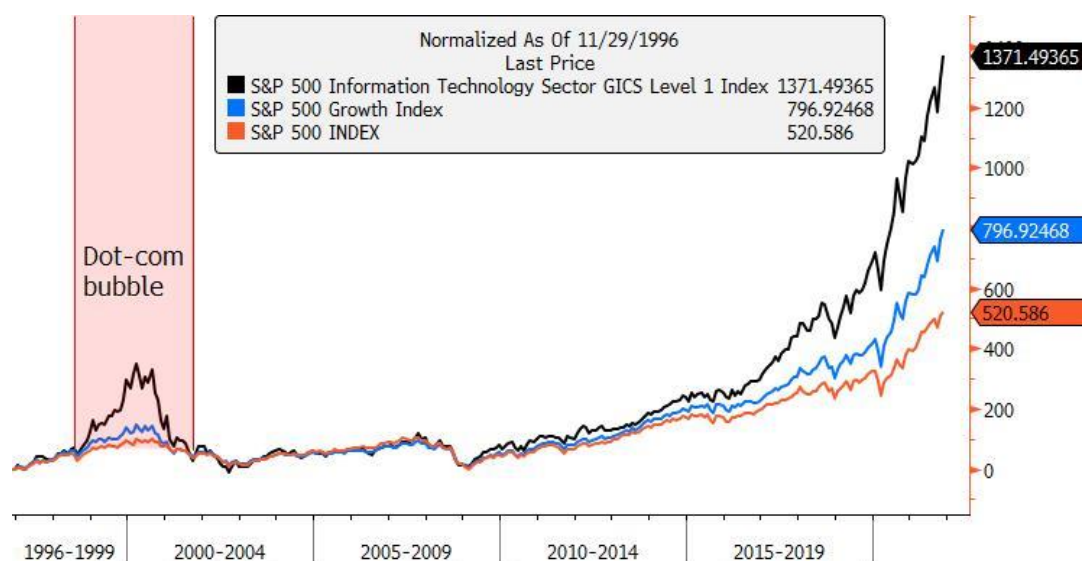


# The Econometrics of Tech Stocks

## Introduction

We are now over a year and a half into the Covid pandemic. Disruptive as this exogenous shock has been, markets have quickly recovered, and proceeded to reach one new record after the other. More interestingly, several information technology stocks have stood the challenge without a bruise. Remote work has forced the world economy to rely on the likes of Apple, Zoom, Nvidia and others on a daily basis. Improved software and hardware boosted earnings, which in turn bolstered their stock returns after the March 2020 slump.



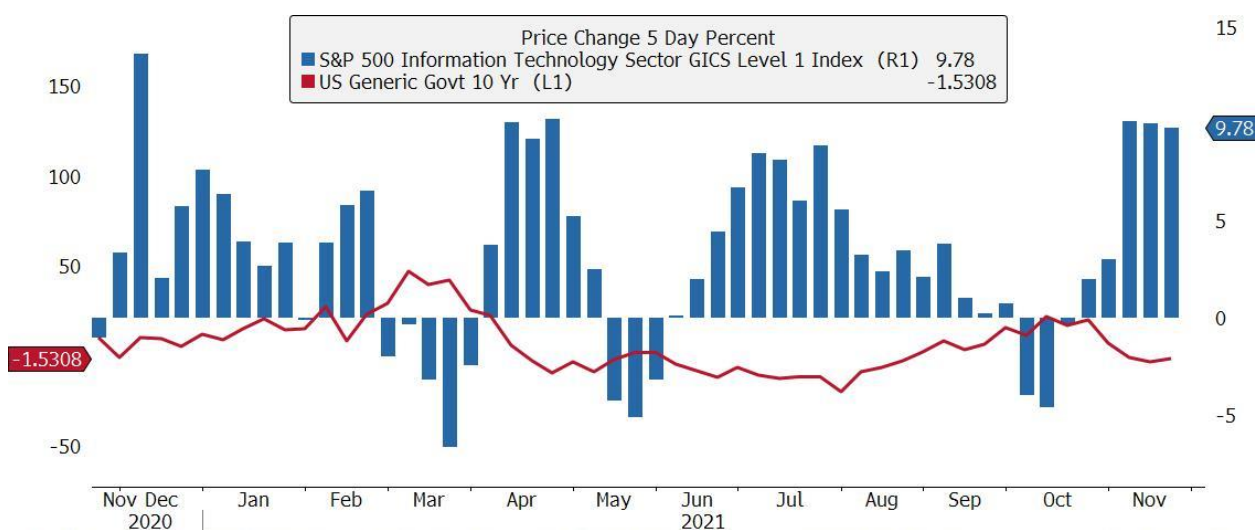
Percentage Appreciation on SPX Info Tech Index, SPX Growth Index and SPX

Source: Bloomberg, Bocconi Students Investment Club

Our goal in this article is to understand if the trend is here to stay in the face of a new market regime, namely with higher inflation as well as interest rates. Interest rates are a key element of the discounted cash flow valuation model, but compressed valuations are not the only factor that could lead to less than enthusiastic returns in the technology sector. A stock trading at a price-to-earnings ratio of 50 effectively offers an earnings yield of 2%. That 2% is very attractive if your alternative is a savings account or government treasury bond that offers roughly 0%. However, if interest rates climb, that 2% yield looks far less attractive. Moreover, the relatively longer equity duration of these stocks makes them more sensitive to the market scenario profiled as most likely.

Rising costs of raw materials — such as hard disk drives and semiconductors — only amplify the concert in the realm of tech stocks, often included in the growth category, as we have seen with the disappointing Q3 earnings for Apple. Heavy borrowing to boost future growth may be feasible for a little longer, but increased leverage can soon become too much of a burden.

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We believe that, to navigate these complex market scenarios, investors are best served by a rigorous statistical approach able to identify the statistically relevant drivers of tech stock returns, and how they may be affected by changing market regimes.

### Methodology

Before we delve into our econometric framework, let us briefly motivate our methodological choices. Firstly, we will rely on regression analysis. Price time series have been stationarized through conversion into return time series. As a proxy for returns on tech stocks we use the S&P 500 Information Technology Index (S5INF1). At the time of writing, the 10 biggest constituents (by market cap) are:

Stock	Market Cap
APPLE INC.	\$ 2,634,047,520,000
MICROSOFT CORPORATION	\$ 2,576,063,017,800
NVIDIA CORPORATION	\$ 824,625,000,000
VISA INC.	\$ 427,192,462,620
MASTERCARD INCORPORATED.	\$ 333,794,399,928
ADOBE INC.	\$ 327,526,446,000
SALESFORCE.COM, INC.	\$ 294,845,430,000
ORACLE CORPORATION	\$ 256,884,473,420
BROADCOM INC.	\$ 234,094,422,136
ACCENTURE PUBLIC LIMITED COMPANY	\$ 242,855,699,705

Rather than OLS, we prefer to use a weighted least squares (WLS) regression, which is robust to the presence of heteroskedasticity. Non-constant variance is a classic feature of return time series of financial assets, and the Breusch-Pagan test rejects the null hypothesis of no heteroskedasticity with a p-value of 0.02. We could also have applied a log transformation to the series, but then the coefficients would have been interpreted as elasticities, which would not be particularly insightful in our setting. The betas we obtain with the chosen framework are to be

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interpreted as the change in the response variable (percentage returns) for a 0.01 increase in the explanatory variable associated with the beta. The regressors are summarized in the following table.

<b>Variable</b>	<b>Full Name (daily returns)</b>
ret	Daily returns of the S&P 500 Information Technology index
ust10y	US 10 Year Treasury
oil	WTI spot
vix	Chicago Board Options Exchange's CBOE Volatility Index
eurusd	EUR USD cross
usdcny	USD CNY cross
sox	PHLX Semiconductor Sector
spx	S&P 500 Index
hsi	Hang Seng Index
2s10s_usa	Index on 2s10s spread US
2s10s_eur	Index on 2s10s spread EUR
5y5y	5y5y forward CPI swaps

As discussed in the introduction, rates and inflation are perceived as important drivers of return on tech stocks. We include them in the regression through the 10-year Treasury rate, the 2s10s spreads on USD and EUR swaps, and the 5y5y forward on CPI swaps. We use the latter instead of CPI YoY data to proxy for inflation (expectations) because we need continuous data. Secondly, we add oil as a gauge of the macroeconomy, to investigate the role it might play in bullishness on the tech sector. The EUR USD and USD CNY crosses are added to analyse if relative strength between these relevant currencies is statistically significant. Finally, we include some market indices to assess the relevance of general market conditions on the tech sector. More specifically, the SOX index should allow us to understand how sentiment on semiconductor companies is related with tech stocks.

The period we chose for our regression analysis goes from 2004 to today. We start from 2004 to ensure that the dot-com bubble and its aftermath don't act as confounding factors, undermining the robustness of our results. We further perform 4 separate regressions subdividing the data into three carefully selected periods, to investigate if/how the drivers change across market and economic conditions. The 4 selected periods are:

<b>Jul 2004 – Aug 2007</b>	After the end of the dot-com bubble, Fed Governors Greenspan and Bernanke hike interest rates up to over 5.25%. Semiconductor prices fall by as much as 50%, powering the growth of hardware-dependent companies. Rising inflation and a looming credit crunch, however, don't stop the successful IPOs of some current index components: Salesforce, Paypal, Mastercard and Visa to name a few.
<b>Sept 2007 - Jan 2009</b>	After a rise in inflation to 3.84% in mid-2007, coupled with a similar rise in commodities and oil prices, the global economy plunges into recession with the collapse of Lehman Brothers in Sept 2008. The VIX reaches 80.
<b>Jan 2009 - Feb 2020</b>	Quantitative easing begins. The US stock market experiences a historical bull run. Inflation is low throughout the developed world and unemployment keeps falling in the US. The consistent GDP growth, despite concerns of being fuelled by debt, is backed by the surge of technological companies, this time – unlike the 2000s – with strong fundamentals. Oil prices at historical lows, as well as a strengthening dollar reaching pre-GFC levels signal an almost goldilocks period.
<b>Feb 2020 - today</b>	The world is hit by COVID 19, forcing businesses to halt operations and ask for Government intervention. In the meantime, amid rising debt levels and lockdown measures, work-from-home companies such as tech stocks see their valuations booming to new all-time highs. The equity market, bolstered by US Treasury yields approaching zero, sees continuously rising valuations. Sudden spikes in the VIX reflect several risks, including financial contagion, rising inflation (post-COVID-19) and recurrent crazes in the equity and crypto market alike (ie. Gamestop, AMD, Digital World Acquisition, NFTs).

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Finally, we employ a very powerful methodology to further analyze how the value and statistical significance of the coefficients change under different regimes, namely a Markov Switching model. The difference, compared to performing separate regression for subintervals of the considered time frame, is that in Markov Switching models, the regimes (in our case, 3) are unobservable and generated by a discrete ergodic first-order Markov chain. While this involves the drawback of not being able to fully understand what the regimes represent (i.e., which market conditions they are associated to), the silver lining is that Markov Switching models are known to lead to more accurate out-of-sample results, proving useful for forecasting.

### Regression Analysis

We now move on to presenting the results of the first regression analysis, which covers the entire period (2004 to today). The coefficients and statistical tests are displayed in the table below.

## Correlation Matrix and Regression Results, 2004-2021

	ust10y	oil	vix	eurusd	usdcny	sox	spx	hsi	2s10s_usa	2s10s_eur	5y5y
ust10y	1	0.13	-0.31	-0.023	-0.02	0.34	0.42	0.13	0.25	0.096	0.16
oil	0.13	1	-0.12	0.083	-0.045	0.13	0.17	0.082	0.055	0.016	0.048
vix	-0.31	-0.12	1	-0.11	0.082	-0.62	-0.72	-0.15	-0.082	-0.048	-0.11
eurusd	-0.023	0.083	-0.11	1	-0.14	0.15	0.2	0.09	0.066	0.021	0.1
usdcny	-0.02	-0.045	0.082	-0.14	1	-0.089	-0.083	-0.14	-0.02	-0.016	-0.062
sox	0.34	0.13	-0.62	0.15	-0.089	1	0.8	0.21	0.11	0.046	0.11
spx	0.42	0.17	-0.72	0.2	-0.083	0.8	1	0.24	0.12	0.064	0.16
hsi	0.13	0.082	-0.15	0.09	-0.14	0.21	0.24	1	0.077	0.051	0.1
2s10s_usa	0.25	0.055	-0.082	0.066	-0.02	0.11	0.12	0.077	1	0.34	0.096
2s10s_eur	0.096	0.016	-0.048	0.021	-0.016	0.046	0.064	0.051	0.34	1	0.0027
5y5y	0.16	0.048	-0.11	0.1	-0.062	0.11	0.16	0.1	0.096	0.0027	1

BSIC BOCCONI STUDENTS INVESTMENT CLUB	Coef.	Std.Err.	t	P >  t
const	0,0002	0,0001	2,425	0,015
ust10y	-0,009	0,003	-2,937	0,003
oil	-0,002	0,001	-1,619	0,105
vix	-0,002	0,001	-1,574	0,116
eurusd	-0,073	0,013	-5,497	0,000
usdcny	-0,086	0,044	-1,961	0,050
sox	0,297	0,007	44,602	0,000
spx	0,706	0,012	59,231	0,000
hsi	0,002	0,005	0,341	0,733
2s10s_usa	-0,400	0,237	-1,688	0,092
2s10s_eur	0,375	0,273	1,374	0,169
5y5y	-0,010	0,003	-3,164	0,002
	RSE	0,004809	Adj. R-squared	0,879

Source: Bocconi Students Investment Club

Despite having tested for multicollinearity and found that it is absent, we can find insights from looking at the correlation between the variables. As expected, there is persistent negative correlation among the VIX and the S&P 500, due to the leverage effect. US Treasury yields are positively correlated (0.4) with the US equity markets, while oil has been uncorrelated to most other variables (as well as inflation expectations), indicating that the commodity can often serve as a good diversifier in a portfolio. The PHLX Semiconductor Sector is strongly correlated (0.8) with the S&P 500. The index, whose performance is now heavily dependent on Taiwan and other Asian semiconductor-producing economies, has recorded a correlation of only 0.2 with the Hang Seng Index.

In the regression, the statistically significant variables are **ust10y**, **eurusd**, **usdcny**, **sox**, **spx** and **5y5y**. While the two equity indexes will remain crucial variables in all the timeframes – here with positive coefficients of 0.297 and

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0.706 respectively – we can see that the mainstream rates/inflation narrative remains consistent: we estimate *negative* betas for both. For instance, a 1% increase in the 10y Treasury is associated with a 0.88% loss in the S5INFT, ceteris paribus. Equally interesting is the statistical significance of the EURUSD (price of 1 EUR in USD) and USDCNY (price of 1 USD in CNY) crosses, both exhibiting negative coefficients. This seems to indicate that an appreciation of the dollar against the euro (lower EURUSD) supports American tech equities, while a relative USD strength against the yuan (higher USDCNY) weighs on the tech sector. This latter result is quite puzzling, as we would expect a stronger dollar to bring down the effective cost of imports from China and thus support American equities, but as we shall see in the last section, with the Markov Switching analysis, a more accurate result will support our intuition.

On another note, our linear regression has an adjusted R-squared of 0.80 and a RSE of 0.004809, indicating that we have captured most of the variability in the data.

### Regressions on different time intervals

#### 1. Jul 2004 – Aug 2007

### Correlation Matrix and Regression Results, 2004-2007

	ust10y	oil	vix	eurusd	usdcny	sox	spx	hsi	2s10s_usa	2s10s_eur	5y5y
ust10y	1	-0.017	-0.13	-0.24	-0.068	0.052	0.089	0.051	0.11	0.0083	0.089
oil	-0.017	1	-0.0051	0.13	0.056	-0.065	-0.027	0.069	0.0088	0.013	0.033
vix	-0.13	-0.0051	1	0.0057	-0.066	-0.5	-0.8	-0.062	0.095	-0.0082	0.04
eurusd	-0.24	0.13	0.0057	1	-0.022	0.012	0.034	0.041	0.12	0.021	0.0088
usdcny	-0.068	0.056	-0.066	-0.022	1	0.046	0.039	-0.01	-0.032	0.056	-0.087
sox	0.052	-0.065	-0.5	0.012	0.046	1	0.66	0.14	-0.018	0.073	-0.005
spx	0.089	-0.027	-0.8	0.034	0.039	0.66	1	0.099	-0.08	0.038	-0.036
hsi	0.051	0.069	-0.062	0.041	-0.01	0.14	0.099	1	0.0082	-0.031	-0.018
2s10s_usa	0.11	0.0088	0.095	0.12	-0.032	-0.018	-0.08	0.0082	1	0.22	0.14
2s10s_eur	0.0083	0.013	-0.0082	0.021	0.056	0.073	0.038	-0.031	0.22	1	0.087
5y5y	0.089	0.033	0.04	0.0088	-0.087	-0.005	-0.036	-0.018	0.14	0.087	1

	Coef.	Std.Err.	t	P >  t
const	0,0001	0,0001	0,758	0,448
ust10y	0,017	0,014	1,185	0,236
oil	-0,026	0,007	-3,987	0,000
vix	-0,002	0,004	-0,575	0,566
eurusd	-0,025	0,028	-0,895	0,371
usdcny	-0,127	0,148	-0,856	0,392
sox	0,311	0,012	26,260	0,000
spx	0,678	0,039	17,602	0,000
hsi	-0,016	0,016	-1,058	0,290
2s10s_usa	0,363	0,637	0,569	0,569
2s10s_eur	0,553	0,788	0,702	0,483
5y5y	-0,018	0,009	-2,014	0,044
RSE		0,0037389	Adj. R-squared	0,84

Source: Bocconi Students Investment Club

On the correlation matrix, US Treasuries show a much weaker correlation with the equity markets considered, perhaps defending the thesis that their diversification benefit was once stronger than today.

In the linear regression, we find as statistically significant **oil**, **sox**, **spx** and **5y5y**. For oil, we estimate a negative beta of -0.0262, almost as strong – in absolute value – as the beta of the PHLX Semiconductor Sector index. Inflation, while still statistically significant, is found to be much lower at -0.0177. On balance, it appears that before the crisis of subprime lending, and the ensuing GFC, tech stocks were driven primarily by economic activity (instrumented with oil), inflation expectations, and general equity market drivers.

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## 2. Sept 2007 – Jan 2009

### Correlation Matrix and Regression Results, 2007-2009

	ust10y	oil	vix	eurusd	usdcny	sox	spx	hsi	2s10s_usa	2s10s_eur	5y5y
ust10y	1	0.21	-0.46	-0.032	0.0035	0.44	0.51	0.13	0.014	-0.032	0.13
oil	0.21	1	-0.18	0.34	-0.093	0.18	0.24	0.24	0.072	-0.084	-0.01
vix	-0.46	-0.18	1	-0.1	0.021	-0.69	-0.81	-0.2	0.072	0.0051	-0.093
eurusd	-0.032	0.34	-0.1	1	-0.13	0.13	0.19	0.21	-0.041	-0.093	0.15
usdcny	0.0035	-0.093	0.021	-0.13	1	-0.011	-0.053	-0.042	-0.039	0.018	0.024
sox	0.44	0.18	-0.69	0.13	-0.011	1	0.84	0.19	0.04	0.013	0.0079
spx	0.51	0.24	-0.81	0.19	-0.053	0.84	1	0.28	-0.0011	-0.00098	0.079
hsi	0.13	0.24	-0.2	0.21	-0.042	0.19	0.28	1	-0.15	-0.15	0.077
2s10s_usa	0.014	0.072	0.072	-0.041	-0.039	0.04	-0.0011	-0.15	1	0.26	-0.0019
2s10s_eur	-0.032	-0.084	0.0051	-0.093	0.018	0.013	-0.00098	-0.15	0.26	1	-0.11
5y5y	0.13	-0.01	-0.093	0.15	0.024	0.0079	0.079	0.077	-0.0019	-0.11	1

BSIC BOCCONI STUDENTS INVESTMENT CLUB	Coef.	Std.Err.	t	P >  t
const	0.0004	0.0004	1.127	0.261
ust10y	0.009	0.018	0.508	0.612
oil	-0.005	0.012	-0.467	0.640
vix	0.003	0.008	0.345	0.731
eurusd	0.034	0.053	0.634	0.527
usdcny	0.293	0.287	1.023	0.307
sox	0.345	0.027	12.956	0.000
spx	0.624	0.039	15.941	0.000
hsi	0.015	0.014	1.094	0.275
2s10s_usa	-0.508	0.757	-0.671	0.503
2s10s_eur	0.760	0.785	0.968	0.333
5y5y	-0.013	0.008	-1.574	0.116
RSE		0.00717238	Adj. R-squared	0.90

Source: Bocconi Students Investment Club

During the GFC, **ust10y** recorded a correlation of 0.5 with the S&P 500, while the only real "hedge" (negatively correlated to most assets) was the VIX. The Hang Seng increased its correlation to the main equity index compared to the previous period, while inflation remained uncorrelated to all variables. In the regression, most variables that were significant in the 2004-2007 interval now have p-values above the 0.05 threshold, therefore, we don't find sufficient evidence to reject the null hypothesis of zero coefficient. **sox** and **spx** persist with relatively high betas.

## 3. Jan 2009 – Feb 2020

### Correlation Matrix and Regression Results, 2009-2020

	ust10y	oil	vix	eurusd	usdcny	sox	spx	hsi	2s10s_usa	2s10s_eur	5y5y
ust10y	1	0.27	-0.36	0.053	-0.026	0.36	0.43	0.14	0.37	0.12	0.23
oil	0.27	1	-0.26	0.21	-0.085	0.28	0.38	0.15	0.15	0.068	0.15
vix	-0.36	-0.26	1	-0.15	0.084	-0.63	-0.75	-0.17	-0.16	-0.071	-0.14
eurusd	0.053	0.21	-0.15	1	-0.14	0.21	0.28	0.048	0.1	0.067	0.093
usdcny	-0.026	-0.085	0.084	-0.14	1	-0.079	-0.065	-0.17	-0.017	-0.025	-0.046
sox	0.36	0.28	-0.63	0.21	-0.079	1	0.8	0.22	0.19	0.068	0.16
spx	0.43	0.38	-0.75	0.28	-0.065	0.8	1	0.22	0.23	0.1	0.22
hsi	0.14	0.15	-0.17	0.048	-0.17	0.22	0.22	1	0.19	0.16	0.12
2s10s_usa	0.37	0.15	-0.16	0.1	-0.017	0.19	0.23	0.19	1	0.35	0.13
2s10s_eur	0.12	0.068	-0.071	0.067	-0.025	0.068	0.1	0.16	0.35	1	0.033
5y5y	0.23	0.15	-0.14	0.093	-0.046	0.16	0.22	0.12	0.13	0.033	1

BSIC BOCCONI STUDENTS INVESTMENT CLUB	Coef.	Std.Err.	t	P >  t
const	0.0002	0.0001	2.199	0.028
ust10y	-0.011	0.004	-2.479	0.013
oil	-0.020	0.004	-4.648	0.000
vix	-0.004	0.002	-2.294	0.022
eurusd	-0.079	0.016	-5.019	0.000
usdcny	-0.123	0.050	-2.470	0.014
sox	0.269	0.009	30.388	0.000
spx	0.734	0.018	41.359	0.000
hsi	0.013	0.007	1.740	0.082
2s10s_usa	-0.282	0.295	-0.955	0.340
2s10s_eur	0.259	0.327	0.792	0.428
5y5y	-0.003	0.005	-0.720	0.471
RSE		0.004478	Adj. R-squared	0.86

Source: Bocconi Students Investment Club

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Oil, US Treasury rates and the S&P 500 persist in their positive correlation among them, in the ballpark of 0.25. The EUR/USD pair records for the first time a positive correlation of 0.28 with the S&P 500, while the USD/CNY remains (weakly) negative correlated with all other variables.

The statistically significant variables are **oil**, **eurusd**, **sox** and **spx**. In this time interval, oil retains a negative beta as it had before the GFC, while the betas of the FX variables are the most interesting. The negative beta of the EUR/USD (-0.0787) suggests that a stronger USD against the EUR boosted US tech stocks, *ceteris paribus*.

#### 4. Feb 2020 – Nov 2021

### Correlation Matrix and Regression Results, 2020-2021

	ust10y	oil	vix	eurusd	usdcny	sox	spx	hsi	2s10s_usa	2s10s_eur	Sy5y
ust10y	1	0.11	-0.28	-0.21	-0.016	0.4	0.51	0.19	0.23	0.27	0.13
oil	-0.11	1	-0.13	-0.0035	-0.054	0.15	0.17	0.071	0.043	0.034	0.053
vix	-0.28	-0.13	1	-0.031	0.17	-0.66	-0.69	-0.15	-0.011	-0.04	-0.16
eurusd	-0.21	-0.0035	-0.031	1	-0.34	0.047	0.031	0.14	-0.02	-0.077	0.21
usdcny	-0.016	-0.054	0.17	-0.34	1	-0.23	-0.21	-0.25	-0.018	-0.04	-0.23
sox	0.4	0.15	-0.66	0.047	-0.23	1	0.86	0.25	-0.049	0.00058	0.18
spx	0.51	0.17	-0.69	0.031	-0.21	0.86	1	0.29	0.039	0.099	0.26
hsi	-0.19	0.071	-0.15	0.14	-0.25	0.25	0.29	1	0.15	0.21	0.2
2s10s_usa	0.23	0.043	-0.011	-0.02	-0.018	-0.049	0.039	0.15	1	0.69	0.19
2s10s_eur	0.27	0.034	-0.04	-0.077	-0.04	0.00058	0.099	0.21	0.69	1	0.16
Sy5y	0.13	0.053	-0.16	0.21	-0.23	0.18	0.26	0.2	0.19	0.16	1

	Coef.	Std.Err.	t	P >  t
const	0.0002	0.0003	0.745	0.456
ust10y	-0.019	0.005	-3.467	0.001
oil	0.000	0.002	-0.270	0.787
vix	0.003	0.004	0.675	0.500
eurusd	-0.132	0.068	-1.939	0.050
usdcny	-0.070	0.120	-0.585	0.559
sox	0.292	0.021	13.912	0.000
spx	0.836	0.035	23.732	0.000
hsi	-0.063	0.021	-3.013	0.003
2s10s_usa	0.088	1.116	0.079	0.937
2s10s_eur	0.056	1.859	0.030	0.976
Sy5y	-0.029	0.012	-2.460	0.014
RSE		0.005563	Adj. R-squared	0.92

Source: Bocconi Students Investment Club

In the past 2 years, the correlation between the 2s10s US and EUR spreads has risen to a high of 0.7, indicating coordinated monetary policy. Oil, positively correlated with the S&P 500 in the previous intervals, is now largely uncorrelated. Interestingly, the EUR/USD and USD/CNY pairs record a negative correlation of -0.34.

After a 11-year hiatus, **ust10y** is seen as a statistically important variable of this regression, along with **inflation**, **hsi** (first time), **sox**, **spx** and **eurusd**. The beta of the former remains consistent with the previous period, while negative returns in the Hang Seng index correspond to higher returns of the S5INFT. The main takeaway is that the US 10Y Treasury has recently become a very relevant driver of losses for tech equities in US markets.

### Markov Switching Analysis

As mentioned above, Markov Switching models have gained more and more traction both in academia and the industry in recent years, thanks to their simplicity of implementation and improvement in accuracy. In our setting, Markov Switching analysis will enable us to better understand how the drivers of return on tech stock change across regimes that are produced by an unobservable Markov process (see Song and Wozniak, 2020), as opposed to time intervals selected by us through macro/financial considerations. This should lead to an improvement in the robustness of our results, and possibly yield some more insight. The table below displays the results.

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### Regime 1

### Regime 2

### Regime 3

BSIC BOCCONI STUDENTS INVESTMENT CLUB	Estimate	Std.Err.	t	P >  t
Intercept	0.0003	0.0001	3.000	0.003
ust10y	0.007	0.005	1.245	0.213
oil	-0.025	0.005	-5.000	0.000
vix	-0.007	0.002	-3.182	0.001
eurusd	-0.016	0.021	-0.790	0.429
usdcny	-0.145	0.058	-2.499	0.012
sox	0.301	0.010	28.942	< 2.2e-16
spix	0.599	0.037	16.220	< 2.2e-16
hsi	0.008	0.009	0.931	0.352
2s10s_usa	-0.870	0.297	-2.928	0.003
2s10s_eur	0.063	0.082	0.763	0.445
5y5y	0.015	0.006	2.632	0.008
RSE	0.002541844		Mult. R-squared	0.9372

BSIC BOCCONI STUDENTS INVESTMENT CLUB	Estimate	Std.Err.	t	P >  t
Intercept	-0.0003	0.0003	-1.000	0.317
ust10y	0.004	0.010	0.396	0.692
oil	-0.001	0.001	-0.462	0.644
vix	0.002	0.006	0.327	0.743
eurusd	-0.059	0.054	-1.098	0.272
usdcny	-0.316	0.165	-1.918	0.055
sox	0.373	0.026	14.566	< 2e-16
spix	0.617	0.042	14.803	< 2e-16
hsi	-0.004	0.007	-0.580	0.562
2s10s_usa	-0.045	0.138	-0.327	0.744
2s10s_eur	0.019	0.129	0.149	0.881
5y5y	-0.001	0.001	-0.923	0.356
RSE	0.008573924		Mult. R-squared	0.852

BSIC BOCCONI STUDENTS INVESTMENT CLUB	Estimate	Std.Err.	t	P >  t
Intercept	0.0003	0.0002	1.500	0.134
ust10y	-0.047	0.011	-4.115	0.000
oil	-0.014	0.007	-2.015	0.044
vix	0.000	0.000	-0.500	0.617
eurusd	-0.112	0.025	-4.541	0.000
usdcny	0.125	0.059	2.113	0.035
sox	0.228	0.013	17.651	< 2.2e-16
spix	0.910	0.044	20.637	< 2.2e-16
hsi	0.013	0.001	18.000	< 2.2e-16
2s10s_usa	0.283	0.795	0.355	0.722
2s10s_eur	0.923	0.493	1.872	0.061
5y5y	-0.040	0.008	-4.926	0.000
RSE	0.003922965		Mult. R-squared	0.9012

### Markov Switching Regression Analysis

BSIC BOCCONI STUDENTS INVESTMENT CLUB	Regime 1	Regime 2	Regime 3
Regime 1	0,6379	0,0163	0,438
Regime 2	0,006	0,816	0,080
Regime 3	0,356	0,168	0,481

### Transition probabilities matrix

Source: Bocconi Students Investment Club

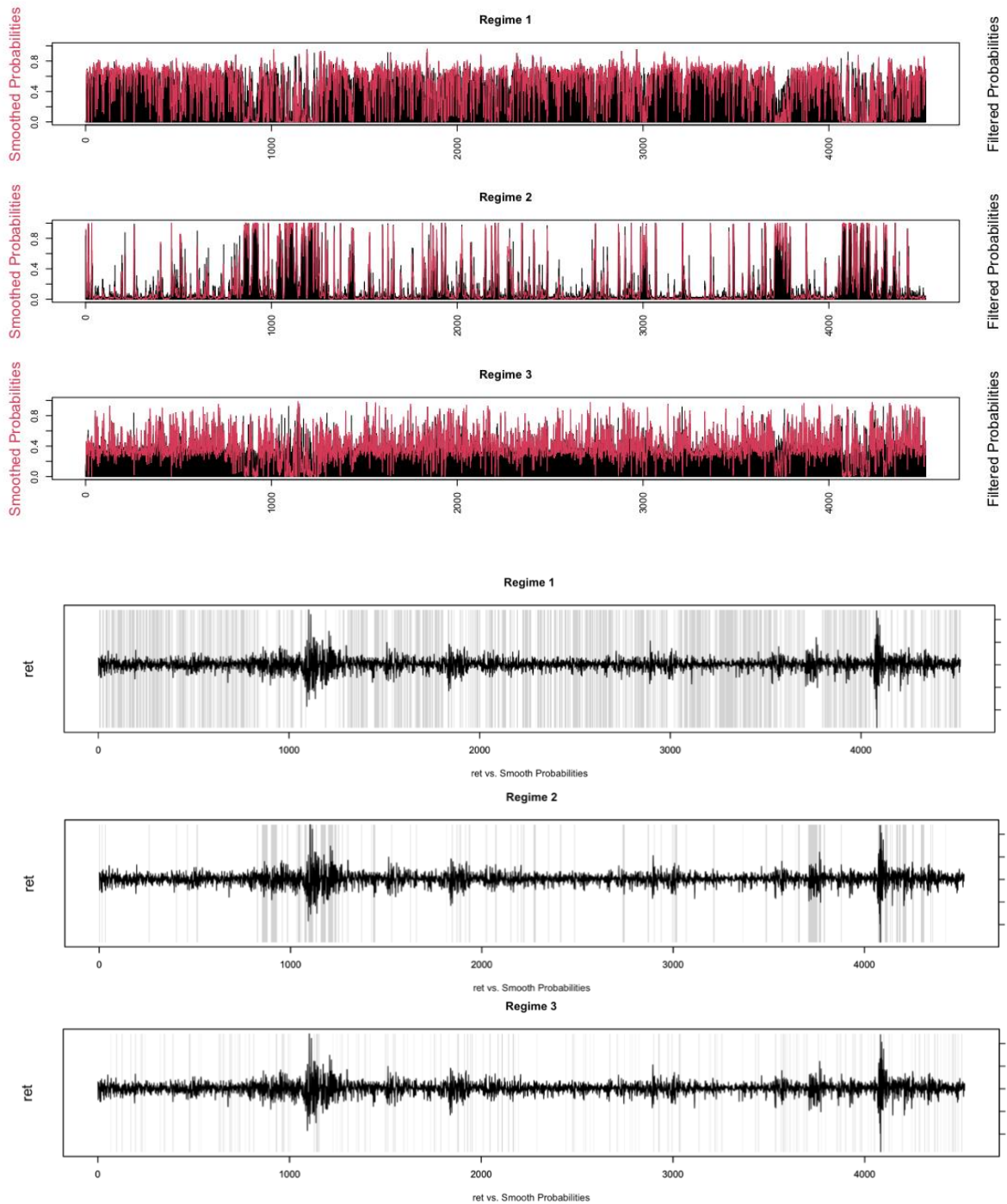
The first regime is characterized by the statistical significance of the more macro regressors, including **oil**, **usdcny**, **2s10s\_usa** and **5y5y**. We can interpret this as a market regime in which tech stocks exhibit enhanced sensitivity to the economy and to monetary policy, and where inflation is a positive driver. As we should expect, a steeper yield curve exerts downward pressure on returns, as do **oil** higher prices. This is consistent with the interpretation that higher rates and oil prices imply higher production costs for firms.

The model then identifies a second regime where only market indices seem to drive returns on tech stocks. Specifically, positive coefficients are estimated for the S&P 500 and the PHLX Semiconductor Sector Index. Finally, the third regime complements our analysis of the first, and it explains some of our earlier results. More specifically, we find a negative and statistically significant coefficient for the 10Y Treasury. This is the only regime in which the variable has p-value below our confidence level, and the fact that it is negative confirms our expectation about the effect of rates on tech. Another important insight is that the USDCNY cross has a positive statistically significant coefficient. This legitimizes our opinion that, under certain circumstances, a dollar appreciation against the yuan should support American equities. However, as we can see from the pictures below, regime 1 is the most frequent one, and in that regime the coefficient is negative (and statistically significant). Thus, we conclude that in general, a weaker yuan against the dollar is negative for the tech sector.

Finally, we show below the probabilities of being in a specific regime, and the historical inference of the same. We remark that on the x axis, dates should be displayed, going from 2004 to today, with daily observation.

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*Source: Bocconi Students Investment Club*

TAGS: technology, tech stocks, equities, stock market, pandemic, econometrics, regression, statistical analysis, statistics, markets

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