Industrial productivity, investment, and corporate performance expectations

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- Investigate the associations between investment efficiency and firm-level productivity at the micro level and corporate performance expectations
- Estimate of investment efficiency at the firm level
- Measure that captures the improvement in total factor productivity to examine the effects of not only the size but also the quality of corporate investment

- Sample of European listed firms during 2004 - 2021
- The findings indicate that investment efficiency and improvements in firm-level productivity are positively associated with corporate performance expectations.
- Financial analysts incorporate the effects of investment and total factor productivity improvement into their forecasts
- Factors such as international operations, and R&D profile can moderate analyst efficiency

To explain the associations between firm characteristics and capital markets valuation, the recent literature at the intersection of finance with microeconomics has introduced neoclassical investment models where ex-ante identical firms are exposed to firm-level total factor productivity (TFP) shocks that lead to different firm characteristics (e.g., Gomes et al., 2003; Zhang, 2005; Li et al., 2009; Lin, 2012; Belo and Lin, 2012).

Imrohoroglu and Tuzel (2014) directly estimate the relationship between TFP, firm characteristics, and stock returns, and document that higher TFP leads to higher stock returns and lower implied risk (ex-ante discount rates).

They find that firms with lower productivity are more vulnerable to business cycles, with low productivity representing a risk factor that is priced by the market with significant variation over business cycles.

Equity valuation entails predicting the expected profitability of the firm to derive the series of implied future earnings and discounting this series to obtain an estimate of intrinsic value.

Consequently, **expectations** of higher future earnings are viewed as positive stock market signals.

Following this line of thought, several studies have documented that **analysts' earnings forecasts are signals** that convey value-relevant information, and that the capital markets move in the direction of these forecasts

- Motivated by the importance of analyst expectations for capital markets valuation, and the evidence of a link between firm-level productivity and market valuation

- This study aims to fill a gap in the related literature by investigating the incorporation of investment efficiency and firm-level productivity characteristics into analysts' forecasts of corporate performance

There are two strands of literature related to this study:

a) changes in investment efficiency and total factor productivity and their effects (e.g., Barney 1991; Biddle et al. 2009; Imrohoroglu and Tuzel 2014; Gomes et al. 2003; Zhang 2005; Zhou and Zhao 2022)

b) the incorporation of fundamentals and factors such as investment on valuation and analyst expectations (e.g., Chen et al. 2017; Dehning et al. 2006; Brogaard et al. 2022; To et al. 2018).

But how is investment efficiency and productivity growth perceived by the markets and market agents?

Hypothesis Development

H1: Financial analysts incorporate investment efficiency and firm-level productivity into their corporate earnings forecasts.

H2: Analysts' forecasts are efficient with respect to investment efficiency and firm-level productivity.

Various definitions of productivity in the Literature

Productivity = units of output/units of input	(Chew, 1988)
Productivity = actual output/expected resources used	(Sink and Tuttle, 1989)
Productivity= total income/(cost + goal profit)	(Fisher, 1990)
Productivity is defined as the ratio of what is produced to what is required to produce it. Productivity measures the relationship between output such as goods and services produced, and inputs that include labour, capital, material and other resources	(Hill, 1993)
Productivity (output per hour of work) is the central long-run factor determining any population's average of living	(Thurow, 1993)
Productivity = the quality or state of bringing forth, of generating, of causing to exist, of yielding large result or yielding abundantly	(Koss and Lewis, 1993)
Productivity means how much and how well we produce from the resources used. If we produce more or better goods from the same resources, we increase productivity. Or if we produce the same goods from lesser resources, we also increase productivity. By "resources", we mean all human and physical resources	(Bernolak, 1997)
Productivity is a comparison of the physical inputs to a factory with the physical outputs from the factory	(Kaplan and Cooper, 1998)
Productivity = efficiency * effectiveness = value adding time/total time	(Jackson and Petersson, 1999)
Productivity = (output/input) * quality = efficiency * utilisation * quality	(Al-Darrab, 2000)
Productivity is the ability to satisfy the market's need for goods and services with a minimum of total resource consumption	(Moseng and Rolstadas, 2001)

Research Design

To test H1 and H2 on the incorporation of investment efficiency into analysts' expectations of corporate profitability we estimate Models 1 and 2 using pooled OLS panel regressions.

The models control for country and industry fixed effects (t-statistics are based on clustered standard errors clustered by firm).

$$\boldsymbol{NETINCOMENEWS}_{t+1,i} = \beta_0 + \beta_1 \boldsymbol{INVEFFICIENCY}_{t,i} + Controls +$$

$$+ CountryFE + IndustryFE + YEARFE + \varepsilon_{t+1,i} \quad (1)$$

$$\boldsymbol{FE(NETINCOME)}_{t+1,i} = \beta_0 + \beta_1 \boldsymbol{INVEFFICIENCY}_{t,i} + Controls$$

$$+ CountryFE + IndustryFE + YEARFE + \varepsilon_{t+1,i} \quad (2)$$

Research Design

To test H1 and H2 on the incorporation of TFP into analysts' expectations of corporate profitability we estimate Models 3 and 4 using pooled OLS panel regressions.

The models control for country and industry fixed effects (t-statistics are based on clustered standard errors clustered by firm).

$$\boldsymbol{NETINCOMENEWS}_{t+1,i} = \beta_0 + \beta_1 \boldsymbol{TFP}_{t,i} + Controls + CountryFE + IndustryFE + YEARFE + \varepsilon_{t+1,i} \quad (3)$$

$$\boldsymbol{FE(NETINCOME)}_{t+1,i} = \beta_0 + \beta_1 \boldsymbol{TFP}_{t,i} + Controls + CountryFE + IndustryFE + YEARFE + \varepsilon_{t+1,i} \quad (4)$$

Controls: lnMV, B/M, DIV, D/B, LEV, INTSALES, lnANALYST, capital intensiveness, inventory intensiveness, R&D expenditure relative to sector average, etc.

Research Design

- **Significant estimated slope β_1** will indicate that analysts incorporate investment efficiency / productivity and their impact on expected profitability into their forecasts *(Models 1 and 3)*

- **Non-statistically significant estimated regression coefficient β_1** will indicate that *INVEFFICIENCY / TFP* have no predictive ability over variation in the analyst forecast error and that analysts efficiently incorporate investment efficiency and total factor productivity and their impact on expected profitability into their forecasts *(Models 2 and 4)*

- **Significant estimated regression coefficient β_1** will indicate systematic inefficiency *(Models 2 and 4)*

Research Design

- *NETINCOMENEWS* represents the analyst consensus of net income t+1, adjusted for realized net income of t and standardized by prior total assets per firm-year from the IBES LSEG database.
- *FE(NETINCOME)* is calculated as the actual net income minus the analyst consensus per firm-year (t+1).
- Evaluate the impact of investment efficiency on revenues and operating expenses using *Revenue* and *Opex* as dependent variables.

Research Design

To approximate firm – level investment efficiency and firm – level TFP:

- The study uses the framework for over-under investment of free cash flows developed by Richardson (2006) and computes investment efficiency at the firm-level.
- A measure that captures the resulting improvement in total factor productivity to examine the effects of not only the size but also the quality of corporate investment (Olley and Pakes, 1996)

Variable measurement *(INVEFFICIENCY)*

- **Corporate investment efficiency** in line with Richardson (2006)
- Framework based on extensive literature on firm level investment decisions (e.g. Hubbard, 1998)
- Investment expectation model separating total investment expenditure into expected investment expenditure and unexpected investment expenditure

$$Invest_{i,t} = \beta_0 + \beta_1 Growth_{i,t-1} + \beta_2 Leverage_{i,t-1} + \beta_3 Cash_{i,t-1} + \beta_4 Age_{i,t-1} + \beta_5 Size_{i,t-1} + \beta_6 Returns_{i,t-1} + \beta_7 Invest_{i,t-1} + CountryIndicator + IndustryIndicator + \varepsilon_{i,t} \quad (5)$$

Variable measurement (*INVEFFICIENCY*)

$Invest_{i,t} = \beta_0 + \beta_1 Growth_{i,t-1} + \beta_2 Leverage_{i,t-1} + \beta_3 Cash_{i,t-1} + \beta_4 Age_{i,t-1} + \beta_5 Size_{i,t-1} + \beta_6 Returns_{i,t-1} + \beta_7 Invest_{i,t-1} + CountryIndicator + IndustryIndicator + \varepsilon_{i,t}$ (5)

The fitted value of regression (5) is the estimate of the expected level of new investment while the unexplained portion (residual) is the estimate of over-investment.

If the residual is positive (negative), it indicates over-investment (under-investment).

$INVEFFICIENCY_{t,i}$ the absolute value of the residual, is a proxy for investment efficiency. The larger the $INVEFFICIENCY_{t,i}$ the lower the investment efficiency.

Variable measurement (*INVEFFICIENCY*)

$Invest_{i,t}$ refers to the fixed assets investment level of firm i in year t.

$Growth_{i,t-1}$, $Leverage_{i,t-1}$, $Cash_{i,t-1}$, $Age_{i,t-1}$, $Size_{i,t-1}$ and $Returns_{i,t-1}$ represent firm i's growth opportunities (Tobin's Q), leverage (debt to assets ratio), cash and equivalent holdings, firm age, firm size *ln[TotalAssets]* and stock return ratio in year t-1.

Tobin's Q is measured as the ratio of the market value of assets to the current replacement cost of those assets, in line with Ryngaert and Thomas (2012) as a measure of growth opportunities.

Variable measurement *(TFP)*

We assume that the industry produces a homogeneous product with Cobb-Douglas technology and that the factors underlying profitability differences among firms are neutral efficiency differences.

We estimate the production function given in:

$$Y_{it} = \beta o + \beta_k k_{it} + \beta_l l_{it} + \omega_{it} + \eta_{it} \quad \textbf{(6)}$$

Y_{it} is the log of value added for firm i in period t; l_{it} and k_{it} are log values of labor and capital of the firm, respectively; ω is the productivity; and η is an error term not known (it can represent a shock of productivity not a priori known).

- Following the methodology of Imrohoroglu and Tuzel (2014), the study employs the semiparametric procedure developed by Olley and Pakes (1996) to estimate the parameters of the production function (6)
- Control for selection and simultaneity biases and deal with the within firm serial correlation in productivity.

Once we estimate the production function parameters (βo, β_l, β_k), we obtain the firm level (log) TFPs by:

$$\omega_{it} = y_{it} - \beta_o - \beta_l * l_{it} - \beta_k * k_{it} \quad (7)$$

Olley and Pakes assume that productivity ω_{it} is observed by the firm before the firm makes some of its factor input decisions, which gives rise to the simultaneity problem.

Labor, l_{it} is the only variable input, i.e., its value can be affected by current productivity, ω_{it}

The other input, k_{it} is a fixed input at time t; and its value is only affected by the conditional distribution of ω_{it} at time t-1.

Consequently, ω_{it} is a state variable that affects firm's decision making where firms that observe a positive productivity shock in period t will invest more in capital, i_{it} and hire more labor, l_{it} in that period.

Research Design

$$\omega_{it} = y_{it} – \beta_o – \beta_l * l_{it} – \beta_k * k_{it} \quad (7)$$

Estimated with industry-specific time dummies. Hence, firm TFPs are free of the effect of industry or aggregate TFP in any given year.

Compute TFPs for each year using that year's financial data and the corresponding production function estimates for that year.

The production function parameters are estimated every year using all data available up until that year to mitigate a potential lookahead bias in the TFP estimates.

Data sources

Main data sources for firm level productivity estimation are Datastream Worldscope and LSEG Eikon. We exclude observations of financial firms, REITS and regulated firms.

Key variables for estimating the firm level productivity are the firm level value added, employment, and physical capital.

GDP as deflator for the value added and price index for private fixed investment as deflator for investment and capital (sources are the World Bank and European Commission), and national average wage index as obtained by OECD.

Research Design

Value added (Yit) is computed as Sales - Materials, deflated by the GDP price deflator. Sales is net sales from Eikon. Materials is measured as Total expenses minus Labor expenses.

Total expenses is approximated as [Sales - Operating Income Before Depreciation and Amortization].

Labor expenses is calculated by multiplying the number of employees from Eikon by the average wages from OECD.

Stock of labor (lit) is measured by the number of employees from Eikon.

Capital stock (kit) is given by gross property, plant, and equipment from Eikon, deflated by the price deflator for investment following the methods of Hall (1990).

Sample Description

Table 1. Sample Description per country

EU Country	No of distinct firms	Firm-years
Austria	35	624
Belgium	67	1182
Bulgaria	83	1232
Croatia	23	412
Cyprus	24	408
Czech Republic	5	90
Denmark	88	1458
Estonia	13	221
Finland	104	1852
France	316	5506
Germany	593	10312
Greece	83	1466
Hungary	22	386
Ireland	9	129
Italy	201	3571
Lithuania	11	196
Luxembourg	3	54
Malta	16	286
Netherlands	59	1005
Poland	280	4923
Portugal	26	451
Romania	75	1323
Slovak Republic	2	36
Slovenia	11	189
Spain	127	2212
Sweden	410	7109
Grand total	2,686	46,633

The sample spans 2004 – 2021 and includes financial data for 26 listed countries in the European Union.

Unbalanced initial panel dataset with approximately 2,686 distinct firms; firm-year observations 46,633.

Notes: *The study includes listed companies from 26 out of the 27 European Union countries. Latvia is not included due to unavailability of relevant data.*

Sample Description

Table 2. Descriptive Statistics

Variable	Obs	Mean	Median	SD	25%	75%
Analyst forecasts						
$NETINCOMENEWS_{t+1}$	11,670	0.0013	0.0002	0.0631	-0.0150	0.0144
$NETINCOMEFE_{t+1}$	11,670	-0.0029	0.00003	0.0269	-0.0056	0.0045
$EBITDANEWS_{t+1}$	11,121	-0.0018	-0.0005	0.0735	-0.0206	0.0181
$EBITDAFE_{t+1}$	11,121	-0.0013	0.0005	0.0274	-0.0048	0.0055
$REVENUENEWS_{t+1}$	13,355	-0.0252	-0.0020	0.3711	-0.0884	0.0711
$REVENUEFE_{t+1}$	13,355	-0.0105	0.0003	0.0949	-0.0141	0.0135
$OPEXNEWS_{t+1}$	2,672	-0.1098	-0.0470	0.4536	-0.1660	0.0021
$OPEXFE_{t+1}$	2,672	0.0966	0.0398	0.2420	0.0048	0.1060
$INVEFFICIENCY_{it}$	19,027	0.0288	0.0181	0.0411	0.0092	0.0307
TFP_{it}	3,747	2.6802	2.8060	1.1393	1.8018	3.5148

Negative skewed analyst forecast error distribution; in line with prior literature.

INVEFFICIENCY and *TFP* measures comparable with prior literature.

Empirical Results

Table 3. Investment efficiency incorporation into analysts' forecasts

	(1)	(2)	(3)	(4)	(5)	(6)
DEP.VAR	*NET INCOME*	*NETINCOME NEWS*	*NETINCOME FE*	*EBITDA*	*EBITDA NEWS*	*EBITDA FE*
INVEFFICIENCY	-0.110***	-0.072**	-0.008	-0.145***	-0.130***	-0.014
	(-3.371)	(-2.123)	(-0.506)	(-3.521)	(-2.928)	(-0.580)
Controls	Included	Included	Included	Included	Included	Included
Year Effects	Included	Included	Included	Included	Included	Included
Industry Effects	Included	Included	Included	Included	Included	Included
Country Effects	Included	Included	Included	Included	Included	Included
Clustering SE	Firm	Firm	Firm	Firm	Firm	Firm
R^2	0.111	0.110	0.020	0.121	0.131	0.020
Adjusted R^2	0.101	0.101	0.009	0.111	0.122	0.008
Observations	4916	4916	4916	4720	4720	4720

Table notes: This table presents the results of the pooled OLS regression of Models 1 – 2. The models control for country, industry, and year effects. All the variables are defined in the Appendix. Continuous variables are winsorized at 1% at both sides. t-statistics (in parentheses) are based on clustered standard errors (clustered by firm).

***, **, and * represent significance levels of 1, 5, and 10 percent, respectively.

Empirical Results

Table 4. Investment efficiency incorporation into analysts' forecasts. Decomposition of profitability into Revenues and Operating Expenses.

	(1)	(2)	(3)	(4)	(5)	(6)
DEP.VAR	*REVENUE*	*REVENUE NEWS*	*REVENUE FE*	*OPEX*	*OPEX NEWS*	*OPEX FE*
INVEFFICIENCY	-0.534***	-0.596***	0.020	-1.052**	-0.647	-0.462*
	(-3.849)	(-3.845)	(0.320)	(-2.584)	(-1.493)	(-1.835)
Controls	Included	Included	Included	Included	Included	Included
Year Effects	Included	Included	Included	Included	Included	Included
Industry Effects	Included	Included	Included	Included	Included	Included
Country Effects	Included	Included	Included	Included	Included	Included
Clustering SE	Firm	Firm	Firm	Firm	Firm	Firm
R^2	0.132	0.127	0.039	0.052	0.101	0.097
Adjusted R^2	0.123	0.117	0.028	0.017	0.068	0.063
Observations	4984	4984	4984	1256	1256	1256

Table notes: This table presents the results of the pooled OLS regression of Models 1 – 2 studying the effect of *INVEFFICIENCY* on firm Revenues and Operating expenses separately. The models control for country, industry, and year effects. All the variables are defined in the Appendix. Continuous variables are winsorized at 1% at both sides. t-statistics (in parentheses) are based on clustered standard errors (clustered by firm).

***, **, and * represent significance levels of 1, 5, and 10 percent, respectively.

Empirical Results

Table 5. Firm productivity incorporation into analysts' forecasts.

	(1)	(2)	(3)	(4)	(5)	(6)
DEP.VAR	*NET INCOME*	*NETINC NEWS*	*NETINC FE*	*EBITDA*	*EBITDA NEWS*	*EBITDA FE*
TFP	0.011***	0.011***	-0.000	0.015***	0.015***	-0.000
	(4.646)	(5.017)	(-0.768)	(4.829)	(4.769)	(-0.345)
Controls	Included	Included	Included	Included	Included	Included
Year Effects	Included	Included	Included	Included	Included	Included
Industry Effects	Included	Included	Included	Included	Included	Included
Country Effects	Included	Included	Included	Included	Included	Included
Clustering SE	Firm	Firm	Firm	Firm	Firm	Firm
R^2	0.214	0.244	0.046	0.278	0.284	0.032
Adjusted R^2	0.195	0.225	0.023	0.259	0.265	0.007
Observations	1298	1298	1298	1229	1229	1229

Table notes: This table presents the results of the pooled OLS regression of Models 3 – 4. The models control for country, industry, and year effects. All the variables are defined in the Appendix. Continuous variables are winsorized at 1% at both sides. t-statistics (in parentheses) are based on clustered standard errors (clustered by firm). ***, **, and * represent significance levels of 1, 5, and 10 percent, respectively.

Empirical Results

Table 6. Firm productivity incorporation into analysts' forecasts.
Decomposition of profitability into Revenues and Operating Expenses.

DEP.VAR	(1) *REVENUE*	(2) *REVENUE NEWS*	(3) *REVENUE FE*	(4) *OPEX*	(5) *OPEX NEWS*	(6) *OPEX FE*
TFP	0.068***	0.067***	0.001	0.112***	0.069**	0.028
	(2.918)	(2.969)	(0.292)	(3.550)	(2.053)	(1.633)
Controls	Included	Included	Included	Included	Included	Included
Year Effects	Included	Included	Included	Included	Included	Included
Industry Effects	Included	Included	Included	Included	Included	Included
Country Effects	Included	Included	Included	Included	Included	Included
Clustering SE	Firm	Firm	Firm	Firm	Firm	Firm
R^2	0.416	0.431	0.038	0.553	0.484	0.064
Adjusted R^2	0.402	0.417	0.015	0.519	0.444	-0.007
Observations	1312	1312	1312	339	339	339

Table notes: This table presents the results of the pooled OLS regression of Models 3 – 4 studying the effect of TFP on firm Revenues and Operating expenses separately. The models control for country, industry, and year effects. All the variables are defined in the Appendix. Continuous variables are winsorized at 1% at both sides. t-statistics (in parentheses) are based on clustered standard errors (clustered by firm).

***, **, and * represent significance levels of 1, 5, and 10 percent, respectively.

Additional Analysis

The effect of **investment on profitability** is significantly higher for:

- the low capital intensiveness firms (log(net PPE / lagged assets)) in the industry.
- in a destocking phase (active destocking vs reactive destocking cycles indicated by [Δ(inventory/sales)] <0 phases

Attributed to Opex containment, thus cost effects of lean management of inventories?

Analysts

- Difficulty in incorporating international sales breakdown impact on profitability (plants and cost centers in different mix of countries, compared to sales and revenue centers).
- Systematic inefficiency with respect to the intangibles' effects (patents etc.) on profitability, even though intangible intensiveness amplifies the positive impact of investment on profitability.
- R&D - intensive sub-sample: analysts are more inefficient.

Can we surmise that the more R&D intensive firms (compared to industry peers) are the leaders instead of the followers? And that it is more difficult to gauge the effects of investment on their performance as they are more likely to invest in new technologies (no precedent)?

Conclusions

- Investigate the associations between investment efficiency and firm-level productivity at the micro level and corporate performance expectations
- Investment efficiency and improvements in firm-level productivity are positively associated with corporate performance expectations
- Financial analysts incorporate the effects of investment / productivity improvement into their forecasts. Under-reaction?
- Complexity of international operations, R&D profile, inventory management factors may play a moderating role