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Global Markets Analyst

The Macro Drivers of Implied Volatility (Rosenberg)

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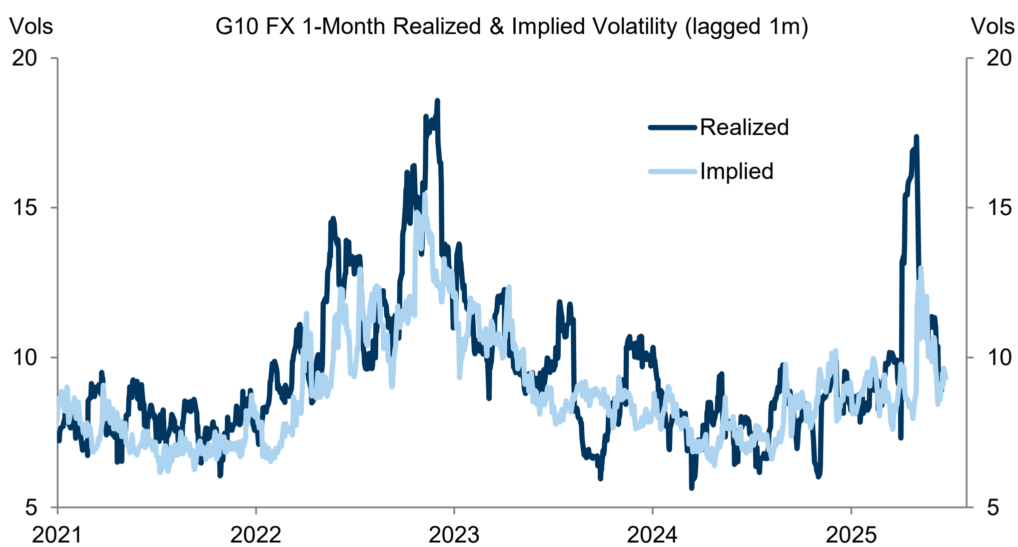
- FX volatility has declined in recent weeks, alongside more benign US economic data and a relaxation in tail recession and inflation risks. We have previously argued that shifts in volatility are closely related to macroeconomic conditions. In this piece, we quantify the impact of macro uncertainty on FX implied volatility and gauge how much economic conditions justify the lower levels of implied vol we see today.
- Despite being linked to future price action, implied volatility is very closely related to realized volatility, primarily because they share macro drivers. While somewhat intuitive, this can also lead markets to misprice future volatility, especially in the early stages of structural shifts in the economic backdrop. In fact, realized volatility has exceeded implied volatility for most of this year, meaning that markets have consistently underpriced higher realized volatility in FX markets.
- In order to quantify the impact of macro uncertainty on FX implied volatility, we begin by constructing simple measures of economic uncertainty using Consensus Economics' surveys of forecast dispersion across GDP, inflation, and monetary policy for the US, Euro area, UK, and Japan. We measure the impact of macro uncertainty on FX implied vol by running regressions of implied volatility on these country-specific measures of macro uncertainty.
- Our results show a strong, positive relationship between FX volatility and macro uncertainty. In other words, when market participants diverge more on inflation or growth outcomes, option-implied FX vol is usually higher. These results support the argument that FX volatility is closely related to shifts in the macro environment. When comparing across regions, we find that US macro uncertainty tends to have more explanatory power than other regions, and US CPI uncertainty has the strongest explanatory power across factors, though domestic monetary policy is often a close second.
- Lower levels of implied volatility in recent weeks can be linked to a slightly less uncertain macroeconomic backdrop, where tail recession and inflation risks have relaxed. Our models support the idea that lower realized and implied vol looks appropriate. However, should inflation uncertainty increase again, FX implied vols could shift higher. Additionally, some of the macro factors driving FX vol higher are not necessarily captured by these models, such as structural shifts in

portfolio flows, which could contribute to higher volatility than our models imply. In the meantime, the upside of lower implied volatility means that directional views can be expressed more inexpensively, particularly in spots where investors think the macro is more likely to surprise.

The Macro Drivers of Implied Volatility

Option-implied volatility in FX markets has declined in recent weeks, alongside a drop in realized volatility (Exhibit 1). US policy has led to a distinctly more uncertain macroeconomic backdrop globally, but there have been several important shifts that have eased market concerns. The recent trade deal between the US and China has removed some of the downside tail risks to growth and upside risks to inflation. Inflation data in the US have remained benign as well and could support earlier Fed easing. We have previously argued that shifts in volatility are closely related to macroeconomic conditions. Given the latest developments, we think the macro risks justify the lower levels of implied vol we see today, but still caution that other factors not necessarily captured by these models could resume putting upward pressure on both realized and implied vol.

Exhibit 1: Option-implied volatility in FX markets has declined in recent weeks, alongside a drop in realized volatility



Source: Goldman Sachs Global Investment Research

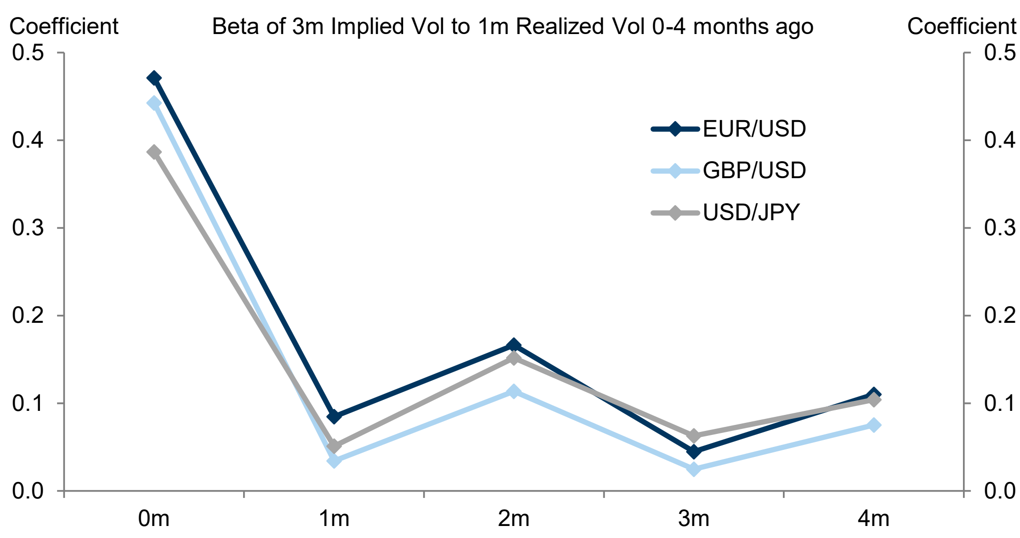
What is Implied Volatility?

FX implied volatility reflects investors' expectations for future volatility in FX markets. Volatility is "implied" from FX options prices; options are priced according to the probability of an exchange rate reaching a certain level. If the macro backdrop is uncertain, the risk of a surprise in growth, inflation, or policy that affects prices is high. Markets need to incorporate that risk as higher future or implied volatility. As a result, underlying trends in both realized and implied volatility can be linked to economic conditions and the business cycle, and reflect investors' uncertainty over economic conditions and the future path of exchange rates.

The Relationship Between Realized and Implied Volatility

Despite being linked to future price action, implied volatility is very closely related to realized volatility. Primarily, this is because they share macro drivers. As discussed below, there is strong evidence that both realized and implied volatility are sensitive to economic factors. That being said, implied volatility tends to follow realized volatility. When past price action is more volatile, markets tend to price greater implied volatility going forward. This is not unintuitive; volatility can be persistent, as can economic shocks. But implied vol has a very short memory. Our estimates suggest that it tends to weigh the most recent period of realized volatility most heavily (Exhibit 2). For example, 3-month implied volatility across EUR, GBP, and JPY tends to be most highly correlated with realized vol in the previous one month. This can lead markets to misprice future volatility, especially in the early stages of structural shifts in the economic backdrop, which is one of the key reasons that implied vol can be a poor predictor of realized vol.

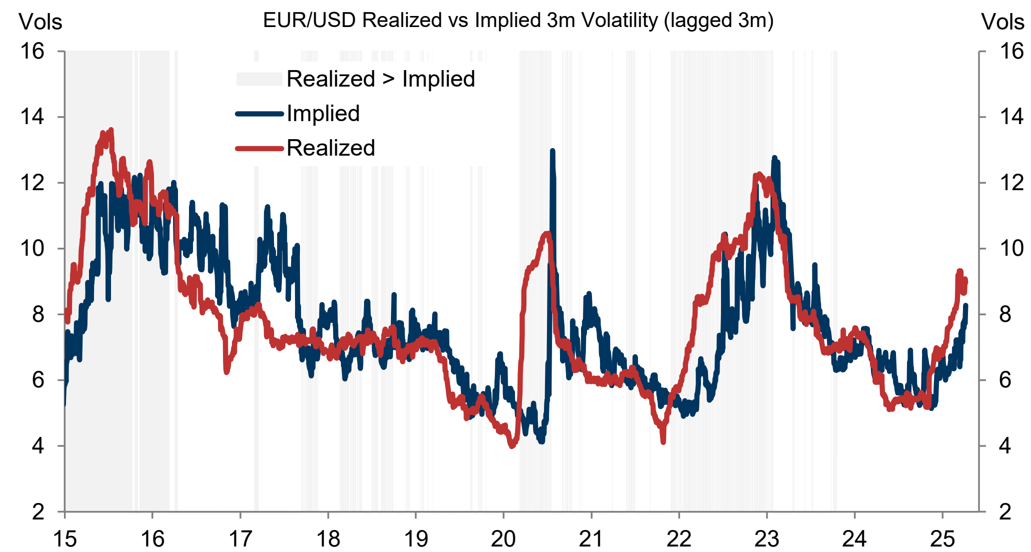
Exhibit 2: Overweighting the recent price action can lead markets to misprice future volatility



Source: Goldman Sachs Global Investment Research

In fact, realized volatility has exceeded implied volatility for most of this year, meaning that markets have consistently underpriced the degree to which realized volatility in FX markets would be high (Exhibit 3). There have been other stretches in recent history where realized vol exceeded implied vol, most notably during the recent inflation surge. Inflation uncertainty rose sharply in 2022, increasing policy uncertainty as well. Implied volatility was slow to adjust higher though, despite a clear increase in realized vol. In contrast, FX markets prior to the covid crisis were exhibiting a secular decline in realized volatility that markets initially did not anticipate. This period lasted from at least 2014-2019 and coincided with a broad decline in policy rate differentials, dovish forward guidance, and low inflation across the G10. Until FX options markets adjusted to the lower levels of volatility, realized vol often underperformed implied vol.

Exhibit 3: Realized vol often exceeds implied vol over a 3-month period

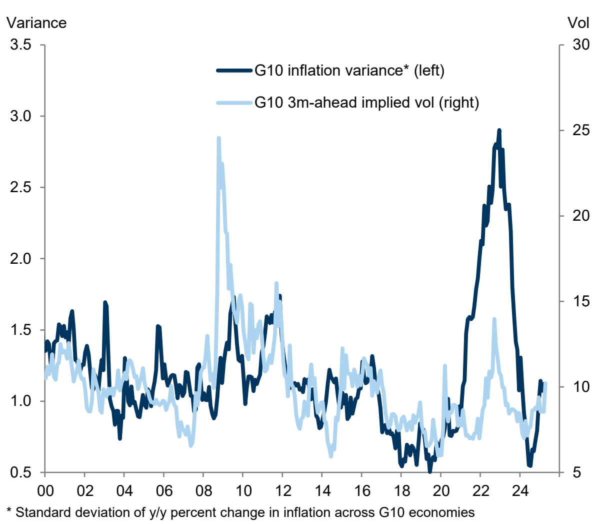


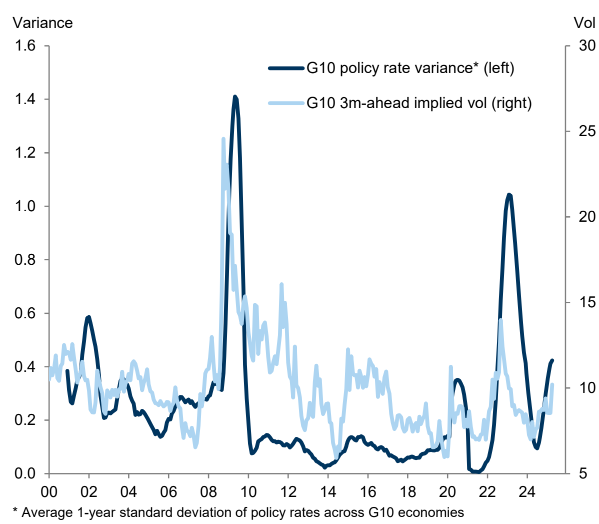
Source: Goldman Sachs Global Investment Research

Literature on the Macro Drivers of Volatility

Prior work on FX and rates volatility also points to economic conditions as a key driver of vol. Ilzetzki, Reinhart, and Rogoff (2020) find that the core macroeconomic driver of realized FX volatility is monetary policy. They argue that the persistent decline in volatility prior to the covid crisis was related to the sharp, coinciding decline in inflation and interest rate differentials. These factors are easy to observe by comparing inflation and policy rate variance with G-10 FX implied volatility (Exhibit 4). Their work also suggests that investor expectations that inflation and rates would stay lower for longer reinforced the decline in volatility. Altogether, the key takeaway for our purposes is that macro uncertainty is a key driver of volatility in FX markets.

Exhibit 4: Trends in FX volatility have closely coincided with structural shifts in inflation and monetary policy variance

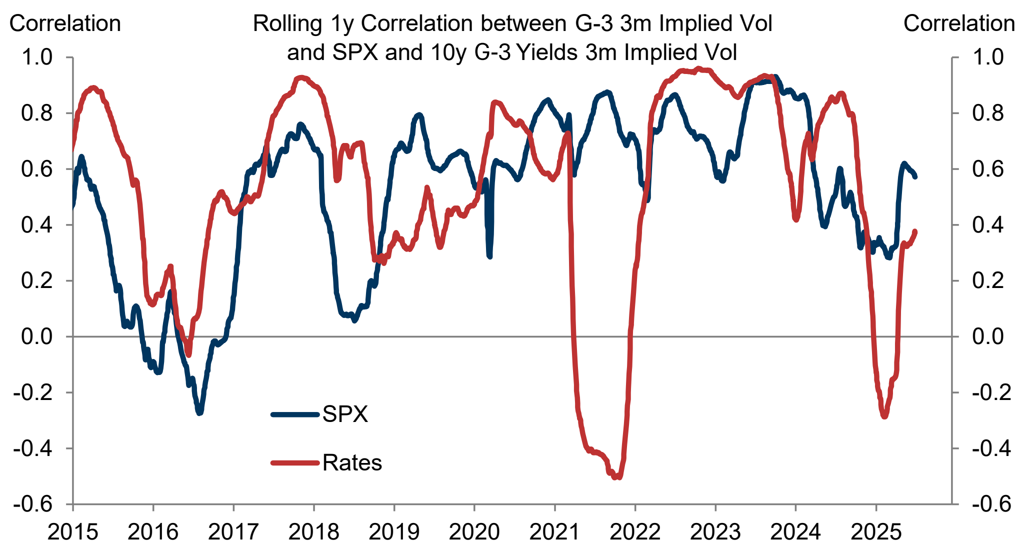




Source: Haver Analytics, Goldman Sachs Global Investment Research

Our cross-asset strategists have also argued that longer-term shifts in volatility across FX, rates, and equities are influenced by macro conditions. Their analysis of the low vol environment of 2014 finds that realized and implied volatility have common macro drivers, such as changes in the unemployment rate and other macro volatility measures. In other words, both can be explained by the same macroeconomic factors. They also find that these factors are common across markets, but note that volatility trends across asset classes are far from perfectly correlated. This is especially true now, as the correlation between FX vol and equity and rates vol has fallen (Exhibit 5). Though macro can explain a portion of asset price volatility, there are asset-specific factors that matter too. Plus, the relative importance of different macro factors varies at different points in time, and there are different relationships across assets to different sets of economic conditions. For the investor, one key takeaway is that though a lack of volatility can make trading opportunities more difficult, it also makes it easier to use options to express directional views.

Exhibit 5: Volatility trends across asset classes are far from perfectly correlated



Source: Goldman Sachs Global Investment Research

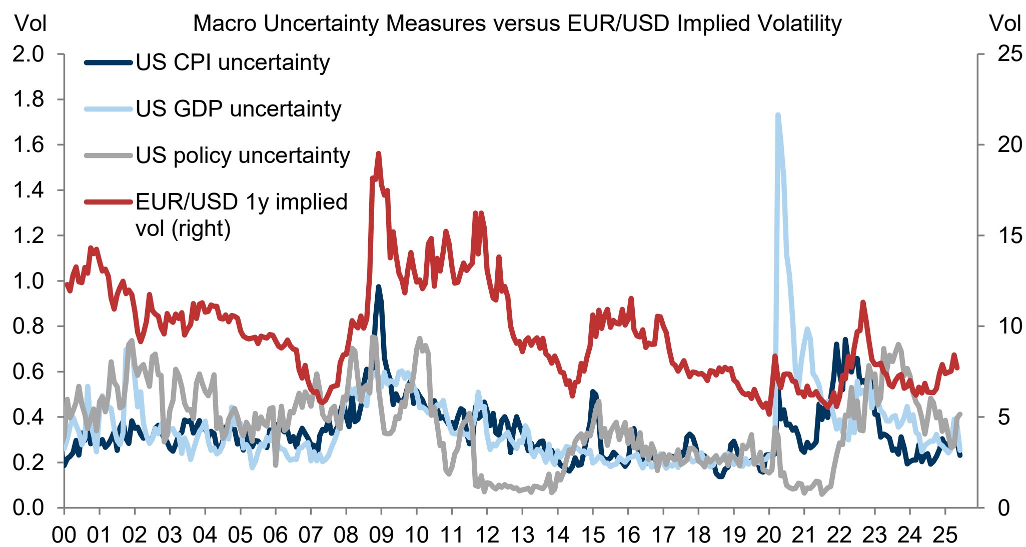
Others have come to similar conclusions regarding implied interest rate volatility. Sarisoy (2024) finds a positive relationship between US inflation and growth uncertainty and US interest rate implied volatility. They note that the relationship is also sensitive to other factors, such as the presence of the effective lower bound. When policy is constrained by the ELB, they find that inflation becomes a stronger driver of rates volatility, while growth uncertainty becomes a weaker driver. Our rates strategists have also found that macro uncertainty is correlated with interest rates implied vol, though they can dislocate at times.

What Drives FX Implied Vol?

In this piece, we quantify the impact of macro uncertainty on FX implied volatility and gauge how much economic conditions justify the lower levels of implied vol we see today. We begin by constructing simple measures of economic uncertainty using Consensus Economics' surveys of forecast dispersion across GDP, inflation, and monetary policy for the US, Euro area, UK, and Japan. When the standard deviation of economic forecasts for the year-ahead increases, we interpret it as an increase in uncertainty on the macroeconomic outlook.

Implied volatility in the G3 has closely tracked our measures of US economic uncertainty over the past two decades, particularly during periods of rising uncertainty (Exhibit 6). These macro uncertainty measures are closely correlated with one another as well. For example, when the US GDP outlook is more variable, the inflation outlook is typically more uncertain too. These measures are also correlated across regions. For example, forecast dispersion for Euro area GDP often moves in tandem with US GDP uncertainty.

Exhibit 6: Implied volatility typically rises with higher US macroeconomic uncertainty



Source: Bloomberg, Consensus Economics, Goldman Sachs Global Investment Research

Estimating the Impact of Macro Uncertainty

We measure the impact of macro uncertainty on FX implied vol by running regressions of implied volatility on our country-specific measures of GDP, CPI, and policy rate uncertainty. Our analysis includes implied volatility in three crosses: EUR/USD, GBP/USD, and USD/JPY. These are among the most traded and liquid crosses in FX and should have accurate implied volatility pricing and reliable macro forecasts. Our sample covers the period from December 2002 to May 2025 and we include four tenors of implied volatility: 1-month, 3-month, 6-month, and 1-year. Beyond 1-year maturities, FX options are usually less liquid.

Our results show a strong, positive relationship between FX volatility and macro uncertainty (Exhibit 7). In other words, when market participants diverge more on inflation or growth outcomes, option-implied FX vol is usually higher. These results support the argument that FX volatility is closely related to shifts in the macro environment. When comparing across regions, we find that US macro uncertainty tends to have more explanatory power than other regions. There are a few plausible explanations for this, including that US economic conditions often have large spillovers to the rest of the world. Additionally, we find that our models work best for estimating

3-month implied vol versus other tenors. Options at the 3m mark are usually among the most liquid in FX. The models also perform best for EUR/USD, followed by GBP/USD, and finally USD/JPY.

Exhibit 7: The drivers of implied volatility

	EUR/USD 3m Implied Vol			GBP/USD 3m Implied Vol			USD/JPY 3m Implied Vol		
	I	II	III	I	II	III	I	II	III
US CPI Uncertainty	11.9***	9.1***	8.1***	7.8***	8.2***	8.7***	6.7***	6.1***	5.4***
	[9.1]	[6.9]	[6.4]	[5.8]	[6.1]	[6.6]	[5.0]	[4.6]	[4.1]
US GDP Uncertainty	0.3	-0.2	-1.3	5.3***	6.0***	5.7***	-2.8***	-2.9***	-3.6***
	[0.2]	[-0.1]	[-0.8]	[3.4]	[3.7]	[3.8]	[-2.7]	[-2.8]	[-3.5]
US Policy Uncertainty	-1.7	0.3	0.1	-0.8	-1.7	0.4	2.7***	3.9***	6.5***
	[-1.6]	[0.2]	[0.1]	[-0.9]	[-1.6]	[0.5]	[2.9]	[3.8]	[5.3]
Domestic CPI Uncertainty	-5.2***	-3.7***	-1.5	0.0	0.0	-0.5	4.9**	4.5**	1.7
	[-3.8]	[-2.8]	[-1.1]	[0.1]	[0.1]	[-0.9]	[2.5]	[2.3]	[0.8]
Domestic GDP Uncertainty	-0.9	-1.5	-0.8	-3.1***	-3.4***	-3.2***	2.3**	1.6	2.8***
	[-0.6]	[-1.1]	[-0.6]	[-3.5]	[-3.8]	[-3.7]	[2.2]	[1.6]	[2.8]
Domestic Policy Uncertainty	7.8***	9.4***	0.9	2.9***	3.1***	4.2***	6.4***	6.4***	8.1***
	[5.2]	[6.4]	[0.5]	[2.7]	[2.9]	[3.8]	[2.9]	[2.9]	[3.7]
ELB		1.9***			-0.6			0.9***	
		[5.9]			[-1.6]			[2.6]	
10y Rate Differential			-2.2***			1.2***			-1.0***
			[-7.8]			[3.9]			[-4.5]
Observations	270	270	270	270	270	270	270	270	270
R-squared	0.41	0.48	0.52	0.34	0.35	0.38	0.32	0.34	0.37

Note: Sample includes monthly data from 2003-present. T-statistics in brackets. * p<.1, ** p<.05, ***p<.01

Source: Consensus Economics, Goldman Sachs Global Investment Research

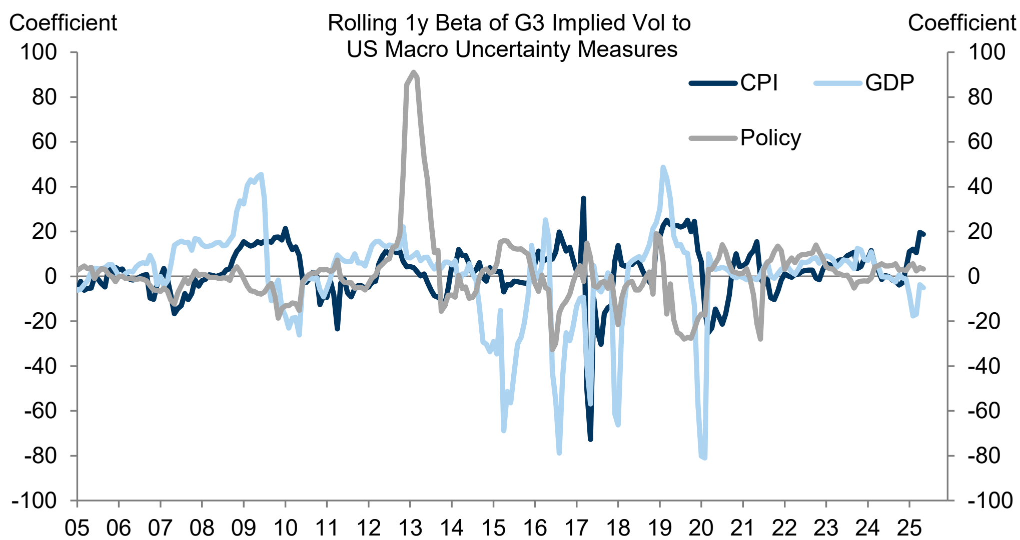
US CPI uncertainty has the strongest explanatory power across factors, though domestic monetary policy is often a close second. It makes sense that inflation is one of the strongest determinants for FX vol. It directly impacts both exchange rates, via purchasing power parity, and monetary policy. Purchasing power parity dictates that if inflation uncertainty is high, nominal exchange rates may have to adjust more significantly in the long run to account for those changes. However, as we discuss later, the relative importance of our macro factors shifts over time. Most of the other factors, while meaningful on their own, lose their explanatory power in a multivariate setting. This is likely because the uncertainty measures are closely correlated. Our results are not improved by using the interaction of US and domestic uncertainty measures—the US measures still outperform.

We also consider several controls, including an indicator for the effective lower bound in the US and interest rate differentials. The ELB has been shown to be a useful indicator for rates volatility, and it is a useful addition to our models as well, improving the fit on the margin, especially for the Euro. Originally, investors thought that the ELB could amplify, rather than suppress FX volatility because the rates channel was constrained and FX would become the natural transmission channel for macro shocks. This was partly true—our results suggest that the presence of the zero lower bound actually increased FX volatility on the margin. However, monetary policy has a direct impact on FX as well, and as we have argued in our clustering framework, the decline in policy and rates volatility in the 2010s had widespread impacts on FX volatility that brought it lower on average. Broadly, our results emphasize that macro uncertainty has a direct and meaningful impact on FX implied vol.

What Matters at Different Points in Time?

While inflation has historically been the key driver of volatility, this is not always true—the relationship has shifted over time. Most recently, FX volatility has been driven by changes in US inflation uncertainty (Exhibit 8). As we noted earlier, inflation should have a direct impact on exchange rates. In the current environment, inflation uncertainty partly reflects shifting trade policy and the difficult monetary policy trade-off that tariffs create. Recently, benign inflation data out of the US have eased concerns that tariffs will generate a large and persistent shock to prices, while the labor market has softened gradually. Recent comments from Fed officials have also suggested some members of the FOMC could support a cut in September if upcoming inflation prints are not too high. The importance of inflation developments has meant that it has been a key driver of FX vol both on the way up and also now on the way down.

Exhibit 8: The recent increase in FX vol has been driven by higher inflation uncertainty

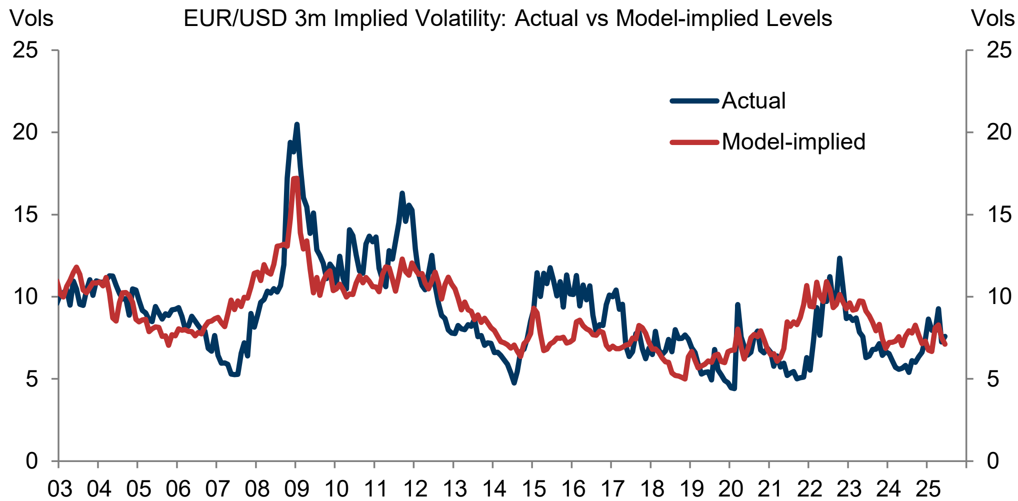


Source: Consensus Economics, Goldman Sachs Global Investment Research

Where Does the Macro Say Implied Vol Should Be?

Using our models, we can estimate where implied vol should be based on macro uncertainty. A key concern across investors is that the recent reset lower in volatility has been larger than the reset in economic uncertainty. Our models suggest that implied vol is largely appropriate relative to the macro, especially for EUR, with some small divergence between actual and model-implied volatility for GBP and JPY (Exhibit 9, Exhibit 10, and Exhibit 11). Taken at face value, the results suggest that the latest decline in EUR/USD implied vol is consistent with a less uncertain macro backdrop. It also indicates that GBP implied vol should be a bit higher to match macro uncertainty, while implied vol for JPY should be slightly lower. In other words, vol markets are pricing less acute macro risks for EUR and GBP and more elevated macro risks for JPY. This could be related to JPY's safe-haven status. We can also use these models to project how implied volatility might evolve. With no reduction in tariff-related inflation, growth, or policy uncertainty, we can expect elevated FX volatility to persist.

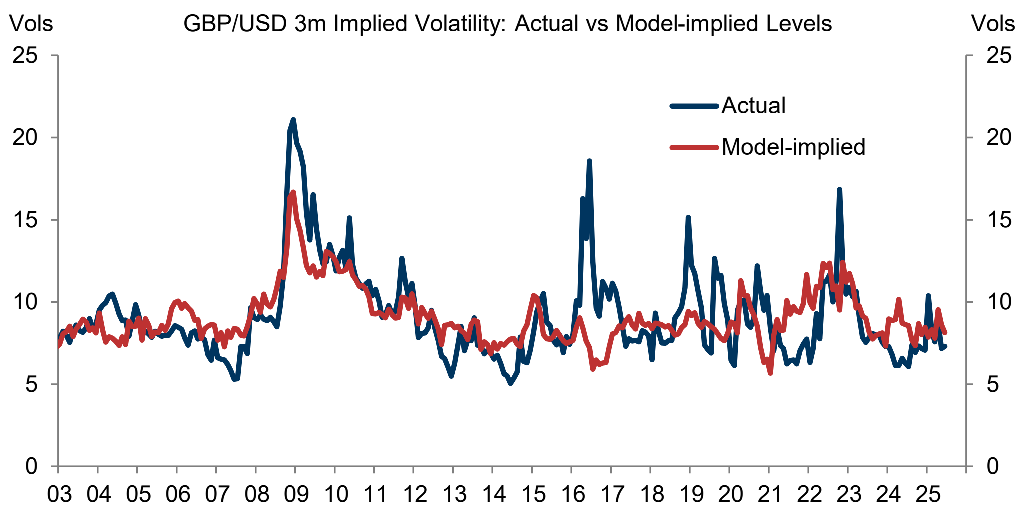
Exhibit 9: Our models suggest that implied vol is largely appropriate relative to the macro, especially for EUR...



Note: Model includes 1-year ahead CPI, GDP, and 3m interest rate expectations for the US and Euro area, and the 10y rate differential vs the US. Sample: 2003-Present. Monthly frequency.

Source: Consensus Economics, Goldman Sachs Global Investment Research

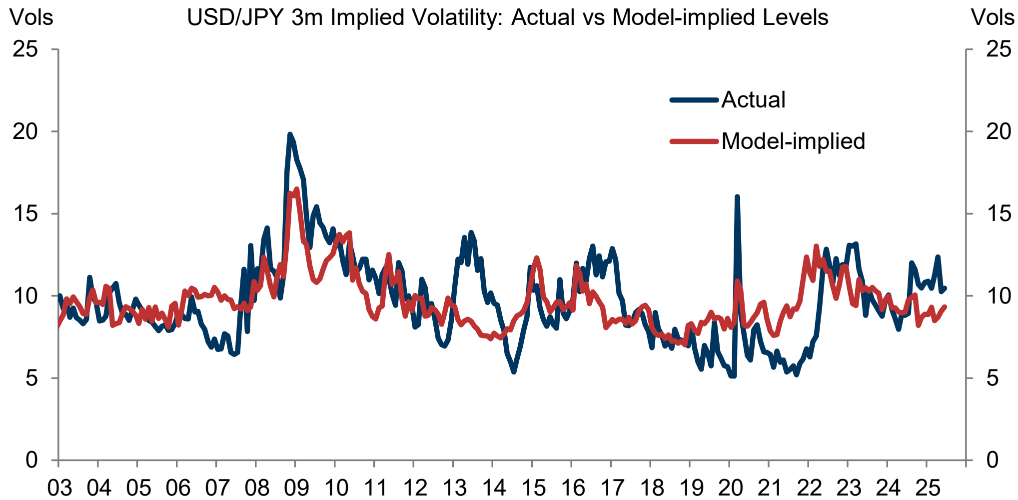
Exhibit 10: ...with some small divergence between actual and model-implied volatility for GBP and JPY



Note: Model includes 1-year ahead CPI, GDP, and 3m interest rate expectations for the US and UK, and the 10y rate differential vs the US. Sample: 2003-Present. Monthly frequency.

Source: Consensus Economics, Goldman Sachs Global Investment Research

Exhibit 11:



Note: Model includes 1-year ahead CPI, GDP, and 3m interest rate expectations for the US and Japan, and the 10y rate differential vs the US. Sample: 2003-Present. Monthly frequency.

Source: Consensus Economics, Goldman Sachs Global Investment Research

Lower levels of implied volatility in recent weeks can be linked to more benign US economic data and a less uncertain macroeconomic backdrop, where tail recession and inflation risks have relaxed. Going forward though, this exercise highlights the types of factors that could shift implied and realized FX volatility higher. Another large increase in tariff rates, for example, could quickly increase macro uncertainty. Additionally, many of the factors driving higher FX volatility have not been directly macro-related. Outsized FX hedging activity and structural shifts in portfolio flows have probably contributed to greater Dollar depreciation than our fundamental models can explain. US policy is making it harder for the US to attract unhedged capital flows, and that may mean larger FX moves than our vol models currently imply. For that reason, realized vol may continue to outpace implied vol as it has done for much of this year. The upside of lower implied volatility means that directional views can be expressed more inexpensively. We have argued that investors need to be more imaginative in their medium-run targets in an environment of rapidly shifting economic outlooks, and our results support that conclusion.

Isabella Rosenberg

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