

US ECONOMICS ANALYST

## AI and (Measured) Inflation: Up Then Down

- We expect artificial intelligence to deliver large productivity gains over the next several years, boosting the economy's potential growth rate and putting downward pressure on production costs. So far, however, AI is boosting US inflation.
- We see three key ways in which AI is boosting consumer prices. First, strong demand for AI infrastructure has raised the price of some key electronics inputs, which has increased computer accessories prices and will likely boost smartphone and computer prices in coming months. Second, the addition of new AI features to existing software has likely put some upward pressure on software prices over the last couple of years. Third, higher electricity demand to power data centers is increasing electricity prices in some US regions, and we expect it to continue boosting inflation over the next couple of years.
- Recent increases in computer software and accessories prices have boosted core PCE inflation significantly, but we think much of that contribution is overstated. First, the software and accessories component receives about 30 times the weight in PCE as it does in CPI, but we think most of that gap reflects an overstatement of software sales to retail customers in the PCE source data. Second, PCE uses the same aggregate index of software and accessories prices as CPI despite putting greater relative weight on software, which has amplified and exaggerated the impact of the recent spike in computer accessories prices on the overall PCE index. Third, software and accessories are not quality-adjusted in either PCE or CPI, so new AI features have likely been captured as pure price (rather than quantity) increases. In contrast, the software deflator for capex—which does not include computer accessories and is quality-adjusted—has *declined* almost 4% over the last year.
- Using our equity analysts' expectations for computer and smartphone price increases, our estimates of changes in production costs from more expensive digital inputs, and our estimates of the contribution from higher power prices, we estimate that AI-related price pressures have boosted year-over-year core PCE and core CPI inflation by about 0.3pp and 0.1pp over the last year, respectively, and will boost them by another 0.3pp and 0.1pp over the next year.
- Once AI-related productivity gains become more widespread, we expect higher productivity growth to prove disinflationary at first—in line with the typical experience in prior episodes of technological innovation—especially if quality

**Manuel Abecasis**  
+1(212)902-8357 |  
manuel.abecasis@gs.com  
Goldman Sachs & Co. LLC

adjustment evolves to capture new AI features. AI could prove less disinflationary than prior episodes of productivity acceleration if it quickly translates into higher profits or wages (rather than lower prices) or if the Fed eases monetary policy in anticipation of disinflation.

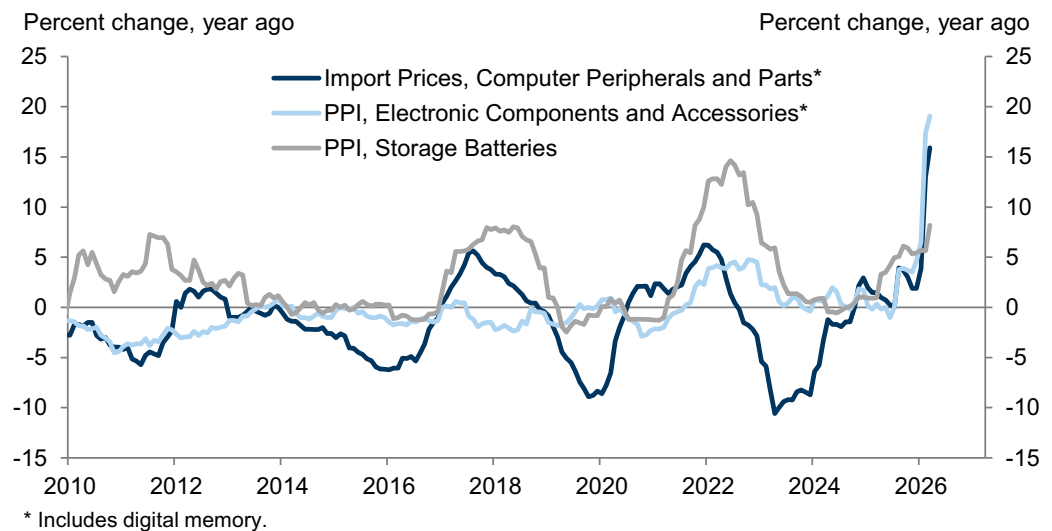
## AI and (Measured) Inflation: Up Then Down

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### Three Input Cost Pressures from AI Spending

We see three key channels through which AI is boosting inflation. First, strong demand for AI infrastructure has raised the prices of some key electronics inputs, including digital memory and batteries (Exhibit 1). Initially, AI-related demand caused sharp increases in the prices of a few specialized inputs like cutting-edge semiconductors. More recently, these cost pressures have broadened into a wider set of inputs that are key to electronics manufacturing, and they have boosted the prices of consumer electronics accessories like flash drives and other memory-related items.

#### Exhibit 1: AI-Related Demand Has Put Upward Pressure on Key Electronics Inputs



Source: Goldman Sachs Global Investment Research, Department of Commerce, Department of Labor

Second, AI-related spending has likely put some upward pressure on software prices over the last couple of years. For example, Microsoft raised the price of M365 consumer subscriptions for the first time ever in early 2025, and it is now including Copilot in all consumer M365 subscriptions (business subscriptions still feature it as a separate add-on). Others, like Adobe, have also raised prices and introduced new AI features into their software.

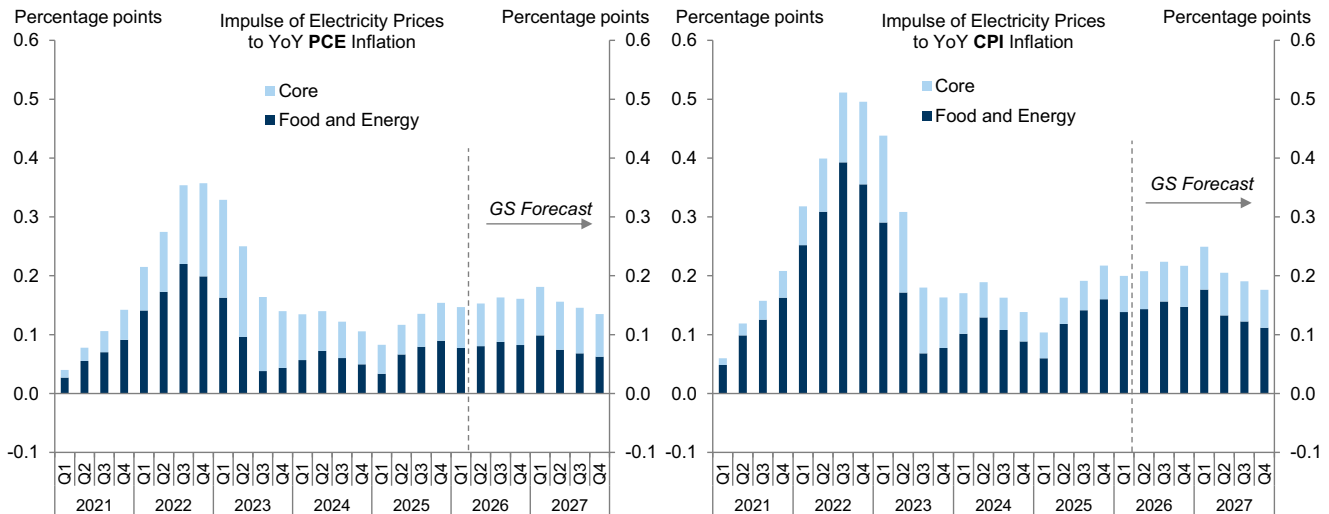
**Exhibit 2: Several Companies Have Recently Raised Software Prices, in Many Cases in Connection with New AI Features**

Product	Date	Approximate Price Increase
Microsoft M365 personal monthly	Jan-25	30%
Adobe Creative Cloud Photography	Jan-25	50%
Adobe Lightroom	Jan-25	30%
Microsoft M365 personal annual	Apr-25	30%
Adobe Creative Cloud Pro	Jun-25	17%
Duolingo	Jun-25	14%
Atlassian	Oct-25	7-10%
Intuit QuickBooks	Oct-25	45%
Apple Creator Studio	Jan-26	Rebranded bundle, about 2.6x old
Microsoft M365 apps	Jun-26	15%

Source: Goldman Sachs Global Investment Research

Third, strong demand for data centers is boosting electricity demand and power prices, and we expect this to continue. We estimate that higher electricity prices will boost headline PCE inflation both directly and indirectly by about 0.1-0.2pp over the next couple of years (left side of Exhibit 3). The boost to headline CPI will be larger because it places a larger weight on electricity (right side of Exhibit 3).

**Exhibit 3: We Estimate That Higher Electricity Prices Will Boost Headline PCE Inflation Both Directly and Indirectly by About 0.1-0.2pp Over the Next Couple of Years**



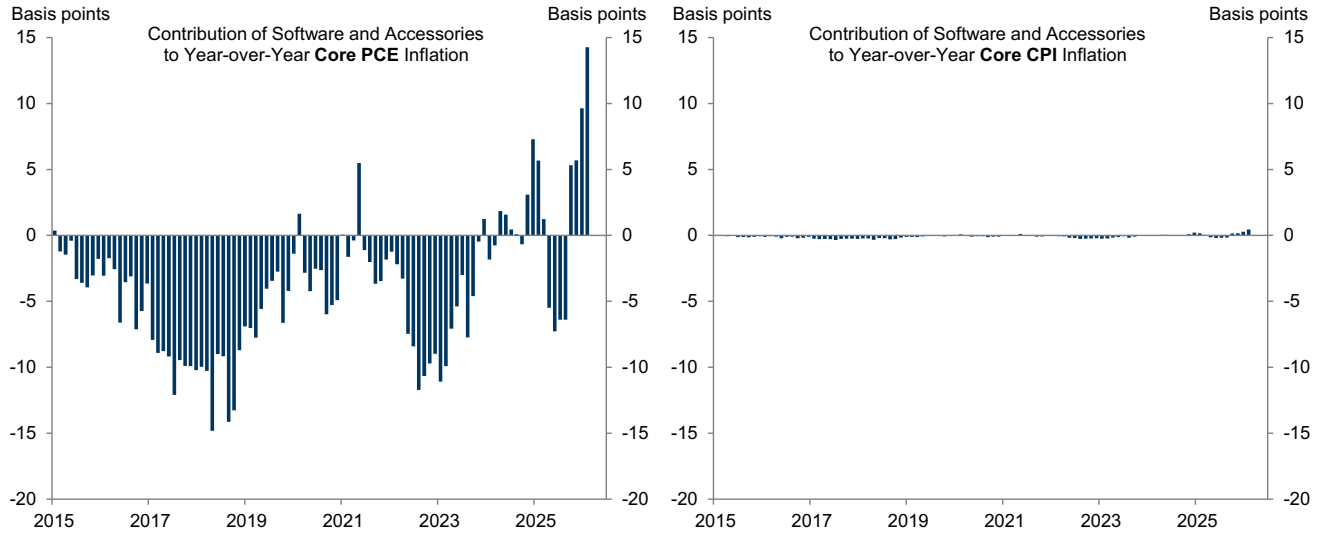
Source: Goldman Sachs Global Investment Research

**The AI Boost to Inflation Is Partly a Measurement Problem**

In recent months, the computer software and accessories component of PCE and CPI has accelerated sharply, likely reflecting a combination of higher accessories prices as a result of memory cost increases and higher software prices. Even though CPI and PCE use the same price index for this component, the recent acceleration has boosted core PCE by much more than core CPI because it receives about 30 times the weight in PCE

compared to CPI (Exhibit 4). Indeed, higher software and accessories prices have boosted core PCE by 0.15pp year-over-year and 0.6pp on a 6-month annualized basis. This is one reason why trimmed mean PCE inflation has been significantly lower than core inflation in recent months.

#### Exhibit 4: Higher Computer Software and Accessories Prices Have Boosted Core PCE by Much More Than Core CPI in Recent Months



Source: Goldman Sachs Global Investment Research, Department of Commerce, Department of Labor

We see a few potential measurement issues related to software’s contribution to PCE inflation, however. First, we suspect that the PCE weight on software is probably too large. The weight is based on a question in the Economic Census that asks businesses how much software they sell to individuals (rather than to companies or the government), which could inadvertently include software that households primarily use for work.<sup>1</sup> By contrast, the CPI weights are based on the Consumer Expenditure survey, which explicitly asks households to exclude business-related purchases.

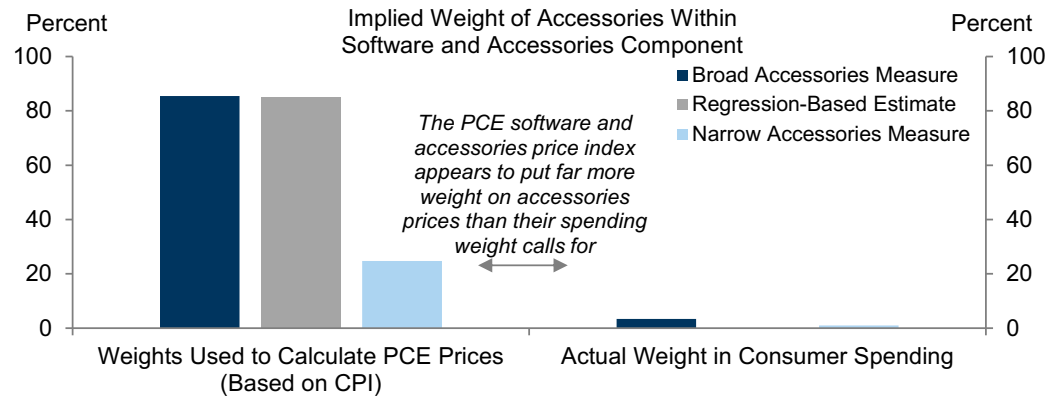
This much higher weight in PCE creates an additional measurement problem. Software and accessories are a single component in the CPI. And while PCE uses different source data than CPI for the software and accessories weight, it uses the CPI itself as source data for prices. Since the CPI’s software weight is relatively small (compared to PCE), computer accessories likely make up a much larger share of the combined software and accessories price index in the CPI than in the PCE index. While the BLS does not publish a breakdown of the relative weights of software and accessories within the overall category, our estimates on the left set of bars in Exhibit 5 show that accessories could receive a weight as high as 20% or more in the combined price index (and software 80% or less), despite accounting for a very small share of actual spending.

Because the different weights of software and accessories in CPI and PCE reflect different assessments of software (not accessories) spending, applying CPI prices to PCE weights likely overstates the importance of accessories prices. The right set of bars in Exhibit 5 shows that the weight of accessories is probably very small relative to the larger software market that informs the consumer spending weights in PCE, even though

<sup>1</sup> See Gerner, Thesia, George Janini, William Passero, Laura Paszkiewicz, and Mark Vendemia. “The CE and PCE: A Comparison,” *Monthly Labor Review* September 2006.

the price index likely receives a much larger weight. Consistent with this, the latest surge in the software and accessories component of PCE happened alongside the large increases in memory prices that mostly boosted accessories (rather than software) prices but a few months after the most prominent price increases in software.

**Exhibit 5: The PCE Price Index Appears to Put Far More Weight on Accessories Than Its Spending Share Calls for, Causing Accessories Prices to Have an Exaggerated Impact on Overall PCE Prices**



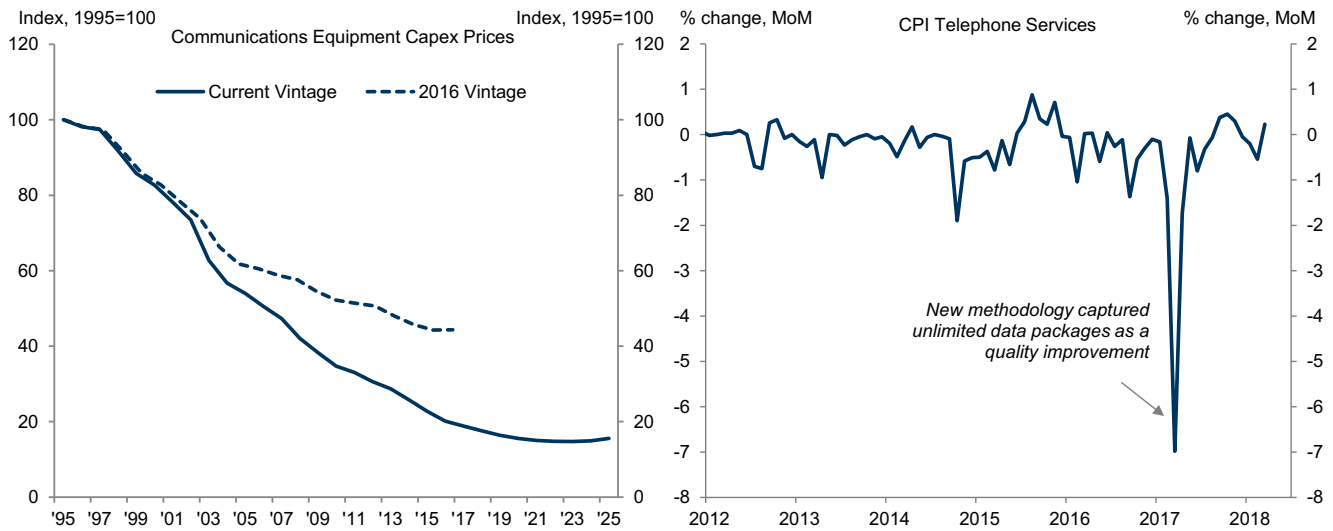
Note: We estimate the broad measure of accessories by subtracting computer, peripheral, and phone spending from retail sales of computers, communications, and related products in the Economic Census. The narrow measure subtracts retail sales of software from consumer spending on software and accessories implied by the CPI. The regression-based measure is based on the coefficients from a regression of the CPI software and accessories component on the PPIs for app software and computer storage devices.

Source: Goldman Sachs Global Investment Research, Department of Commerce

Second, the price index for software should account for the inclusion of AI features when comparing prices over time, but software and accessories are not quality-adjusted in CPI or PCE.<sup>2</sup> The statistical agencies could eventually introduce methodological adjustments that capture this—as they did with previous waves of technological innovation—but so far these improvements have probably gone unmeasured, meaning that inflation has been overstated.

<sup>2</sup> The Bureau of Labor Statistics (BLS) has not detailed its software pricing methodology in depth beyond saying that it does not quality-adjust this component. It might make adjustments beyond those that are publicly available, though the large price increases in early 2025 suggest this is unlikely.

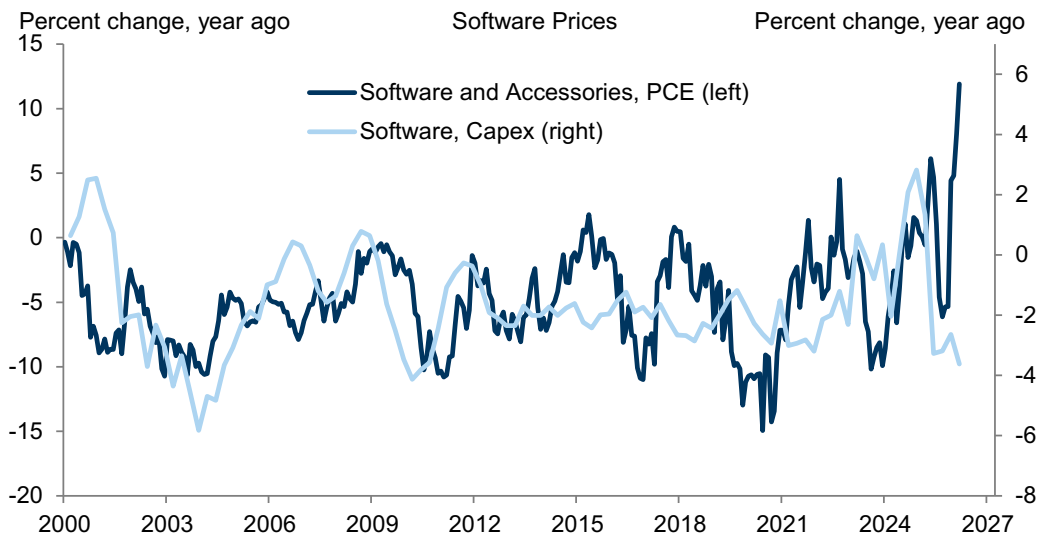
**Exhibit 6: Software Is Not Quality-Adjusted in Consumer Prices; Over Time, the Statistical Agencies Have Incorporated Quality Adjustment in Other Digital Goods and Services to More Accurately Capture Price Changes**



Source: Goldman Sachs Global Investment Research, Department of Commerce, Department of Labor

Comparing the PCE software and accessories index with other software price indices also suggests that accessories price pressures and methodological problems are likely contributing to the recent strength in the PCE measure. The software deflator for business investment—which leaves out accessories and is quality-adjusted—has continued to decline in recent quarters (Exhibit 7). While some companies have bundled AI-related software features into consumer prices but not business prices, we suspect that most of the discrepancy reflects measurement differences.

**Exhibit 7: The Business Investment Software Deflator—Which Leaves Out Computer Accessories and Is Quality-Adjusted—Has Diverged Sharply From Its PCE Analogue**



Source: Goldman Sachs Global Investment Research, Department of Commerce

**Near-Term Pressure on (Measured) Inflation from AI Spending...**

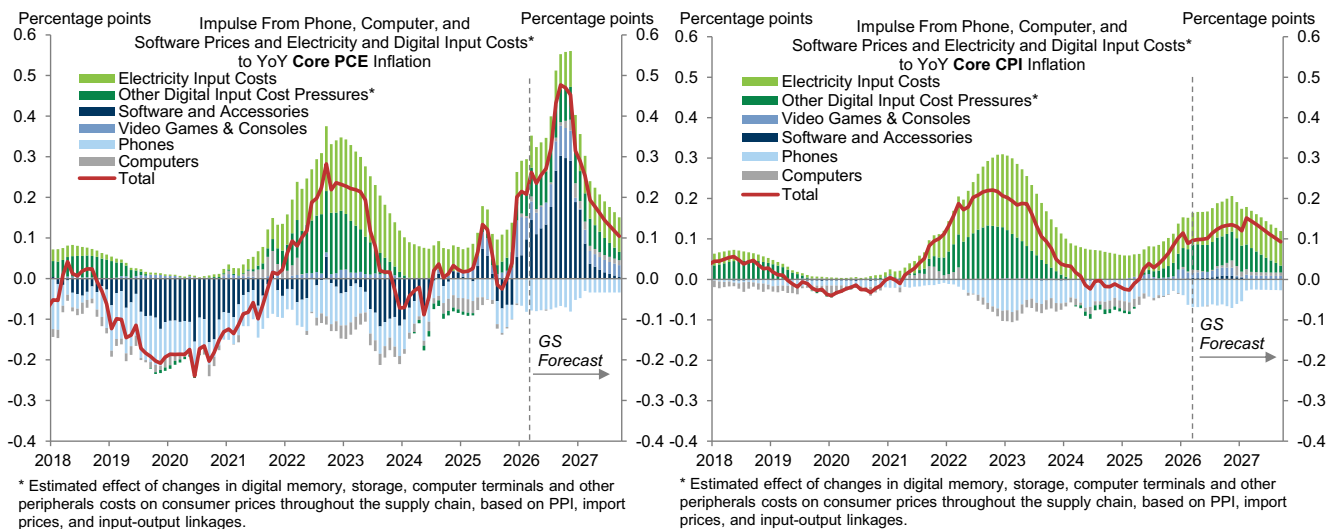
To gauge how AI-related price pressures on electronics and software will evolve, we

combine a few approaches. We rely on our equity analysts' forecasts for computer and phone prices, which point to increases in average selling prices of about 10% this year. We assume that this applies largely to non-Apple products (as our analysts expect that Apple has greater margin to manage the impact of higher memory costs without significant price increases) and combine these price increases with the typical contribution from quality adjustment in each category. We also incorporate our analysts' expectations that video game and console prices are likely to rise further this year, as well as our software analysts' expectation of moderate further increases in software prices for the remainder of the year.

Higher prices for digital inputs will also likely raise costs for goods and services beyond those we accounted for above. We therefore complement our estimates for computer, phone, games, and software prices with an estimate of the impulse from higher memory and other digital input costs to core inflation based on the BEA's input-output tables, the producer price index (PPI), and import prices. We assume that memory prices follow our equity analysts' expectation of positive-but-moderating price increases over the remainder of the year.

Exhibit 8 shows our forecasts for the corresponding categories. Taken together, we expect higher electronics and digital input prices to boost year-over-year core PCE inflation by about 0.3pp (with a 0.5pp peak in 2026Q3, partly reflecting the recent sharp increases in accessories prices) and core CPI inflation by about 0.1pp over the next year.

**Exhibit 8: We Expect Higher Electronics and Software Prices to Boost Year-over-Year Core PCE Inflation by About 0.3pp and Core CPI Inflation by About 0.1pp Over the Next Year**

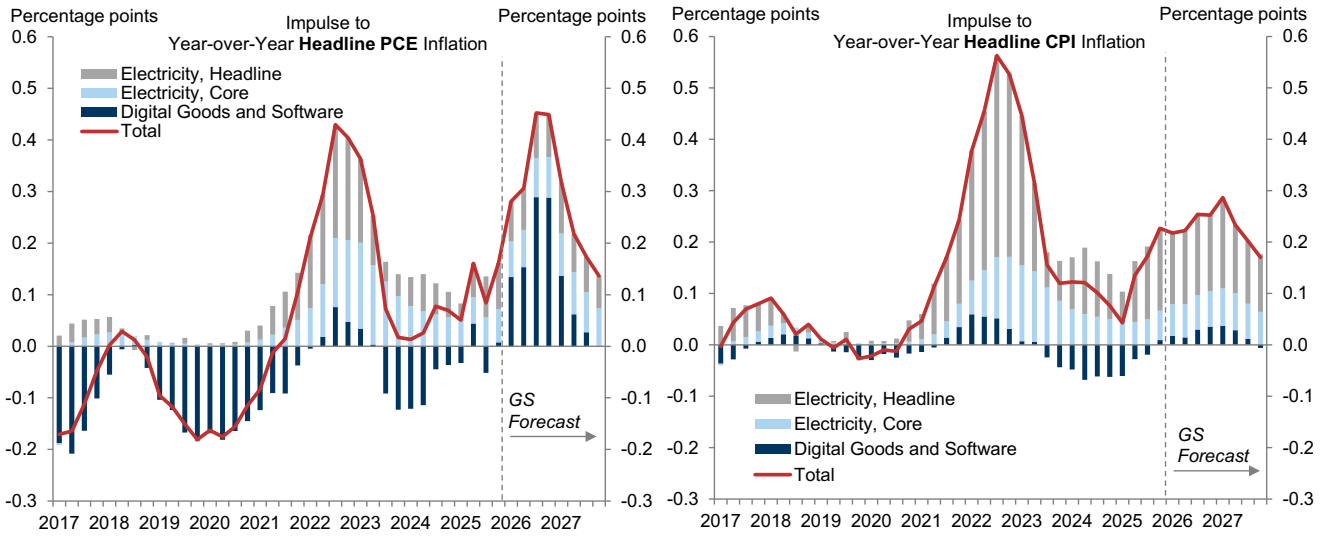


Source: Goldman Sachs Global Investment Research, Department of Commerce, Department of Labor

Exhibit 9 shows our combined impulses. Taken together, we estimate that these cost pressures have boosted year-over-year headline PCE and CPI inflation by about 0.3pp and 0.2pp over the last year and will boost them both by about 0.3pp over the next year.



**Exhibit 9: We Expect Higher Software and Accessories, Electronics, and Electricity Prices to Boost Headline Inflation Over the Next 1-2 Years**

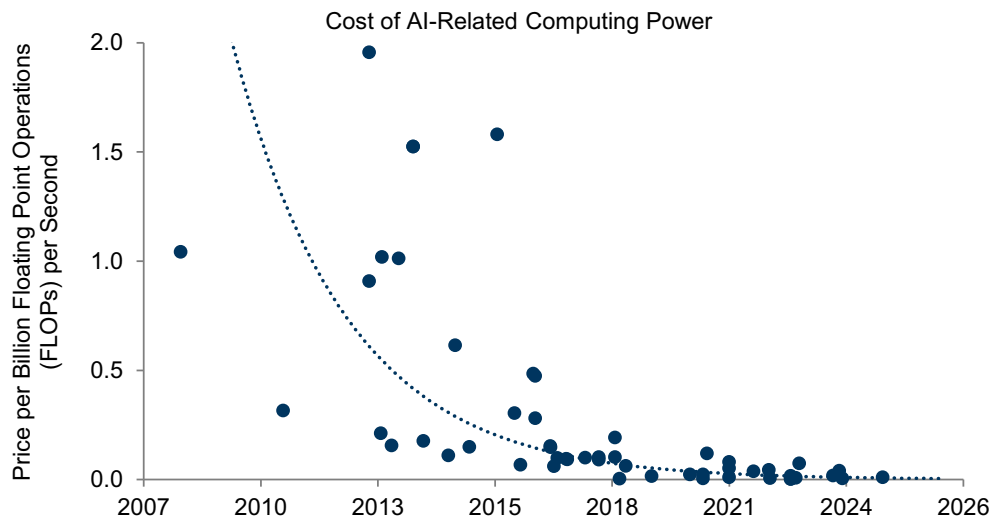


Source: Goldman Sachs Global Investment Research, Department of Commerce, Department of Labor

**... Followed by Medium-Term Disinflationary Relief from AI Productivity Gains**

We expect these upward price pressures from AI to prove temporary, for a couple of reasons. First, price pressures on critical inputs will likely moderate over the medium term because high prices will incentivize companies to boost supply. At the same time, AI companies will likely continue to find ways of operating more efficiently, as they have over the last several years and as happened in previous episodes of technological innovation. Exhibit 10 shows that AI-related hardware has become significantly cheaper over the last several years already.

**Exhibit 10: AI Hardware Has Become More Efficient Over Time**



Source: Goldman Sachs Global Investment Research, Epoch AI

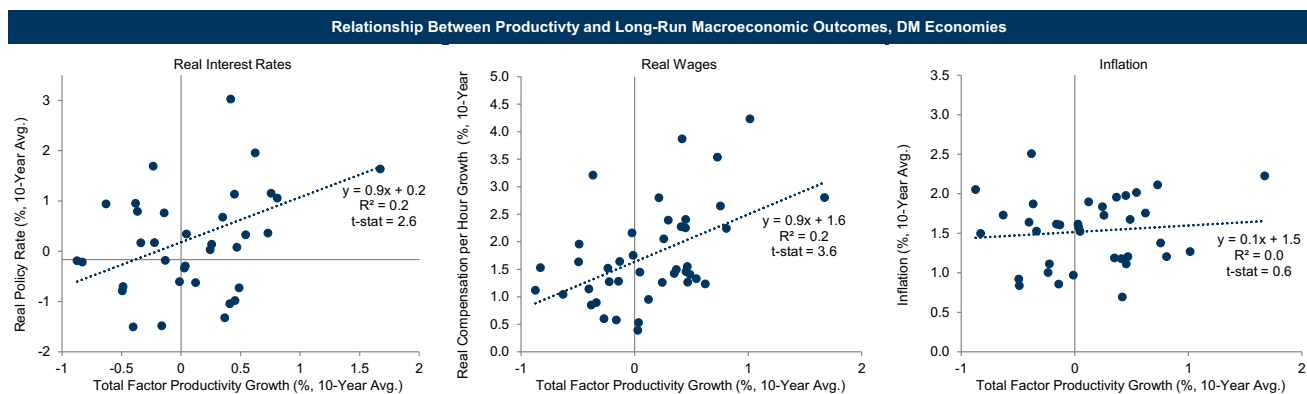
Second, as AI adoption continues to increase, we expect the disinflationary impact from

higher productivity growth to outweigh AI-related inflationary pressure.

Economic theory suggests that higher productivity of capital and labor should increase the real interest rate and wages in the long run, as capital owners and workers are compensated for their higher contributions to production. At the same time, inflation is largely the choice of the central bank over the long run. As it calibrates policy to achieve its inflation target, the central bank's policy rate will average the real neutral interest rate—which is determined by non-monetary forces, including productivity—plus its inflation target.

As shown in Exhibit 11, we find some evidence consistent with these economic principles: using long-run cross-country data as a proxy for different economic equilibria, we find that countries with faster productivity growth tend to have higher real interest rates and wages but find no relationship with inflation. That being said, other research has found little relationship between real output growth and long-term real interest rates over longer time horizons, so the strength of this mechanism could change over time.<sup>3</sup>

### Exhibit 11: Countries With Faster Productivity Growth Tend to See Higher Real Interest Rates and Real Wages, but There Is No Relationship With Inflation



Source: Goldman Sachs Global Investment Research, EUKLEMS

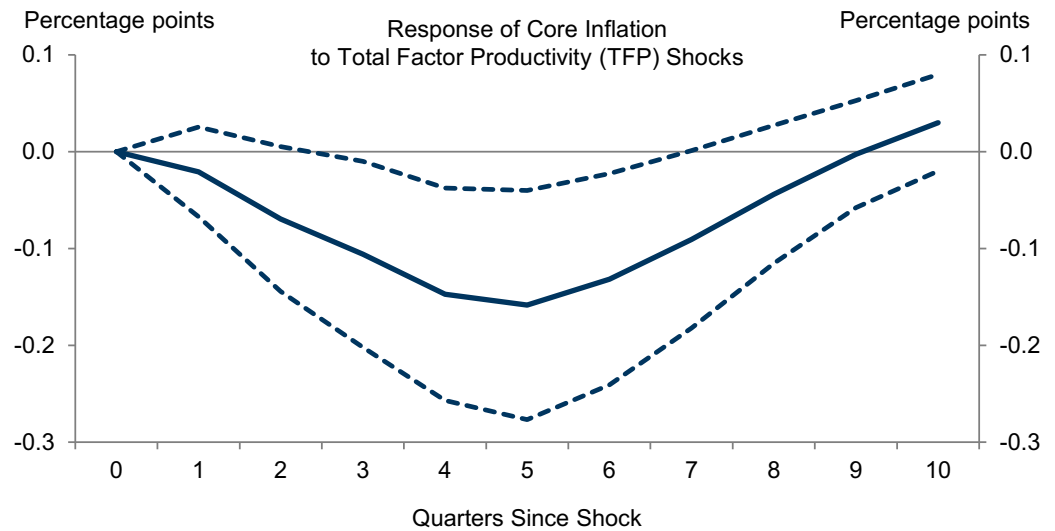
In the medium term, however, the transition to higher productivity growth is likely to weigh on prices, for at least a couple of reasons. First, wages typically take longer to adjust than prices, so businesses' production costs can fall before higher wages offset the decline. Second, faster productivity growth implies lower demand for labor and other production inputs if final demand doesn't immediately rise to its new potential level, and this can put downward pressure on wages and prices.<sup>4</sup>

We find some support for these short- and medium-run dynamics. As shown in Exhibit 12, positive shocks to total factor productivity—output divided by labor and capital inputs—tend to lower inflation at first. They also temporarily boost unemployment. These effects should surface after AI delivers more widespread productivity gains than it has so far, which we expect will happen in coming years.

<sup>3</sup> Rogoff, Kenneth S., Barbara Rossi, and Paul Schmelzing. 2024. "Long-Run Trends in Long-Maturity Real Rates, 1311–2022." *American Economic Review* 114 (8): 2271–2307.

<sup>4</sup> See, for example, Basu, Susanto, John G. Fernald, and Miles S. Kimball. 2006. "Are Technology Improvements Contractionary?" *American Economic Review* 96 (5): 1418–1448; and Delli Gatti, Domenico, Mauro Gallegati, Bruce C. Greenwald, Alberto Russo, and Joseph E. Stiglitz. 2012. "Mobility constraints, productivity trends, and extended crises." *Journal of Economic Behavior & Organization* 83 (3): 375–393.

**Exhibit 12: Faster Productivity Growth Is Associated With Lower Inflation at First**



Source: Goldman Sachs Global Investment Research

We see some risk that AI provides a more modest disinflationary impulse than our analysis suggests, for a few reasons. First, while we expect productivity gains to be sufficiently widespread to lower costs across a variety of industries, some AI-related product improvements—such as better software features—could be missed by the inflation statistics (as they likely are now). Second, the distribution of AI-enabled productivity gains is uncertain. While recent technological innovations have lowered consumer prices, the extent of the disinflationary impulse will depend on the degree to which competition forces businesses to lower prices, which remains highly uncertain. Third, the investment costs of AI are very high, and recovering those costs could keep prices high and counteract AI-driven declines in production costs. Fourth, the Fed could ease monetary policy in anticipation of the productivity benefits from AI, which could counteract the disinflationary impact of faster productivity growth.

**Manuel Abecasis**

## The US Economic and Financial Outlook

## THE US ECONOMIC AND FINANCIAL OUTLOOK

(% change on previous period, annualized, except where noted)

	2023	2024	2025	2026	2027	2025				2026			
						Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
<b>OUTPUT AND SPENDING</b>													
Real GDP	2.9	2.8	2.1	2.1	2.0	-0.6	3.8	4.4	0.5	2.0	1.8	1.9	1.9
Real GDP (annual=Q4/Q4, quarterly=yoy)	3.4	2.4	2.0	1.9	2.2	2.0	2.1	2.3	2.0	2.7	2.1	1.5	1.9
Consumer Expenditures	2.6	2.9	2.6	1.8	1.8	0.6	2.5	3.5	1.9	1.6	0.9	1.4	1.5
Residential Fixed Investment	-7.8	3.2	-2.2	-3.0	2.0	-1.0	-5.1	-7.1	-1.7	-8.0	2.0	1.5	1.5
Business Fixed Investment	7.3	2.9	4.1	5.9	4.9	9.5	7.3	3.2	2.4	10.4	6.0	5.2	4.6
Structures	16.7	1.1	-5.3	-2.9	3.7	-3.1	-7.5	-5.0	-6.6	-6.7	2.2	4.0	4.0
Equipment	2.9	3.5	8.3	8.9	5.4	21.3	8.5	5.2	4.3	17.2	9.0	6.0	5.0
Intellectual Property Products	6.2	3.5	5.6	7.7	4.9	6.5	15.0	5.6	5.4	13.0	5.0	5.0	4.5
Federal Government	3.3	3.8	-1.2	-1.0	0.9	-5.6	-5.3	2.7	-16.7	9.4	0.0	1.0	1.0
State & Local Government	3.6	3.8	2.5	1.3	0.9	1.9	3.1	2.0	1.5	1.6	0.5	0.5	1.0
Net Exports (\$bn, '17)	-925	-1,033	-1,091	-1,095	-1,153	-1,381	-1,058	-956	-969	-1,068	-1,095	-1,103	-1,115
Inventory Investment (\$bn, '17)	47	44	29	24	49	172	-18	-24	-16	-8	25	35	45
Nominal GDP	6.7	5.3	5.0	5.9	4.6	2.9	6.0	8.3	4.2	5.6	7.6	4.8	4.4
Industrial Production, Mfg.	-1.0	-1.0	0.9	2.7	3.3	4.0	2.5	2.5	-3.1	5.7	4.3	3.5	3.2
<b>HOUSING MARKET</b>													
Housing Starts (units, thous)	1,421	1,371	1,356	1,286	1,322	1,401	1,354	1,346	1,323	1,280	1,290	1,280	1,292
New Home Sales (units, thous)	665	685	672	670	644	655	665	688	680	690	690	662	638
Existing Home Sales (units, thous)	4,103	4,067	4,076	4,212	4,375	4,087	4,013	4,047	4,157	4,169	4,189	4,223	4,267
Case-Shiller Home Prices (%yoy)*	5.3	3.8	0.6	0.8	2.2	3.9	2.4	1.5	0.6	0.3	0.8	0.7	0.8
<b>INFLATION (% ch, yr/yr)</b>													
Consumer Price Index (CPI)**	3.3	2.9	2.7	3.5	2.0	2.7	2.5	2.9	2.7	2.7	3.8	3.6	3.6
Core CPI **	3.9	3.2	2.6	2.1	2.0	3.1	2.8	3.1	2.7	2.5	2.6	2.3	2.2
Core PCE** †	3.1	3.0	3.0	2.7	2.0	2.8	2.7	2.9	2.9	3.1	3.2	3.1	2.9
<b>LABOR MARKET</b>													
Unemployment Rate (%)^	3.8	4.1	4.4	4.6	4.4	4.2	4.1	4.4	4.4	4.3	4.5	4.6	4.6
U6 Underemployment Rate (%)^	7.2	7.6	8.4	8.7	8.3	7.9	7.7	8.1	8.4	8.0	8.4	8.6	8.7
Payrolls (thous, monthly rate)	210	122	10	40	92	20	34	23	-39	68	20	27	47
Employment-Population Ratio (%)^	60.1	59.9	59.7	58.9	58.9	59.9	59.7	59.7	59.7	59.2	59.1	59.0	58.9
Labor Force Participation Rate (%)^	62.5	62.5	62.4	61.8	61.6	62.5	62.3	62.5	62.4	61.9	61.9	61.8	61.8
Average Hourly Earnings (%yoy)	4.2	5.4	4.6	4.0	3.9	5.0	4.6	4.5	4.4	4.2	4.1	3.9	3.8
<b>GOVERNMENT FINANCE</b>													
Federal Budget (FY, \$bn)	-1,694	-1,833	-1,775	1,950	2,050	--	--	--	--	--	--	--	--
<b>FINANCIAL INDICATORS</b>													
FF Target Range (Bottom-Top, %)^	5.25-5.5	4.25-4.5	3.5-3.75	3-3.25	3-3.25	4.25-4.5	4.25-4.5	4-4.25	3.5-3.75	3.5-3.75	3.5-3.75	3.25-3.5	3-3.25
10-Year Treasury Note^	3.88	4.58	4.18	4.20	4.25	4.23	4.24	4.16	4.18	4.30	4.20	4.20	4.20
Euro (€/€)^	1.11	1.04	1.17	1.19	1.20	1.08	1.18	1.17	1.17	1.15	1.14	1.18	1.19
Yen (\$/¥)^	141	157	157	155	141	150	144	148	157	160	160	158	155

\* Weighted average of metro-level HPIs for 381 metro cities where the weights are dollar values of housing stock reported in the American Community Survey. Annual numbers are Q4/Q4.

\*\* Annual inflation numbers are December year-on-year values. Quarterly values are Q4/Q4.

† PCE = Personal consumption expenditures. ^ Denotes end of period.

Note: Published figures in bold.

Source: Goldman Sachs Global Investment Research.

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## The US Economics Team

**Jan Hatzius**

+1(212)902-0394  
jan.hatzius@gs.com  
Goldman Sachs & Co. LLC

**Alec Phillips**

+1(202)637-3746  
alec.phillips@gs.com  
Goldman Sachs & Co. LLC

**David Mericle**

+1(212)357-2619  
david.mericle@gs.com  
Goldman Sachs & Co. LLC

**Ronnie Walker**

+1(917)343-4543  
ronnie.walker@gs.com  
Goldman Sachs & Co. LLC

**Manuel Abecasis**

+1(212)902-8357  
manuel.abecasis@gs.com  
Goldman Sachs & Co. LLC

**Elsie Peng**

+1(212)357-3137  
elsie.peng@gs.com  
Goldman Sachs & Co. LLC

**Pierfrancesco Mei**

+1(212)902-8809  
pierfrancesco.mei@gs.com  
Goldman Sachs & Co. LLC

**Jessica Rindels**

+1(972)368-1516  
jessica.rindels@gs.com  
Goldman Sachs & Co. LLC