



Does Firm-Level Productivity Predict Stock Returns?

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Motivation

- Although productivity is an important issue for the Japanese economy, little is known about the relationship between stock returns and firm-level productivity.
- İmrohoroğlu and Tüzel (2014) and Ang, Lam, and Wei (2020) find a negative relationship between year-ahead returns and total factor productivity (TFP) for US companies.
 - IT: systematically related to the size and value factors.
 - ALW: reversal of mispricing (under (over) price low (high) productivity firms).
- No research on the relationship between stock returns and firm-level TFP for Japanese firms, previous studies have looked only at returns and labour productivity.
- Risk factors, if any, that may lead to a relationship between future returns and firm-level TFP are unclear.

Questions and findings

- Does the firm-level TFP of Japanese manufacturers predict their future stock returns?

⇒ Yes.

- Is the relationship negative, similar to recent US studies?

⇒ No. High TFP Japanese manufacturing firms have high future stock returns.

- What is the reason behind the predictive power of TFP for future returns?

⇒ Risks related to intangible expenditure, primarily those for R&D and personnel, explain a substantial fraction of the predictive power of firm-level TFP. Organisational capital also appears to be important.

⇒ Mispricing due to limits-to-arbitrage does not explain the relationship.

Modelling road map

1. Estimate firm-level total factor productivity.
2. Characteristics of low through to high TFP firms.
3. Estimate risk factor loadings.
4. Estimate risk premia associated with TFP.
5. Evaluate alternative risk-based explanations of the premium.
6. Decompose the predictive power of TFP.
7. Robustness check – limits to arbitrage.

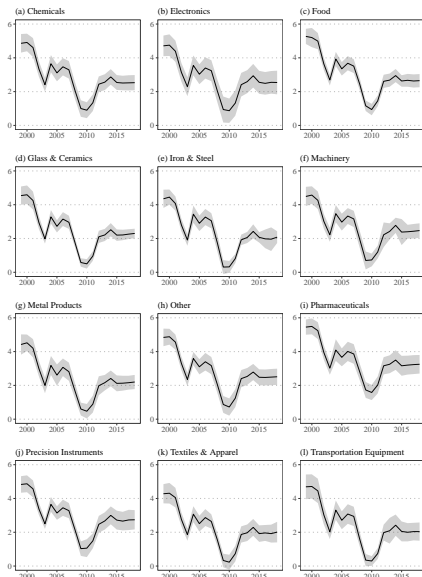
Data

- Manufacturing firms in the TOPIX (large manufacturers) for 12 sectors, March FY-end firms only.
- Panel data constructed from consolidated corporate financial reports.
- Annual corporate financial data from FY1999 (end March 2000) to FY2018 (end March 2019), from Quick AstraManager/Nikkei NEEDS.
- Stock returns from July 2000 to June 2020.
- Corporate financial data refer to the fiscal year (April to March) and future stock returns refer to the one-year period beginning three months after the end of the fiscal year (July to June).

Estimating firm-level TFP

$$\omega_{i,t} = y_{i,t} - \hat{\alpha}_k k_{i,t} - \hat{\alpha}_l l_{i,t}$$

- Cobb-Couglas production function used to estimate TFP.
 - Value added, tangible assets, employees.
- OLSE biased, use control function approach of Levinsohn and Petrin (2003), Wooldridge (2009).
- Annual recursive estimation to avoid look-ahead bias.
- Coefficient estimates:
 - Capital: mean 0.375 , sd 0.108.
 - Labour: mean 0.498, sd 0.024.
- 20 years of annual firm-level TFP estimates for FY1999 to FY2018.



Annually rebalanced TFP-quintile portfolios

	(Low)	TFP Quintiles				(High)	(High-Low)
	Q1	Q2	Q3	Q4	Q5	Q5-Q1	
TFP	2.005	2.415	2.659	2.918	3.373	1.368	
Contemp. return (%)	7.467	9.760	12.474	13.490	12.689	5.222	
Future return (%)	7.349	9.058	8.638	8.292	7.863	0.514	
ln(ME)	9.990	10.548	10.998	11.551	12.371	2.381	
ln(B/M)	0.159	0.056	-0.023	-0.186	-0.383	-0.542	
ROE (%)	1.697	4.201	5.051	6.172	7.364	5.667	
ROE _{t+1} (%)	2.398	4.167	5.297	6.261	6.918	4.521	
Net Income/Sales (%)	1.031	2.467	3.422	4.267	5.165	4.134	
Net Income/Sales _{t+1} (%)	1.316	2.554	3.570	4.282	4.993	3.678	
Net Income/MV (%)	-0.251	2.743	2.921	4.099	3.655	3.905	
Net Income/MV _{t+1} (%)	0.192	2.471	3.784	3.680	3.863	3.671	
AG (%)	2.185	2.540	2.764	3.701	4.020	1.835	
ln(L)	7.548	7.824	8.042	8.361	8.795	1.247	
Observations	2,366	2,235	2,229	2,235	2,329		

- High (low) TFP firms tend to be large growth (small value) firms.
- High TFP firms have better operating performance, higher asset growth and more employees than low TFP firms.
- Same general characteristics as İmrohoroglu and Tüzel (2014) for US.

Risk factor loadings for the TFP-quintile portfolios

- Do Japanese manufacturing stock returns exhibit TFP-related alpha while controlling for a variety of widely-recognized risk factors? Yes.

	Dependent variable: future monthly excess portfolio return					
	(1) Q1	(2) Q2	(3) Q3	(4) Q4	(5) Q5	(6) Q5-Q1
(a) Fama-French 3-Factor						
MKT (Market)	1.179*** (0.026)	1.119*** (0.027)	1.107*** (0.024)	1.076*** (0.023)	1.022*** (0.025)	-0.158*** (0.028)
SMB (Size)	0.961*** (0.051)	0.750*** (0.042)	0.663*** (0.041)	0.434*** (0.037)	0.230*** (0.044)	-0.731*** (0.067)
HML (Value)	0.539*** (0.049)	0.456*** (0.043)	0.388*** (0.042)	0.241*** (0.041)	0.110** (0.044)	-0.429*** (0.059)
Alpha	-0.109 (0.111)	0.054 (0.097)	0.084 (0.098)	0.172** (0.083)	0.200** (0.094)	0.309** (0.136)
Adj. R ²	0.925	0.923	0.923	0.927	0.924	0.506
(b) Carhart 4-Factor						
MKT (Market)	1.159*** (0.024)	1.106*** (0.027)	1.090*** (0.024)	1.062*** (0.022)	1.008*** (0.023)	-0.151*** (0.029)
SMB (Size)	1.018*** (0.046)	0.789*** (0.040)	0.710*** (0.035)	0.474*** (0.036)	0.269*** (0.045)	-0.749*** (0.067)
HML (Value)	0.509*** (0.051)	0.436*** (0.044)	0.364*** (0.046)	0.220*** (0.041)	0.090** (0.042)	-0.420*** (0.061)
UMD (Momentum)	-0.146*** (0.051)	-0.098** (0.042)	-0.119** (0.050)	-0.101*** (0.036)	-0.099*** (0.033)	0.047 (0.045)
Alpha	-0.121 (0.101)	0.046 (0.094)	0.074 (0.091)	0.164** (0.078)	0.192** (0.091)	0.313** (0.134)
Adj. R ²	0.931	0.926	0.928	0.931	0.928	0.507

Risk factor loadings for the TFP-quintile portfolios

	Dependent variable: future monthly excess portfolio return					
	(1) Q1	(2) Q2	(3) Q3	(4) Q4	(5) Q5	(6) Q5-Q1
(c) Fama-French 5-Factor						
MKT (Market)	1.156*** (0.030)	1.103*** (0.031)	1.092*** (0.029)	1.063*** (0.026)	1.022*** (0.026)	-0.134*** (0.026)
SMB (Size)	0.913*** (0.048)	0.732*** (0.046)	0.639*** (0.043)	0.419*** (0.038)	0.232*** (0.044)	-0.680*** (0.063)
HML (Value)	0.442*** (0.049)	0.424*** (0.050)	0.343*** (0.041)	0.212*** (0.044)	0.115** (0.048)	-0.327*** (0.067)
RMW (Profitability)	-0.238** (0.111)	-0.182** (0.084)	-0.156 (0.100)	-0.143 (0.088)	-0.001 (0.080)	0.237** (0.119)
CMA (Investment)	0.053 (0.102)	-0.086 (0.098)	-0.020 (0.090)	-0.058 (0.079)	-0.018 (0.075)	-0.071 (0.113)
Alpha	-0.059 (0.106)	0.088 (0.096)	0.115 (0.100)	0.199** (0.082)	0.200** (0.094)	0.259** (0.130)
Adj. R ²	0.931	0.924	0.925	0.928	0.923	0.539
(d) q-factor						
MKT (Market)	1.191*** (0.030)	1.126*** (0.029)	1.115*** (0.026)	1.082*** (0.024)	1.022*** (0.026)	-0.169*** (0.028)
ME (Size)	0.911*** (0.055)	0.741*** (0.048)	0.653*** (0.044)	0.428*** (0.040)	0.217*** (0.045)	-0.694*** (0.066)
I/A (Investment)	0.227** (0.089)	0.051 (0.079)	0.064 (0.073)	0.001 (0.061)	-0.031 (0.066)	-0.259*** (0.096)
ROE (Profitability)	-0.422*** (0.123)	-0.397*** (0.102)	-0.371*** (0.105)	-0.318*** (0.087)	-0.121 (0.081)	0.301*** (0.106)
Alpha	-0.015 (0.117)	0.154 (0.102)	0.164 (0.101)	0.231*** (0.083)	0.235** (0.096)	0.250* (0.138)
Adj. R ²	0.912	0.915	0.920	0.929	0.923	0.481

FMB regressions of future returns on TFP, controls

$$r_{i,t+1} = \gamma_0 + \gamma_1 \beta_{i,t} + \gamma_2 \ln(ME)_{i,t} + \gamma_3 \ln(B/M)_{i,t} + \gamma_4 ROE_{i,t} + \gamma_5 AG_{i,t} + \gamma_6 TFP_{i,t} + \sum_{j=1}^{11} \chi_j DS_j + \epsilon_{i,t+1}$$

- TFP has a positive and significant relationship with future returns in the cross-section, controlling for the Fama-French factors, sectors.
 - Contrary to Imrohoroğlu and Tüzel (2014) who find a negative relationship that is not significant when controlling for Fama-French three factors.

	Dependent variable: future return, $r_{i,t+1}$			
	(1)	(2)	(3)	(4)
β	0.973 (2.490)	0.448 (1.926)	0.769 (2.378)	0.224 (1.835)
$\ln(ME)$	-0.933 (0.840)	-1.001 (0.895)	-0.876 (0.781)	-0.947 (0.822)
$\ln(B/M)$	5.235*** (1.513)	5.087*** (1.340)	4.902*** (1.620)	4.718*** (1.409)
ROE			-0.123** (0.046)	-0.128*** (0.043)
AG			-0.013 (0.037)	-0.023 (0.034)
TFP	3.893*** (1.083)	3.730*** (1.188)	4.068*** (1.103)	3.983*** (1.138)
Sector dummies	No	Yes	No	Yes
Observations	10,739	10,739	10,580	10,580
Adj. R^2	0.093	0.143	0.101	0.149

A risk-based explanation for the TFP premium?

- The preceding analyses show a positive and significant risk premium for high TFP firms.
- Does this premium represent compensation for investors bearing risk?
- We investigate three types of investment risk that are prominent in the literature:
 1. Bankruptcy risk.
 2. Macroeconomic risk.
 3. Capital and intangibles expenditure risk.
- Conditions:
 - i. The risk and firm-level TFP are positively correlated.
 - ii. The impact of firm-level TFP on returns increases as the risk increases.

1. Is bankruptcy risk positively related to TFP?

- No.
- Fama MacBeth regressions of TFP on two accounting information-based measures of bankruptcy risk:
 - Altman's (1968) Z-score is a measure of credit strength.
 - Ohlson's (1980) O-score is a measure of credit weakness.

	Dependent variable: total factor productivity, $TFP_{i,t}$	
	(1)	(2)
Z-score	0.106*** (0.007)	
O-score		3.49e-04 (0.001)
Constant	2.300*** (0.253)	2.633*** (0.243)
Observations	10,843	10,399
Adj. R ²	0.144	0.005

1. Future returns, controls, TFP and bankruptcy risk

- Are future returns more sensitive to TFP as the probability of bankruptcy increases? No.
 - TFP \times Z-score should be negative and significant while TFP \times O-score should be positive to be consistent with bankruptcy risk explaining the TFP effect.

	Dependent variable: future return, $r_{i,t+1}$			
	(1)	(2)	(3)	(4)
β	0.537 (1.823)	0.255 (1.860)	0.707 (1.955)	0.094 (2.050)
ln(ME)	-0.723 (0.827)	-0.226 (0.734)	-0.753 (0.824)	-0.154 (0.712)
ln(B/M)	4.747*** (1.365)	4.742*** (1.405)	4.374*** (1.442)	4.070** (1.517)
ROE	-0.134*** (0.046)	-0.124** (0.046)	-0.130*** (0.045)	-0.112** (0.044)
AG	-0.015 (0.035)	-0.027 (0.034)	-0.026 (0.038)	-0.036 (0.036)
TFP	3.153*** (1.012)		3.563*** (1.050)	
TFP \times Z-score	0.052 (0.096)	0.150 (0.111)		
TFP \times O-score			0.014 (0.024)	-0.005 (0.028)
Observations	10,107	10,107	10,053	10,053
Adj. R ²	0.143	0.138	0.142	0.136

2. Are TFP and macroeconomic risk related?

- No.
- DI is the BoJ Tankan diffusion index of business conditions for large manufacturers.
- Q1 to Q5 represent the TFP-quintile portfolio average TFPs.
- Q5-Q1 is the difference between the high and low TFP portfolio productivities.
- Correlations are close to zero.

Correlation between TFP and DI	
Q1	0.001
Q2	0.005
Q3	0.002
Q4	0.000
Q5	-0.001
Q5-Q1	-0.024

2. Macroeconomic risk, TFP and returns

- Average TFP-quintile portfolio future return, positive (negative) DI year defined as expansion (contraction).
- If macroeconomic risk is behind the TFP effect high TFP firms should trade at a premium during recessions.
- However, the table below suggests the opposite.
- Low productivity firms have more volatile returns suggesting they are more susceptible to macroeconomic shocks.

Quintile portfolio	(Low)	TFP Quintiles				(High)	(High-Low)
future returns (%)	Q1	Q2	Q3	Q4	Q5	Q5-Q1	
All states, 20 fiscal years	7.364	9.150	8.571	8.223	7.659	0.294	
Expansions, 13 fiscal years	1.427	3.367	3.436	3.482	3.937	2.510	
Contractions, 7 fiscal years	18.391	19.889	18.107	17.027	14.570	-3.821	

2. Macroeconomic risk, TFP and returns

- If macroeconomic risk explains the TFP premium, the correlation between Q5-Q1 future returns and the DI should be negative.
 - The Q5-Q1 spread represents a strategy that is long high-TFP and short low TFP firms.
- The chart shows Q5-Q1 future returns conditioned on known equity factors and the DI.
 - While the DI and conditioned spread future returns move together in some years, in most they do not and the correlation is close to zero.
- Macroeconomic risk does not explain the TFP premium.

	Obs.	Correlations		
		DI	Q1	Q5
DI	20	1.00		
Q1	20	-0.33	1.00	
Q5	20	-0.09	0.89***	1.00
Q5-Q1	20	0.48**	-0.12	0.35



3. Capital and intangibles expenditure risks

- Hypothesis: high TFP firms undertake greater capital and intangibles expenditure and their future returns are higher to compensate investors for the risks associated with this higher expenditure.
- Both tangible and intangible expenditure involve foregoing current production to increase future production (Corrado, Hulten, and Sichel, 2005).
- Capital expenditure (CE):
 - Increases in capital investment are followed by lower returns (Berk, Green, and Naik, 1999; Baker, Stein, and Wurgler, 2003; Titman, Wei, and Xie, 2004).
 - However, the negative relationship doesn't hold for Japanese firms (Titman, Wei, and Xie, 2009; Miyagawa and Takizawa, 2017; Kubota and Takehara, 2018).

3. Capital and intangibles expenditure risks

- Intangible capital: computerized information, innovative property and economic competencies (Corrado, Hulten, and Sichel, 2005).
- Intangible expenditure is positively related to productivity (Scherer, 1982; Lin and Lo, 2015; Montresor and Vezzani, 2016) or contributes to the development of organisational capital which is positively related to productivity (Tronconi and Vittucci Marzetti, 2011; Lev and Radhakrishnan, 2005).
- Intangibles expenditure and returns:
 - R&D intensity or expenditure positively related to returns (Lev and Sougiannis, 1996; Bae and Kim, 2003; Hou et al., 2021)
 - Organisational capital and returns are positively related to compensate investors for the risk that senior employees leave (Eisfeldt and Papanikolaou, 2013; Leung et al., 2018).
 - Human capital is positively related to returns (Palacios, 2015), firms with higher labour share have higher returns (Donangelo et al., 2019)

3. TFP on capital and intangibles expenditure

- TFP is positively related to capital (CE) and intangibles expenditures.
 - R&D expenditure (RD) reflects innovative property; personnel expenditure (PE) reflects human capital; selling, general and administrative expenses (SGA) proxy for organisational capital.

	Dependent variable: total factor productivity, $TFP_{i,t}$					
	(1)	(2)	(3)	(4)	(5)	(6)
ln(CE)	0.089*** (0.016)					
ln(RD)		0.143*** (0.011)				
ln(PE)			0.226*** (0.019)			
ln(AD)				0.055*** (0.004)		
ln(SGAexRD)					0.075*** (0.004)	
ln(SGAexRDPEAD)						0.075 (0.004)
Constant	1.991*** (0.122)	1.623*** (0.164)	0.751*** (0.085)	2.436*** (0.229)	2.001*** (0.210)	2.039*** (0.217)
Observations	11,285	11,206	10,969	4,526	11,394	11,394
Adj. R ²	0.099	0.228	0.296	0.048	0.035	0.037

3. Future returns on TFP, capital, intangibles exp.

Dependent variable: future return, $r_{i,t+1}$						
	(1)	(2)	(3)	(4)	(5)	(6)
β	-0.036 (1.791)	-0.204 (1.769)	-0.134 (1.823)	0.589 (1.970)	0.279 (1.829)	0.220 (1.833)
ln(ME)	-2.029** (0.950)	-2.034* (0.993)	-2.014** (0.874)	-1.564* (0.859)	-1.054 (0.839)	-0.993 (0.837)
ln(B/M)	4.437*** (1.399)	4.318*** (1.379)	4.344*** (1.359)	4.007 (2.318)	4.705*** (1.400)	4.704*** (1.411)
ROE	-0.124*** (0.042)	-0.119** (0.042)	-0.110** (0.041)	-0.277*** (0.089)	-0.127*** (0.043)	-0.128*** (0.043)
AG	-0.024 (0.035)	-0.014 (0.033)	-0.014 (0.034)	0.054 (0.059)	-0.022 (0.033)	-0.023 (0.034)
TFP	3.841*** (1.116)	2.366* (1.267)	1.708 (1.378)	4.929*** (1.657)	3.238** (1.152)	3.243** (1.176)
Dummies:	CI	RD	PE	AD	SGAex RD	SGAex RDPEAD
TFP \times dummy2	-0.564 (0.367)	0.783 (0.577)	0.669 (0.594)	-0.324 (0.587)	0.812** (0.331)	0.899** (0.347)
TFP \times dummy3	0.792 (0.459)	0.919 (0.570)	0.642 (0.516)	1.132 (0.676)	0.870 (0.506)	0.941* (0.489)
TFP \times dummy4	1.536** (0.667)	2.050*** (0.660)	1.885** (0.729)	1.423* (0.723)	1.094*** (0.370)	1.082** (0.451)
TFP \times dummy5	1.679** (0.616)	2.403*** (0.767)	2.859*** (0.915)	0.405 (0.632)	1.217* (0.623)	0.995* (0.565)
Observations	10,580	10,580	10,580	4,169	10,580	10,580
Adj. R ²	0.160	0.159	0.159	0.236	0.156	0.156

Decomposing the predictive power of TFP

- Hou and Loh (2016) univariate and multivariate (next slide) methods for evaluating competing explanations used to decompose the predictive power of TFP.

Stage	Description		Coefficient					
1	$r_{i,t+1}$ on TFP	TFP	3.983 ^{***} (1.138)	Candidates				
			ln(CE)	ln(RD)	ln(PE)	ln(AD)	ln(SGA exRD)	ln(SGA exRDPEAD)
2	$r_{i,t+1}$ on TFP and Candidate	TFP	4.130 ^{***} (0.994)	3.626 ^{***} (1.099)	3.261 ^{**} (1.221)	5.775 ^{***} (1.578)	3.971 ^{***} (1.134)	3.965 ^{***} (1.137)
		Candidate	0.752 (0.659)	0.965 (0.564)	1.620 [*] (0.894)	0.536 ^{**} (0.244)	0.595 ^{**} (0.258)	0.544 ^{**} (0.245)
3	TFP on Candidate	Candidate	0.089 ^{***} (0.016)	0.143 ^{***} (0.011)	0.226 ^{***} (0.019)	0.055 ^{***} (0.004)	0.075 ^{***} (0.005)	0.075 ^{***} (0.004)
4	Decompose Stage-1 Coefficient	Explained (%)	0.206 5.2 ^{**} (2.441)	0.525 13.2 ^{***} (2.391)	0.699 17.6 ^{***} (2.821)	0.172 4.3 [*] (2.523)	0.096 2.4 (1.590)	0.097 2.4 (2.424)
			3.777 94.8 ^{***} (4.593)	3.458 86.8 ^{***} (5.662)	3.284 82.4 ^{***} (6.233)	3.811 95.7 ^{***} (4.714)	3.887 97.6 ^{***} (5.012)	3.886 97.6 ^{***} (6.564)
		Residual (%)						

Decomposing TFP for all candidates simultaneously

Stage	Description		Coefficient		SE	Coefficient		SE
1	$r_{i,t+1}$ on TFP	TFP	3.983***		(1.138)			
			(1)			(2)		
2	$r_{i,t+1}$ on TFP and Candidates	TFP	3.706***		(0.986)	5.299***		(2.143)
		ln(CE)	0.328		(0.593)	0.092		(0.624)
		ln(RD)	0.766		(0.473)	1.053		(0.854)
		ln(PE)				1.578		(1.284)
		ln(AD)				0.204		(0.430)
		ln(SGAexRD)	0.557**		(0.230)			
		ln(SGAexRDPEAD)				0.599		(0.671)
3	TFP on Candidates	ln(CE)	-0.103		(0.019)	-0.183***		(0.023)
		ln(RD)	0.212***		(0.005)	0.067***		(0.015)
		ln(PE)				0.335***		(0.012)
		ln(AD)				0.025***		(0.005)
		ln(SGAexRD)	0.051***		(0.002)			
		ln(SGAexRDPEAD)				0.015		(0.009)
			Explained (%)			Explained (%)		
4	Decompose Stage-1 Coefficient	ln(CE)	-0.264	-6.6**	(3.056)	-0.858	-21.5***	(2.483)
		ln(RD)	0.470	11.8***	(3.172)	0.355	8.9**	(3.532)
		ln(PE)				1.511	37.9***	(8.960)
		ln(AD)				0.037	0.9	(7.553)
		ln(SGAexRD)	0.063	1.6	(2.319)			
		ln(SGAexRDPEAD)				0.024	0.6	(1.091)
		Residual	3.714	93.2***	(15.904)	2.913	73.1***	(13.147)

Does mispricing explain the TFP premium?

- Does the TFP premium exist because the stocks of high TFP firms are mispriced due to being relatively difficult to arbitrage? No.
 - For mispricing to explain the TFP effect, the coefficients for IVOL, ILLIQ and OPVOL should be positive while those for INST and FRGN should be negative.
 - Our results are the opposite to those of Ang, Lam, and Wei (2020) for US stocks.

	Dependent variable: total factor productivity, $TFP_{i,t}$				
	(1)	(2)	(3)	(4)	(5)
IVOL	-0.006*** (0.001)				
ILLIQ		-2.97e-05*** (3.26e-06)			
OPVOL			-3.83e-06*** (1.67e-07)		
INST				0.006*** (0.001)	
FRGN					0.020*** (0.001)
Constant	2.894*** (0.251)	2.795*** (0.255)	2.949*** (0.247)	2.553*** (0.211)	2.455*** (0.241)
Observations	11,380	11,390	11,394	11,394	11,394
Adj. R ²	0.025	0.056	0.100	0.026	0.158

Conclusion

- Contrary to the findings of previous U.S. studies, we show that the firm-level TFP of Japanese manufacturers positively predicts their future stock returns in the cross-section when controlling for relevant risk factors, such as those of Fama and French.
- However, the financial characteristics of high and low TFP Japanese and US firms are very similar.
- The premium for highly productive firms compensates investors for risks related to innovation and human and organizational capital formation.
- Investing in R&D and personnel in a way that improves productivity has a substantial positive impact on Japanese firms' stock returns.

Thank you!

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Annually rebalanced arbitrage cost portfolios

	1	2	3	4	5	6	7	8	9	10	Spread 10-1
IVOL	18.470	22.060	24.086	26.106	28.048	30.066	32.348	35.392	39.761	56.645	38.175
TFP	2.780	2.792	2.782	2.757	2.678	2.657	2.667	2.606	2.558	2.458	-0.322
Return	8.097	9.064	7.461	8.251	10.234	9.988	7.831	9.037	7.695	4.804	-3.294
ILLIQ	21.281	72.953	139.181	274.614	487.578	800.626	1242.422	2112.807	3397.734	10686.175	10664.894
TFP	3.170	2.926	2.805	2.774	2.667	2.503	2.512	2.464	2.474	2.392	-0.778
Return	6.916	7.739	7.920	7.611	8.532	7.389	8.537	7.415	10.399	9.648	2.732
OPVOL	16,776	24,068	29,771	34,947	41,341	48,389	57,263	69,884	88,335	155,937	139160.459
TFP	2.926	2.811	2.721	2.747	2.696	2.626	2.624	2.630	2.538	2.409	-0.517
Return	7.163	7.591	7.085	7.013	9.407	9.394	9.103	7.290	8.228	9.709	2.546
INST	11.753	17.574	21.500	25.219	28.494	32.019	35.229	38.658	42.690	49.452	37.699
TFP	2.663	2.617	2.589	2.604	2.595	2.659	2.684	2.694	2.757	2.848	0.185
Return	9.093	9.385	8.002	7.837	8.808	8.797	9.130	8.260	6.531	6.519	-2.574
FRGN	1.641	3.865	5.930	8.328	11.176	14.517	18.142	22.226	27.343	36.916	35.275
TFP	2.307	2.438	2.494	2.593	2.674	2.696	2.732	2.809	2.912	3.073	0.766
Return	7.834	10.047	9.689	8.989	7.686	7.311	8.226	8.380	6.798	7.374	-0.460

- We investigated whether TFP as a predictor of stock returns may be non-linearly related to arbitrage costs, such as the U-shaped pattern noted in Lam and Wei (2011), and found that it is not.

FMB regressions with TFP and arbitrage costs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
beta	0.696 (1.908)	0.378 (1.917)	0.784 (1.871)	0.179 (1.846)	-0.393 (1.942)	0.156 (1.834)	0.00140 (1.632)	-0.467 (1.725)	0.00231 (1.649)	0.223 (1.808)	0.0393 (1.806)	0.212 (1.812)	0.0132 (1.812)	-0.215 (1.846)	0.0268 (1.806)
lnME	-1.278 (0.802)	-0.763 (0.704)	-1.221 (0.788)	-0.958 (0.846)	-0.270 (0.667)	-1.011 (0.838)	-0.844 (0.813)	-0.349 (0.695)	-0.815 (0.810)	-0.851 (0.783)	-0.762 (0.777)	-0.837 (0.785)	-1.331 (0.919)	-0.883 (0.882)	-1.373 (0.948)
lnBM	4.188** (1.553)	4.165** (1.588)	4.198** (1.519)	4.575*** (1.423)	4.265** (1.498)	4.669*** (1.424)	4.665*** (1.432)	4.441*** (1.491)	4.633*** (1.406)	4.707*** (1.366)	4.689*** (1.357)	4.727*** (1.388)	4.632*** (1.388)	4.730*** (1.398)	4.736*** (1.414)
ROE	-0.121** (0.0430)	-0.126*** (0.0438)	-0.125*** (0.0432)	-0.129*** (0.0431)	-0.116** (0.0430)	-0.127*** (0.0438)	-0.122*** (0.0411)	-0.125*** (0.0414)	-0.125*** (0.0409)	-0.126*** (0.0415)	-0.122*** (0.0415)	-0.128*** (0.0419)	-0.128*** (0.0423)	-0.120** (0.0421)	-0.127*** (0.0432)
AG	-0.0263 (0.0355)	-0.0296 (0.0332)	-0.0231 (0.0338)	-0.0263 (0.0312)	-0.0366 (0.0290)	-0.0239 (0.0313)	-0.0137 (0.0345)	-0.0219 (0.0332)	-0.0125 (0.0344)	-0.0258 (0.0349)	-0.0226 (0.0345)	-0.0223 (0.0337)	-0.0229 (0.0340)	-0.0263 (0.0343)	-0.0181 (0.0340)
TFP	6.097*** (1.761)		5.011*** (1.115)	3.971*** (1.201)		3.980*** (1.150)	3.724*** (1.293)		3.397** (1.247)	3.158* (1.791)		4.072*** (1.219)	2.710* (1.415)		3.121** (1.246)
IVOL	0.0964 (0.130)	-0.219*** (0.0702)													
TFP*IVOL	-0.0619 (0.0511)	0.0668** (0.0292)	-0.0354** (0.0164)												
ILLIQ				-8.42e-05 (0.000576)	-0.000649 (0.000576)										
TFP*ILLIQ				-1.54e-05 (0.000273)	0.000240 (0.000258)	3.57e-06 (6.05e-05)									
OPVOL							1.15e-05 (3.43e-05)	-6.83e-05 (4.05e-05)							
TFP*OPVOL							1.57e-06 (1.11e-05)	3.02e-05*** (1.05e-05)	3.96e-06 (5.69e-06)						
INST										-0.114 (0.193)	-0.343** (0.128)				
TFP*INST										0.0251 (0.0552)	0.109*** (0.0333)	-0.00636 (0.0108)			
FRGN													-0.0235 (0.204)	-0.273 (0.213)	
TFP*FRGN													0.0552 (0.0651)	0.123** (0.0554)	0.0463* (0.0228)
Observations	10,580	10,580	10,580	10,580	10,580	10,580	10,580	10,580	10,580	10,580	10,580	10,580	10,580	10,580	10,580
R-squared	0.154	0.149	0.152	0.158	0.150	0.154	0.156	0.151	0.154	0.155	0.151	0.151	0.158	0.153	0.155

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

- Coefficient of TFP remains positive and significant when the arbitrage cost and interaction terms included.
- Arbitrage cost and interaction term coefficients are either not significant or have the wrong signs.