncertain. This is precisely why we advocate for frameworks like FPAS Mark II that can provide a comprehensive and systematic approach for managing this risk and uncertainty. This paper specifically provides multiple scenarios for thinking about the macroeconomic dynamics associated with a soft and hard landing that would require different trajectories of the short-term interest rate. Furthermore, we incorporate judgment which is informed by a wide array of available and relevant information. Indeed, no model can incorporate all the relevant features of the economy, and, of course, episodes such as the pandemic make this even more obvious. But this does not mean that policymakers cannot inform their real-time measures of policy-relevant latent variables with sensible and relevant information outside their existing models. In fact, we argue that this is part of policymakers' direct responsibility, and provide a description of the treatment of the output gap by various institutions in the previous paper. Both monetary and fiscal policy during this period would have benefitted immensely from sensible measures of the output gap that adjusted for the supply-side implications of COVID-19-related shocks.[7]

[2] See Avagyan and others (2023d).
[3] Refer to Archer and others (2022).
[4] See Williams (2021).
[5] See Kostanyan and others (2022b, c).
[6] Charles Evans (October 2022).
[7] See Avagyan and others (2022a).

This paper provides an update for the US economy and pulls together analysis by the Global Forecasting School (GFS). The paper illustrates the treatment of different unobservable variables such as the NAIRU and potential GDP in "real time," particularly during periods of high uncertainty and volatility. In such an environment, where estimates come under political scrutiny, it can be natural to fall into a trap of treating it as "business as usual." However, given these constraints, it should not impede us from doing such analysis and testing different judgments based on some simple economic logic. The paper provides a practical example for how an institution such as a central bank can implement judgment in service of communicating in a macroeconomic-consistent manner the demand-side and the supply-side implications of COVID-related shocks (lockdowns, social distancing, uncertainty, and macroeconomic policy responses, etc.).

We distinguish the terms "trend output" used for the Financial Cycle Model (FCMOD) and the concept of potential output developed with the Monetary Policy Model (MPMOD), which is based on the notion of imbalances between aggregate demand and supply in the goods and services markets. The monetary-policy output gap is constructed from MPMOD that includes: a Phillips curve; a dynamic Okun's law equation; a monetary policy reaction function; a term-structure equation; and an equation that links the economywide output gap to measures of capacity utilization in the manufacturing sector. The exact model specification is based on a simplified version of a model presented in Alichi and others (2018). Using standard techniques for combining forecasts, this paper shows how to condition medium-term projections of actual and potential output on measures of trend output that can account for the financial cycle.

The remainder of the paper is organized in the following way. Section II summarizes MPMOD and the estimates developed in Alichi and others (2018). Section III updates the results and provides multiple scenarios and motivation for different cases that will be used as inputs for the forthcoming Not the Fed Tealbook as part of the FPAS Mark II framework. Section IV provides some concluding remarks.

II. MPMOD ESTIMATES OF THE OUTPUT GAP AND POTENTIAL OUTPUT

The COVID-19 shock represented a novel type of economic and public health crisis. When thinking about unobservable variables like the NAIRU or potential output in the context of COVID, historical precedents are very difficult to come by, and there is an exceptional need for economists to make critical judgments when thinking about these variables as the crisis is unfolding. To factor in the effects of COVID, we have adjusted the first shock of the model—the level shock—so that the upward adjustments to the NAIRU are mirrored in downward adjustments to potential.[8] This is encapsulated by the notion that the decline in potential output was clearly due in large part to the lockdown policies that prevented people from working and in countries like the US, these people were correctly counted as unemployed. In other words, a meaningful share of the increase in unemployment in the first lock-down phase of COVID-19 in 2020 reflected an increase in the natural rate of unemployment. Allowing for some excess supply in the labor and goods market in this initial phase is consistent with the notion that aggregate demand fell by more than aggregate supply in the goods market, which reflects the basic idea that COVID-associated increases in uncertainty would trigger increases in precautionary savings and negative confidence effects on investment. The COVID shock also impacted aggregate demand, given that the consumption bundle was severely constrained and resulted in some additional savings for certain items in the basket (e.g. things like international travel) that could be consumed after the public health crisis had dissipated and the economy had recovered. These adjustments also reflect the work we have done looking at "real-time" retail and recreation activity from the Google mobility data. It is therefore plausible that a modeler could adjust such estimates in a relatively short time span following the onset of the pandemic. Although such adjustments are done with a wide degree of judgment, undertaking such analysis is necessary in times where historical precedents are virtually nonexistent, and where the failure to not do so risks underestimating the inflationary consequences of the pandemic.

MPMOD is based on Alichi and others (2018), which describes the model and estimation results in detail. The model is an extension of the simple multivariate filter presented in Alichi and others (2015). The basic idea behind the multivariate filter approach is to inform estimates of latent variables, such as the output gap, with theoretical relationships linking unobservable with observable variables. This is in sharp contrast to the approach of extracting measures of latent variables from purely statistical filters.

The original model included a Phillips curve, a dynamic Okun's law equation linking the unemployment gap to the output gap, and an equation that linked the output gap to the Fed's measure of capacity utilization in the manufacturing sector. The stochastic process for GDP included a persistent cyclical component as well as two shocks that could permanently change the level of potential output. The first shock to potential output accounts for simple level shifts, while the second shock can account for episodes when the growth rate of potential output deviates persistently from its long-term growth rate. The model has been extended to include a monetary policy reaction function and a model for 10-year bond yields. This allows us to estimate and project the short-term equilibrium real interest rate, the 10-year term premium and 10-year bond yields.

[8] Fernald and Li (2021), in "The Impact of COVID on Potential Output," provide a good example of employing judgment in thinking about short-run reductions in potential output during the "extraordinary and unprecedented" crisis, and Fernald and Li (2022) also argue that the reductions in potential output represent a level shock.

The model[9] is estimated with annual data covering the period from 1980 to 2022. The list of standard macro variables used in the model includes real GDP, the unemployment rate, CPI inflation, the Fed's survey of capacity utilization, as well as 1-year and 10-year government bond yields. We use long-term CPI forecasts from the Congressional Budget Office (CBO) as a measure of the perceived long-term inflation target. In addition, to avoid the uncertainty in the estimates at the beginning of the sample, we take the CBO's estimate of the NAIRU to be 6.2% in 1980. Unlike Alichi and others (2018), which used a regularized maximum-likelihood procedure to impose priors in the estimation procedure, we present results based on calibrated versions of the model. Conditional on these parameters, we use the Kalman filter to compute the most likely evolution of all the latent variables in the system.

[9] Equations and parameters can be found in the appendix.

III. APPLYING THE FRAMEWORK FOR SCENARIOS

We constructed two scenarios that incorporate some prevailing beliefs about how the US economy could evolve, namely some of the differences between a soft or hard landing of the economy. The implications of a soft and hard landing have important consequences when thinking about the initial conditions assumed in those forecasts, especially as it pertains to the latent variables, namely the output gap. MPMOD provides a practical modeling environment for "testing" those assumptions and it is precisely for this reason that it is necessary to provide multiple scenarios, since these differing perspectives can have major implications and risks on the future path for policy rates. In this case, these two scenarios represent the Case B and Case A scenarios in the FPAS Mark II framework, where Case B is a soft landing scenario that requires a lower interest rate than what is currently priced in financial markets—where the output gap is expected to be smaller and close much quicker—while Case A is a hard landing scenario with higher interest rates, partly on account of an inherently stronger economy that pushes the output gap of an already overheated economy more positive. Of course, this set of scenarios is not exhaustive. There are a multitude (perhaps infinite number) of other plausible scenarios where the economy could move, but within the FPAS Mark II framework, the intention is not to craft an exhaustive list of scenarios representing every plausible future. Rather, the case scenarios in FPAS Mark II serve an illustrative purpose, highlighting (through narrative extrapolations) two of many plausible hawkish and dovish scenarios that represent some of the risks and challenges latent in the policymaking round. Importantly, these are not baseline or alternative scenarios that seek to predict the most-likely future. Refer to Archer and others (2022) for a further, nuanced discussion of the role and purpose of case scenarios, as contrasted with baseline scenarios. Table 1 summarizes some of the important narrative rationale of each scenario.

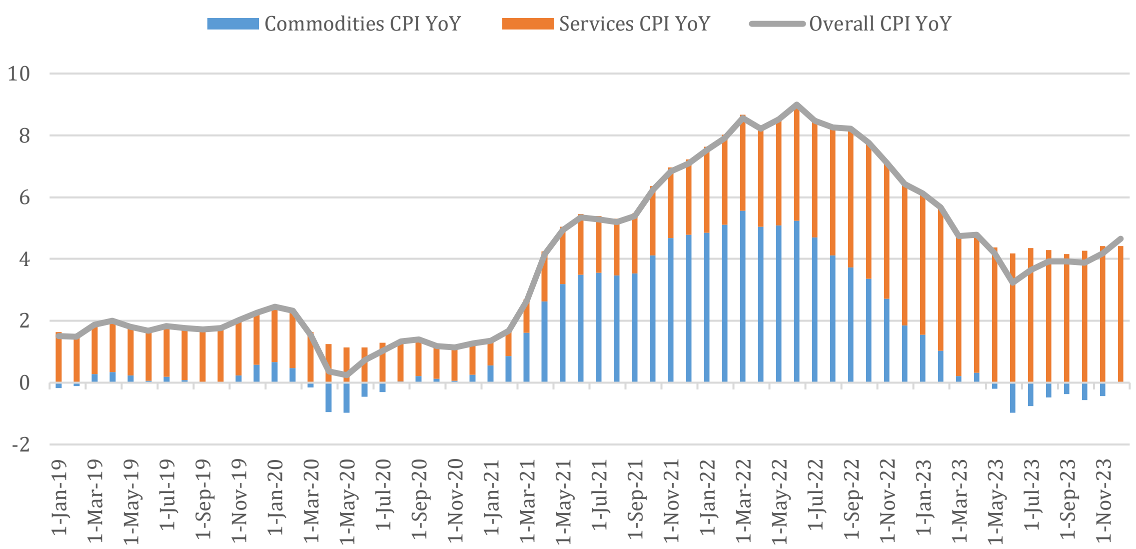
Table 1: Narratives of Different Scenarios

Case B: Soft Landing (3 S's)		**Case A: Hard Landing (3 L's)**
Soon	***Timing***	**Later**
Modest Recession Imminent (2023H1). Begin to see the broader impact of tightening from 2022 on slowing economic activity. Helps slow sticky-price inflation combined with strong disinflationary forces in the goods market is sufficient to bring overall inflation within the ballpark of the target.		Underlying inflation reveals itself to be higher and more rigid than what is currently priced-in financial markets. "Tightness" of monetary policy must be re-evaluated despite the relative rapid increase in recent rate hikes.
Shallow	***Magnitude***	**Lower**
Modest contraction or simply low growth in 2023 is enough of an output trade-off to bring inflation down.		The inflation problem worsens requiring a larger offset from output to bring balance to the economy or lower/negative growth.
Short	***Resolution***	**Longer**
Only about 1-year of below trend growth is enough to bring balance to the economy and in 2024 the Fed can start reigning in rate hikes toward the long-run neutral rate.		Culminating in a Fed that is behind the curve and needs to tighten its policy stance further in the second half of 2023, eventually pushing out the return of an economy to equilibrium.

Although this iteration of MPMOD is in annual frequency,[10] we considered what the monthly and quarterly profile might look like for some variables, namely inflation, to get a sense of the plausibility of judgments made by the market and our estimates for the annual outlook.

In particular, the inflation dynamics in 2023 will be a key determinant for both scenarios and likely would have some interesting implications on the timing for re-evaluating the stance of monetary policy in 2022: has the relatively rapid rise in interest rates been sufficiently restrictive to slow growth, cool the labor market, and put inflation on a sustainable path to the target? In a high-inflation environment (especially one driven by supply-side shocks), it is difficult to know where the neutral policy rate is and therefore, there is significant uncertainty about what can be considered to be sufficiently restrictive. We can imagine that this uncertainty could lead to a relative pause in interest rate hikes in the first half of 2023, as policymakers wait for the large disinflation process in some sectors (goods and commodities) to play out, Figure 1. Then, starting in the second half of 2023, as the dust clears, and when underlying inflation is better understood, policymakers would likely be better able to evaluate where interest rates need to go to achieve their policy objectives.

Figure 1: Disinflation Likely Coming, but Will It Remain?



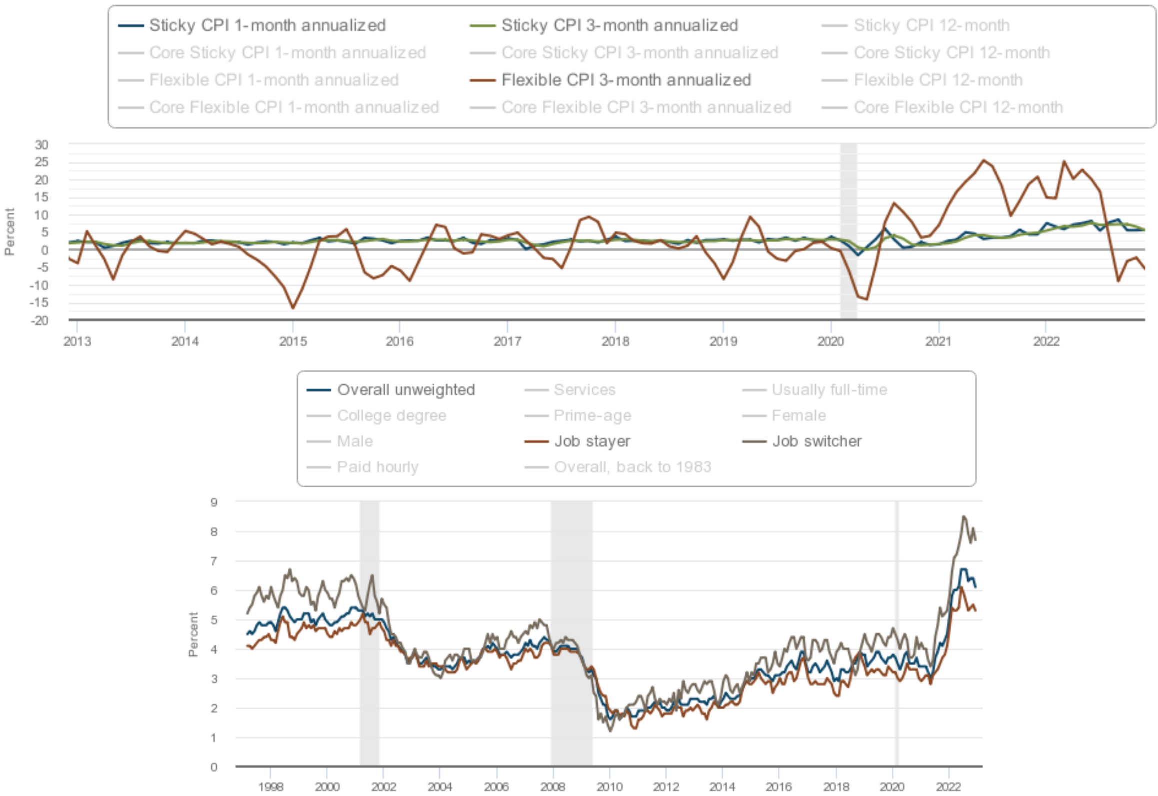
Source: FRED, Authors' Estimates (Case A)

At this point, we meet the proverbial fork in the road and we either move down a Case A- or Case B-type path, where Case A is exemplified by services and shelter inflation remaining persistently high, consistent with a labor market that remains stubbornly tight along with correspondingly high wage inflation. In our view, it would be the developments of service inflation in the first half of 2023 that take precedence for thinking about underlying inflationary pressures that would contribute to the more medium-term dynamics and therefore be useful for anticipating whether we are in a Case A- or Case B-type world. Figure 2 fleshes out the same story when looking at the Atlanta Fed's Sticky/Flexible Price paradigm and Wage Tracker as motivation for thinking about how "flexible" prices can fall rapidly while "sticky" price inflation remains high, reflecting continuing strong wage gains as shown by the job switcher/stayer dynamic. In our estimation, the ingredients included in Case A have a high likelihood of ending with a hard landing, since it implies that monetary policy remains behind the curve and would have to do more to reign in underlying inflation, making the possibility of avoiding a major recession less likely. Box 1

[10] The April 2023 edition will feature an update to quarterly frequency.

presents the historical overview along with the outlook for all the major variables in the Case A scenario.

Figure 2a/b: Flexible Prices Fall but Sticky Price Inflation Stubbornly High Given High Wage Growth

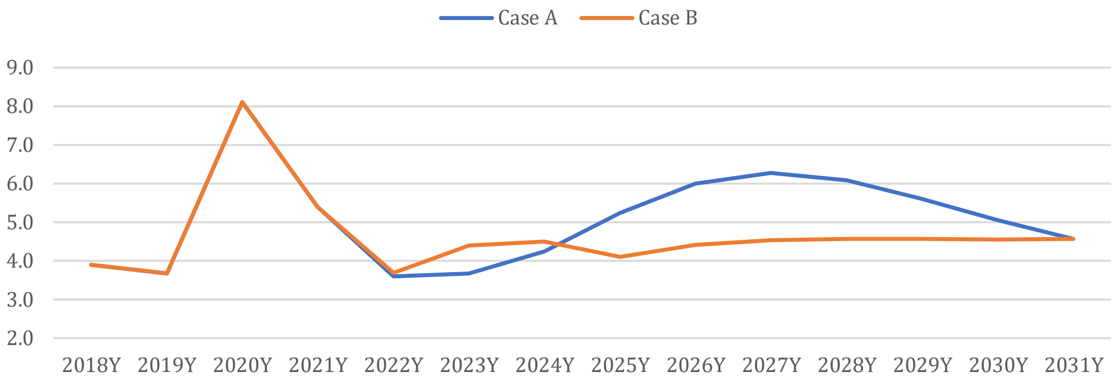


Source: Atlanta Fed

The soft-landing scenario (Case B) in many respects reflects a lot of current market expectations, where economic activity in 2023 is already moderating below trend growth and this slowdown would contribute to a modest rise in the unemployment rate and this cooling of the labor market is enough to start slowing inflation more broadly, namely the service sector. This, in tandem with the disinflation in the goods and commodity markets, suggests that the inflation gains in the first half of 2023 can be maintained, putting underlying inflation within striking distance of the Fed target. Therefore, the current policy stance can be viewed as sufficiently tight, where the real interest rate is indeed positive. Box 2 presents the historical overview along with the outlook for the major variables in the Case B scenario.

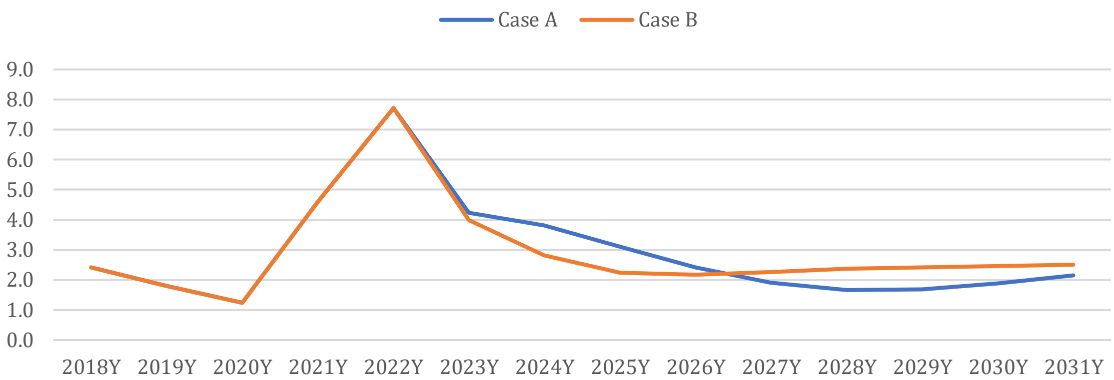
We begin with a brief set of charts comparing some of the key outputs of the Case A and Case B scenarios on the following page. Future publications by the Global Forecasting School will continue to draw upon and expand this modeling framework to construct several other scenarios that incorporate different plausible underlying assumptions about where the economy is situated that would necessitate a tighter or looser policy stance than what is currently priced in financial markets.

Figure 3: Unemployment Rate



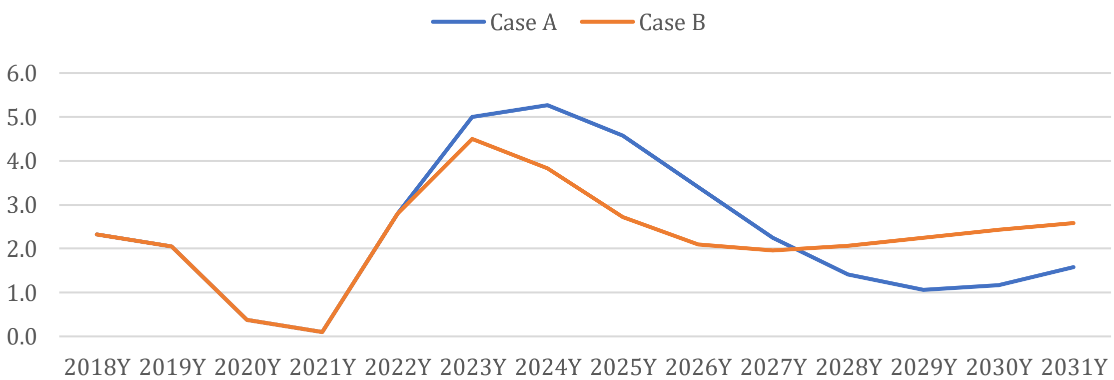
Source: Authors' Estimates

Figure 4: CPI Inflation



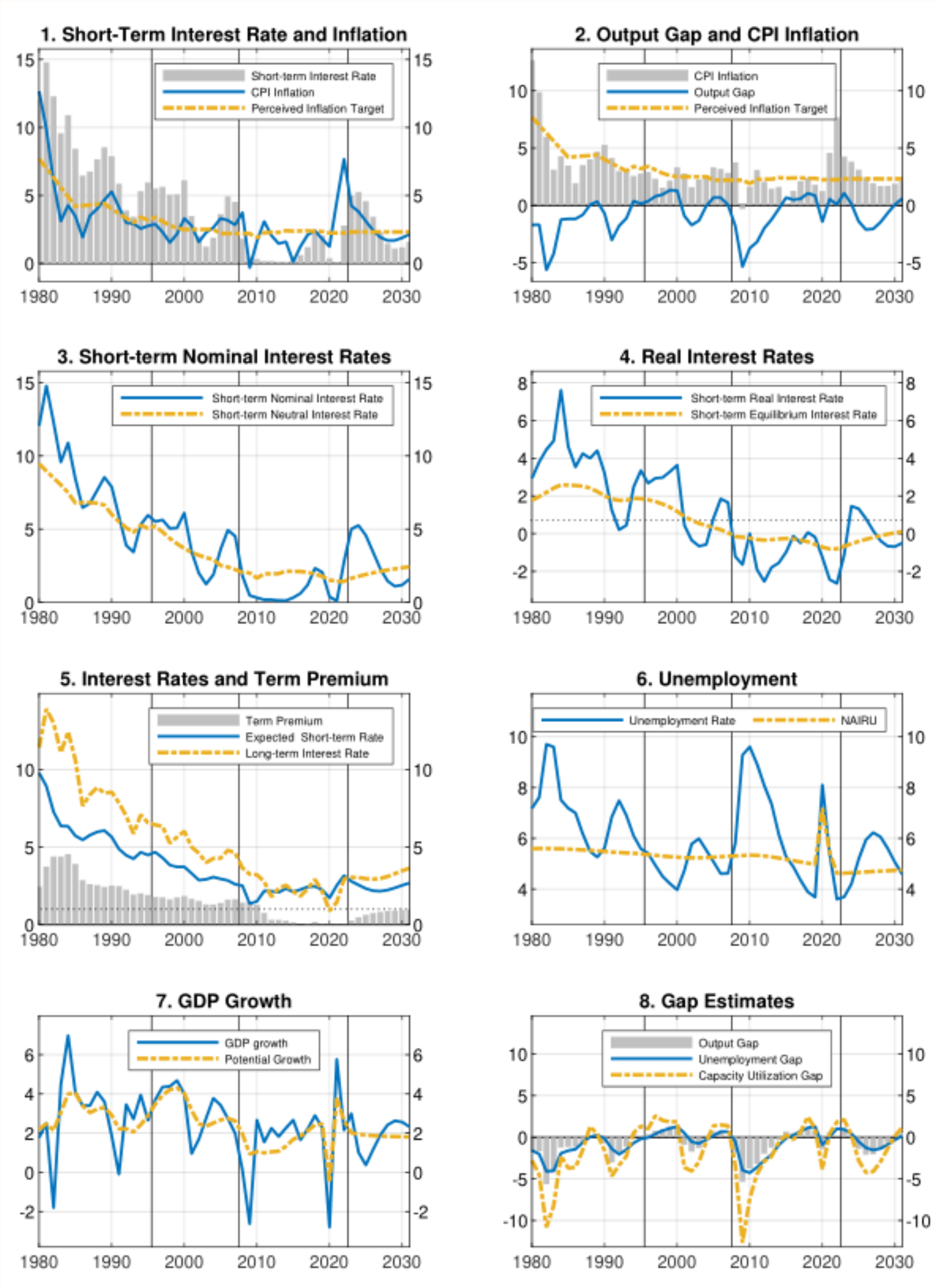
Source: Authors' Estimates

Figure 5: 1Y Nominal Interest Rate

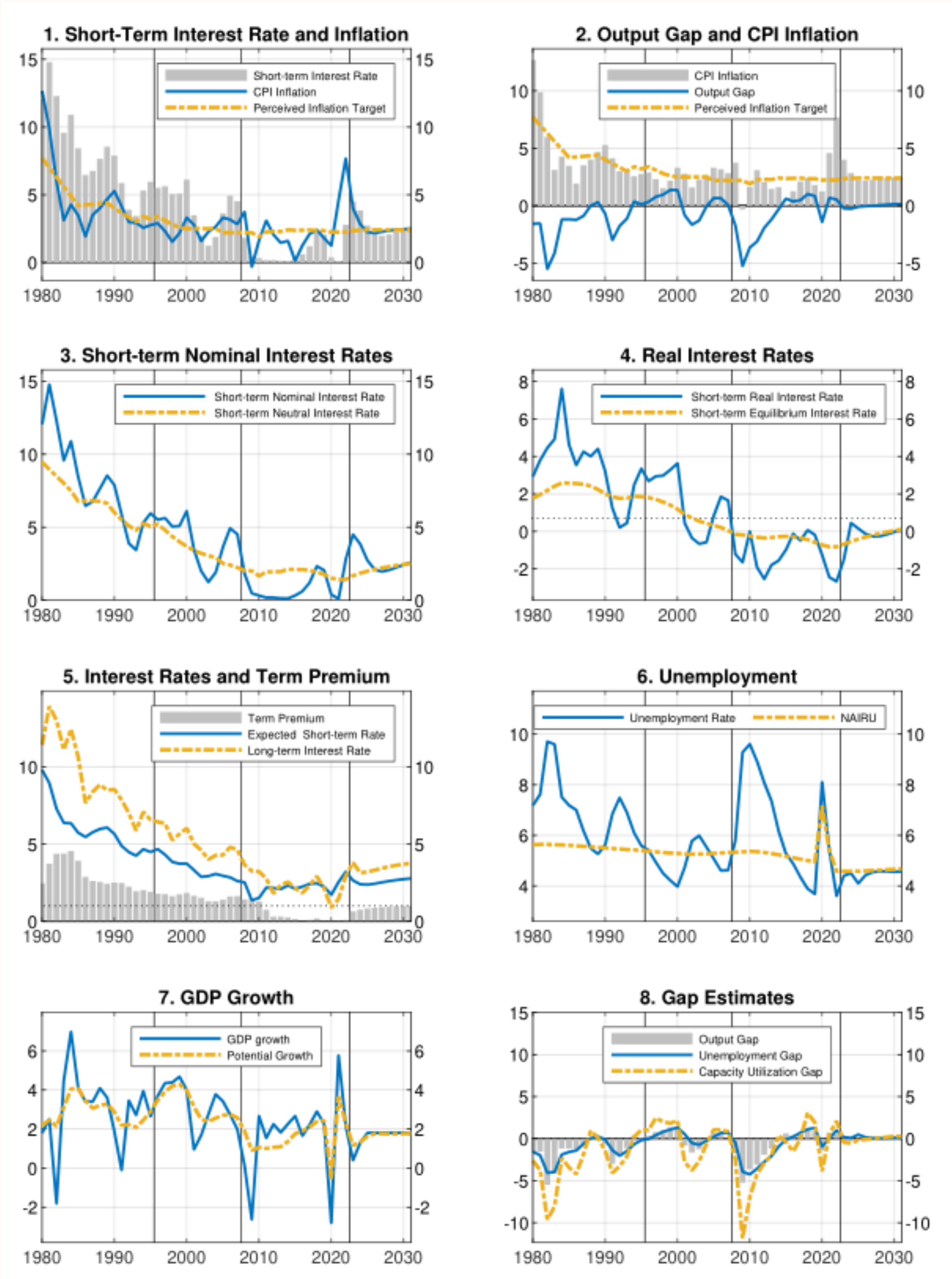


Source: Authors' Estimates

BOX 1: CASE A SCENARIO – "HARD LANDING"



BOX 2: CASE B SCENARIO – "SOFT LANDING"



IV. CONCLUSION

The next releases of "Not the Fed Tealbook" will draw upon this update as an application of using the insights from satellite models for creating a more comprehensive and richer discussion about the economic outlook.[11] "Not the Fed Tealbook" is the Global Forecasting School's simulation of a state-of-the-art macroeconomic analysis and streamlined monetary policy note with limited resources, applied to the case of the United States. It serves as a testing ground for simulating the FPAS Mark II framework—including real-world applications of some of the ideas explored in this and other recent working papers of the Global Forecasting School of the Central Bank of Armenia. It represents a simple and accessible working application of the FPAS Mark II framework that incorporates uncertainty, nonlinearities, and Alan Greenspan's 2004 formulation of "monetary policy as a risk management exercise." These ideas will be further explored in the CBA's forthcoming working paper, "FPAS Mark II Credit Gaps."

This paper provides an update of the MPMOD approach covering the COVID pandemic period and a 10-year outlook to 2032. The key insight of this paper is how to incorporate analysis during a highly volatile period, where latent variables such as potential GDP, the NAIRU, and the neutral interest rate are likely jumping around based on the extreme conditions presented by the pandemic. In such scenarios, institutions tend to be reticent of "aggressively" changing these "trendy" variables, even though their qualitative statements and narratives about where the economy is today and what the underlying forces are indicate that, by all measures, these variables do need to be adjusted aggressively. The advantage of MPMOD is that it uses a structured economic framework that includes information about the labor market, capacity utilization, and economic relationships such as the Phillips Curve and Okun's Law, and importantly allows for short-term judgment of latent variables and provides a path for policy based on those judgmental implications. MPMOD should serve as a practical example for central banks and fiscal authorities on how to use this framework in a volatile period connected with COVID-related shocks and its implication on managing the short-run output inflation tradeoff.

[11] See Papikyan and others (2022b, 2023a-h).

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APPENDIX

A. MPMOD Equations

In this section, we present the equations of the model. Parameter values and the standard errors of shock terms for these equations are estimated using Bayesian estimation techniques and are provided (see Table B1 and B2).

The output gap is defined as the deviation of real GDP, in log terms (y_t), from its potential level ($\bar{y}_t$):

(1) $\hat{y}_t = y_t - \bar{y}_t$

The stochastic process for output (real GDP) is defined by three equations, (2)-(6), and three types of shocks:

(2) $\bar{y}_t = \bar{y}_{t-1} + g_{\bar{y},t} + \varepsilon_{\bar{y},t}$

(3) $g_{\bar{y},t} = (1 - \rho_{g_{\bar{y}}})g_{\bar{y},t-1} + \rho_{g_{\bar{y}}} g_{\bar{y}}^{SS} + \varepsilon_{g_{\bar{y}},t}$

(4) $\hat{y}_t = \varphi_1 \hat{y}_{t-1} - \varphi_2 \widehat{rr}_t^{1Y} - \varphi_3 \widehat{rr}_{t-1}^{1Y} + \varphi_4 \varepsilon_{g_{\bar{y}},t} - \varphi_5 \varepsilon_{\bar{y},t} + \varepsilon_{\hat{y}_t}$

(5) $g_t = y_t - y_{t-1}$

(6) $g_{\bar{y},t} = \bar{y}_t - \bar{y}_{t-1}$

The level of potential output ($\bar{y}_t$) evolves according to trend potential growth ($g_{\bar{y},t}$) and a level-shock term ($\varepsilon_{\bar{y},t}$). Potential growth is also subject to shocks ($\varepsilon_{g_{\bar{y}},t}$), whose impact fades gradually according to the parameter $\rho_{g_{\bar{y}}}$ (a lower value means a slower adjustment back to the steady-state growth rate following a shock). Finally, the output gap ($\hat{y}_t$) is a function of contemporaneous and lagged values of the one-year real interest rate gap ($\widehat{rr}_{t-1}^{1Y}$) which is the deviation of short-term interest rate from its equilibrium level. The output gap equation also incorporates shocks to potential growth $\varepsilon_{g_{\bar{y}},t}$ and shocks to the level of potential output $\varepsilon_{\bar{y},t}$. It is also subject to shocks ($\varepsilon_{\hat{y}_t}$), which are interpreted as demand shocks (raise demand).

To help identify the three output shock terms, a Phillips Curve equation for inflation (π_t) is added, which links the evolution of the output gap (an unobservable variable) to observable data on inflation, according to the process:

(7) $\pi_t = \lambda_1 \pi_{t+1}^e + (1 - \lambda_1)\pi_{t-1} + \lambda_3 y_t + \varepsilon_{\pi,t} - \lambda_4 \varepsilon_{\bar{y},t}$

The last term allows the model to mimic the effects of shocks to productivity which lower marginal cost and therefore reduce inflation.
The inflation target, which can be time-varying, is modeled as a random walk:

(8) $\pi_t^{Tar} = \pi_{t-1}^{Tar} + \varepsilon_{\pi_t^{Tar}}$

The measure of inflation expectations that is used to calculate the real return on financial instruments is modeled as a linear combination of model-consistent expected inflation and lagged inflation:

(9) $\pi_t^e = \beta_1 \pi_{t+1}^e + (1-\beta_1)\pi_{t-1}$

The real one-year interest rate is defined as the difference between the nominal one-year interest rate and expected inflation:

(10) $\mathrm{rr}_t^{1Y} = \mathrm{rs}_t^{1Y} - \pi_t^e$

To close the model, we introduce a policy interest rate reaction function, where the one-year nominal interest rate responds to the deviation of inflation from target and the output gap:

(11) $\mathrm{rs}_t^{1Y} = \alpha_1 \mathrm{rs}_{t-1}^{1Y} + (1-\alpha_1)[\overline{rr}_t^{1Y} + \pi_t^e + \alpha_2(\pi_t - \pi_t^{Tar}) + \alpha_3 \hat{y}_t] + \varepsilon_{rs_t^{1Y}} - \alpha_4 \varepsilon_{\pi_t^{Tar}}$

The equilibrium real interest rate is modeled as a slow-moving autoregressive process that reverts to its long-run steady-state level ($\overline{rr}^{SS}$).

(12) $\mathrm{rr}_t^{1Y} = \overline{rr}_t^{1Y} + \overline{\widehat{rr}}_t^{1Y}$

(13) $\overline{rr}_t^{1Y} = \rho^{\overline{rr}^{1Y}} \overline{rr}_{t-1}^{1Y} + (1-\rho^{\overline{rr}^{1Y}})\overline{rr}^{SS} + \varepsilon_{\overline{rr}_t^{1Y}}$

The model allows for longer-term bond yields to shed light on the estimates of the equilibrium real interest rate. Based on the expectations theory of the term structure, the interest rate on 10-year government bonds is modeled as the sum of the average expected future short-term interest rates over 10 years and a term premium.

(14) $\mathrm{rs}_t^{10Y} = \frac{\sum_{i=t}^{t+9} rs_i^{1Y}}{10} + \sigma_t^{Term} + \varepsilon_{rs^{10Y}}$

(15) $\sigma_t^{Term} = \rho^{\sigma^{Term}} + \sigma_{t-1}^{Term} + (1-\rho^{\sigma^{Term}})\sigma^{Term,SS} + \varepsilon_{\sigma_t{}^{term}}$

(16) $\hat{u}_t = \bar{u}_t - u_t$

(17) $\bar{u}_t = (1-\rho_{\bar{u}})\bar{u}_{t-1} + \rho_{\bar{u}} u^{ss} + g_{\bar{u},t} + \varepsilon_{\bar{u},t}$

(18) $g_{\bar{u},t} = \rho_{g\bar{u}} \rho_{\bar{u},t-1} + \varepsilon_{g_{\bar{u},t}}$

(19) $\hat{u}_t = \rho_{\hat{u}} \hat{u}_{t-1} + \tau \hat{y}_t + \varepsilon_{\hat{u},t}$

Here, $\bar{u}_t$ is the equilibrium value of the unemployment rate (the NAIRU), which is time varying, and subject to shocks ($\varepsilon_{\bar{u},t}$) and to variation in its trend ($g_{\bar{u},t}$), which is itself also subject to shocks ($\varepsilon_{g_{\bar{u},t}}$). This specification allows for long-lasting deviations of the NAIRU from its steady-state value.

Most importantly, equation (19) specifies an Okun's law relationship wherein the gap between actual unemployment and its equilibrium rate ($\hat{u}_t$) is a function of the output gap ($\hat{y}_t$).

Finally, we incorporate information from measures of capacity utilization rates in the manufacturing sector to help shed some light on the overall slack in the entire economy at a given point in time.

(20) $\hat{c}_t = \bar{c}_t - c_t$

(21) $\bar{c}_t = (1-\delta_2)\bar{c}_{t-1} + \delta_2 c^{ss} + g_{\bar{c},t} + \varepsilon_{\bar{c},t}$

(22) $g_{\bar{c},t} = (1-\delta_1)g_{\bar{c},t-1} + \varepsilon_{g_{\bar{c},t}}$

(23) $\hat{c}_t = \kappa\hat{y}_t + \varepsilon_{\hat{c}_{,t}}$

In the above, $\bar{c}_t$ is the equilibrium value of the capacity utilization rate, which changes over time, and is subject to shocks ($\varepsilon_{\bar{c},t}$). The equilibrium capacity utilization rate grows at $g_{\bar{c},t}$, which is itself also subject to shocks ($\varepsilon_{g_{\bar{c},t}}$), with their impact fading gradually according to the parameter δ_2. This specification allows for permanent movements in the equilibrium capacity utilization rate. The capacity utilization gap, which is meant to capture the economic slack in the manufacturing sector, should be correlated with the measure of the overall economic slack in the economy ($\hat{y}_t$).

B. MPMOD Parameters

Parameter	Calibration
$\boldsymbol{\rho_{g_{\bar{y}}}}$	0.3
$\boldsymbol{\varphi_1}$	0.7
$\boldsymbol{\varphi_2}$	0.4
$\boldsymbol{\varphi_3}$	0.4
$\boldsymbol{\varphi_4}$	0.3
$\boldsymbol{\varphi_5}$	0.8
$\boldsymbol{\lambda_1}$	0.4
$\boldsymbol{\lambda_3}$	0.1
$\boldsymbol{\lambda_4}$	0.1
$\boldsymbol{\beta_1}$	0.4
$\boldsymbol{\alpha_1}$	0.5
$\boldsymbol{\alpha_2}$	1.5
$\boldsymbol{\alpha_3}$	0.1
$\boldsymbol{\alpha_4}$	2.0
$\boldsymbol{\rho^{\overline{rr}^{1Y}}}$	0.9
$\boldsymbol{\rho^{\sigma^{Term}}}$	0.7
$\boldsymbol{\tau}$	0.5
$\boldsymbol{\rho_{\hat{u}}}$	0.4
$\boldsymbol{\rho_{\bar{u}}}$	0.1
$\boldsymbol{\rho_{g\bar{u}}}$	0.1
$\boldsymbol{\delta_1}$	0.1
$\boldsymbol{\delta_2}$	0.2
$\boldsymbol{\kappa}$	2.0