PRODUCTIVITY AND FINANCE: A FIRM LEVEL ANALYSIS OF THE INTANGIBLE ASSETS CHANNEL

Lilas Demmou
OECD

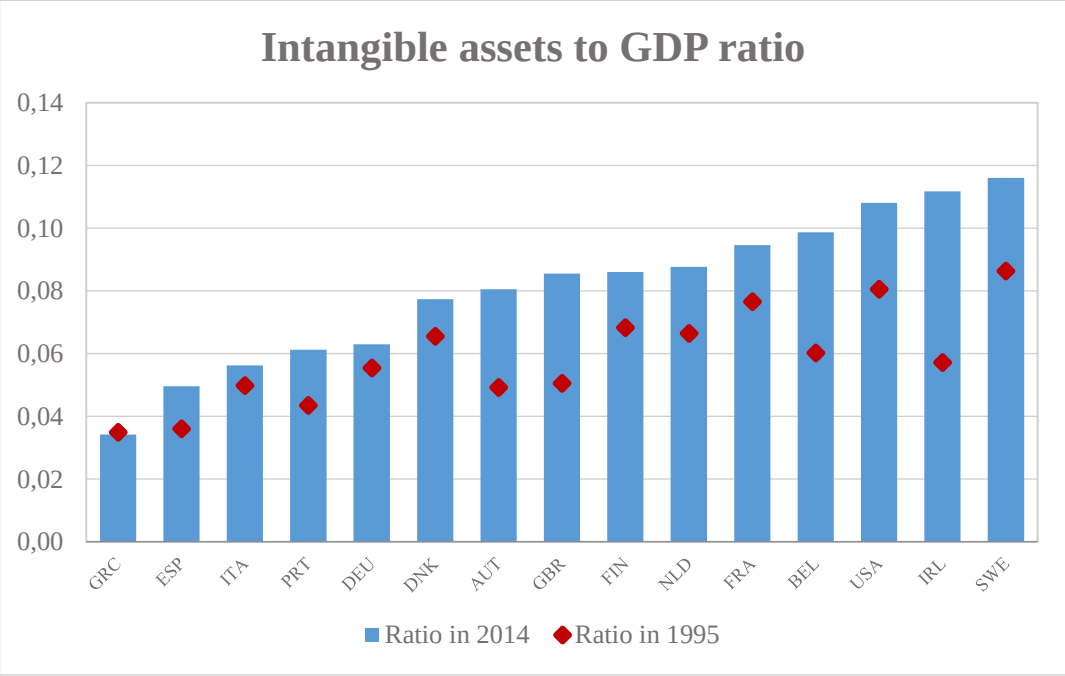
Guido Franco
OECD

Irina Stefanescu
FRB

Séminaire Fourgeaud – November 13th , 2019

OCDE
DES POLITIQUES MEILLEURES POUR UNE VIE MEILLEURE

Stylized Fact 1. Rise of intangible assets

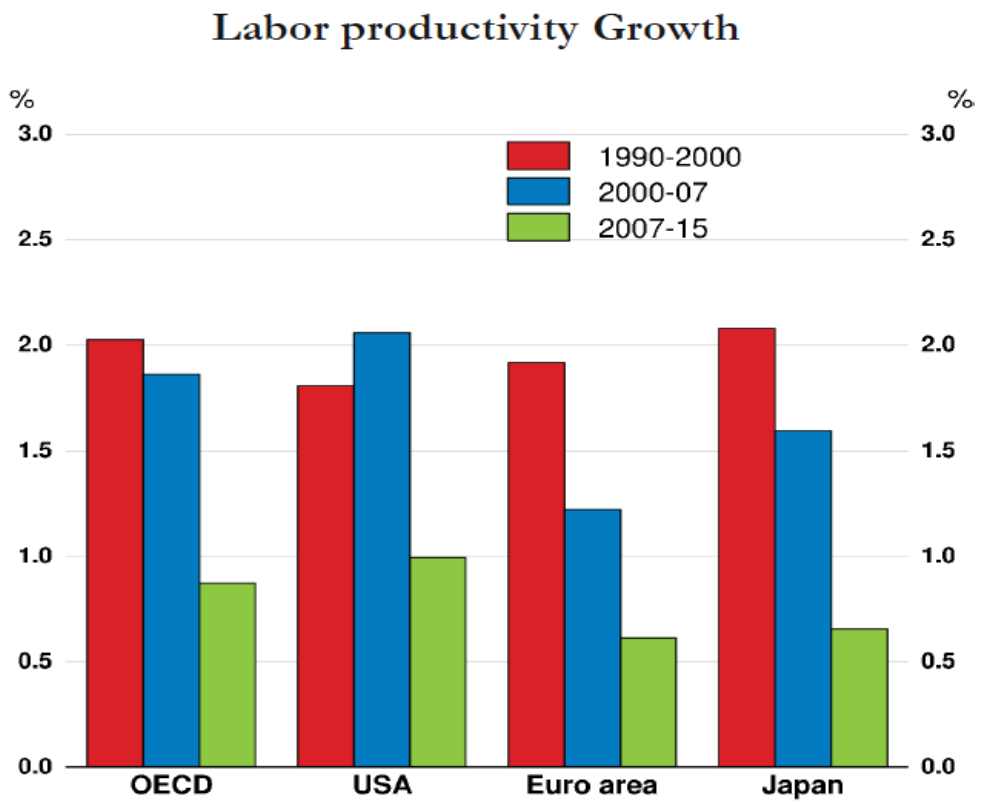


- Intangible assets are now a pivotal component in firms' production function.
- Ample evidence that innovation and productivity are positively related.

Notes: OECD calculations based on Corrado et al. (2016) and OECD National Accounts datasets.

Detail

Stylized Fact 2. Productivity growth slowdown



Notes: OECD calculations based on the OECD Productivity Database.

- Despite the rise of intangibles, productivity growth has declined in many OECD countries.
- The most important challenge faced by advanced economies in the last decades.
- Among several explanations, the literature stresses the role played by **financing frictions.**

Research question

- This paper explores **the mechanisms linking financial frictions, intangible assets and productivity.**

- We argue that, despite their aggregate rise, intangible assets often fall short of desired levels, because **financing the acquisition of intangibles is more difficult than that of tangibles.**
  - ***Asymmetry of information***.
  - Intangible assets are ***harder to pledge as collateral*** when searching for external capital.

- As a result, **in sectors structurally relying on intangible assets, financial constraints become even more binding** in harming productivity growth.

Research question (cont'd)

- Using sector level data, Demmou, Stefanescu and Arquie' (2018) show that the **positive impact of financial development on productivity growth is more pronounced for intangible intensive sectors.**

- The effect found at the sector level could be driven by:
  - An **absolute level effect** on the productivity of each firm operating in the sector.
  - A **relative effect** on how efficiently resources are allocated across firms.

Module 1: WP1 10/2018

Module 2: this presentation!

Module 3: we will have preliminary hints

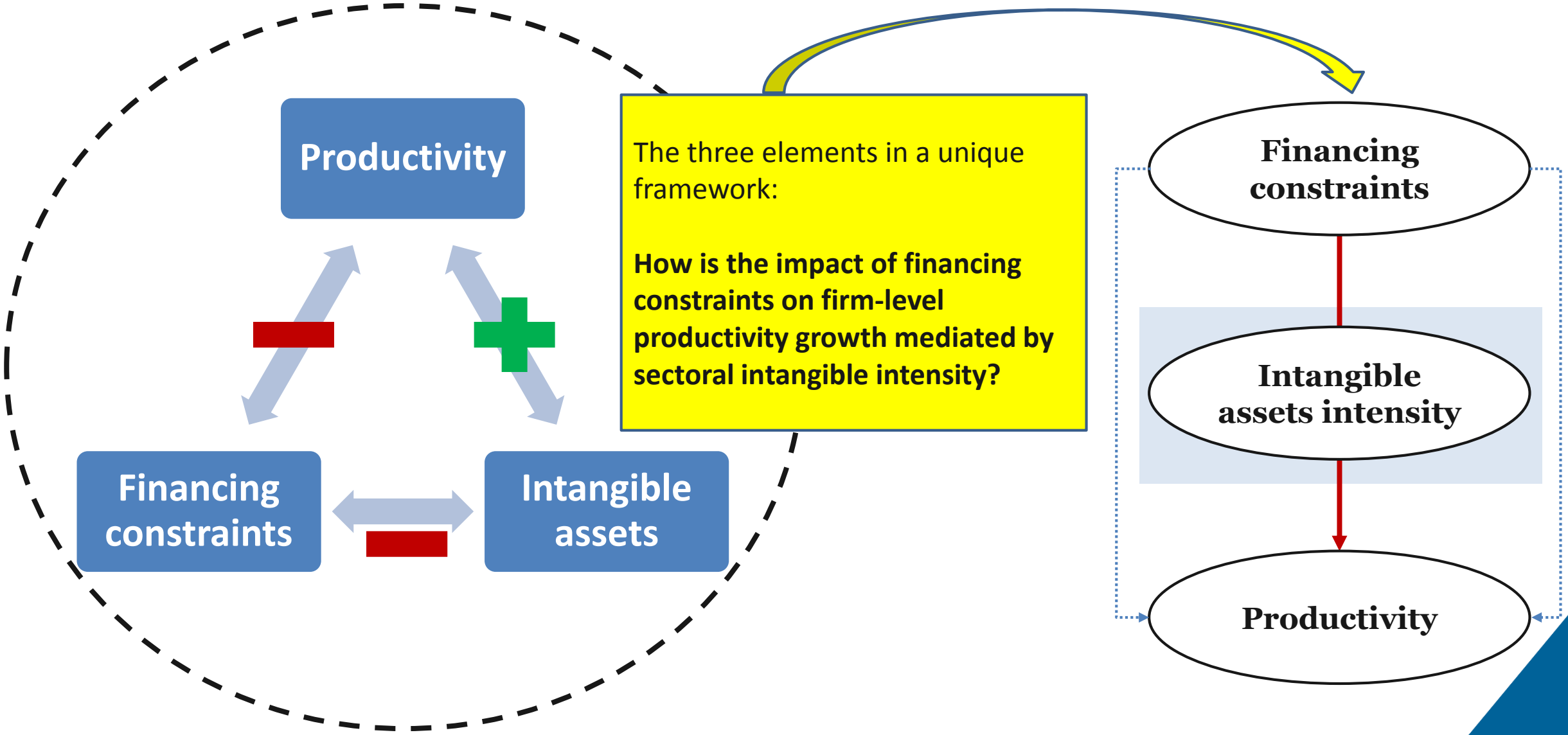
Related literature

- **The impact of financing constraints on innovation:**
  - Brown et al. (2009), Hall and Lerner (2010), Aghion et al. (2010, 2012), Campello and Hackbarth (2012), Garcia-Macia (2015).

- **The impact of financing constraints on productivity:**
  - Levine and Warusawitharana (2016), Dorr et al. (2017), Manaresi and Pierri (2017), Ferrando and Ruggieri (2018), Duval et al. (2018).

- **Intangible assets and their impact on productivity:**
  - Hall (2011), Andrews and De Serres (2012), Doraszelski and Jamandreu (2013), Crass and Peters (2014).
  - Corrado et al. (2005, 2012, 2013), Corrado and Hulten (2010, 2014), Peters and Taylor (2017).

Contribution to the literature



Methodology: baseline specification

- We estimate the following **saturated panel fixed effects** model:

$$Productivity_{icst} = \beta_0 + \beta_1 FinConstr_{ics,(t-1)} + \beta_2 \left(FinConstr_{ics,(t-1)} * IntangIntens_s\right) + \beta_3 \boldsymbol{X}_{ics,(t-1)} + \beta_4 \left(\boldsymbol{X}_{ics,(t-1)} * IntangIntens_s\right) + \delta_i + \delta_{cst} + \epsilon_{icst}$$

- Firm fixed effects (δ_i) absorb the unobserved firm-specific heterogeneity: focus on **within firm variation**.

- Country by sector by year dummies (δ_{cst}) **control for all time varying shocks at the country-sector level.**

- **No causality, but controlling for a wide range of confounding factors.**

- **Exogeneity of intangible intensity**:
  - **Underlying assumption:** in the absence of financial constraints, intangible intensity is akin to a sectoral technological characteristic that should not vary across countries.

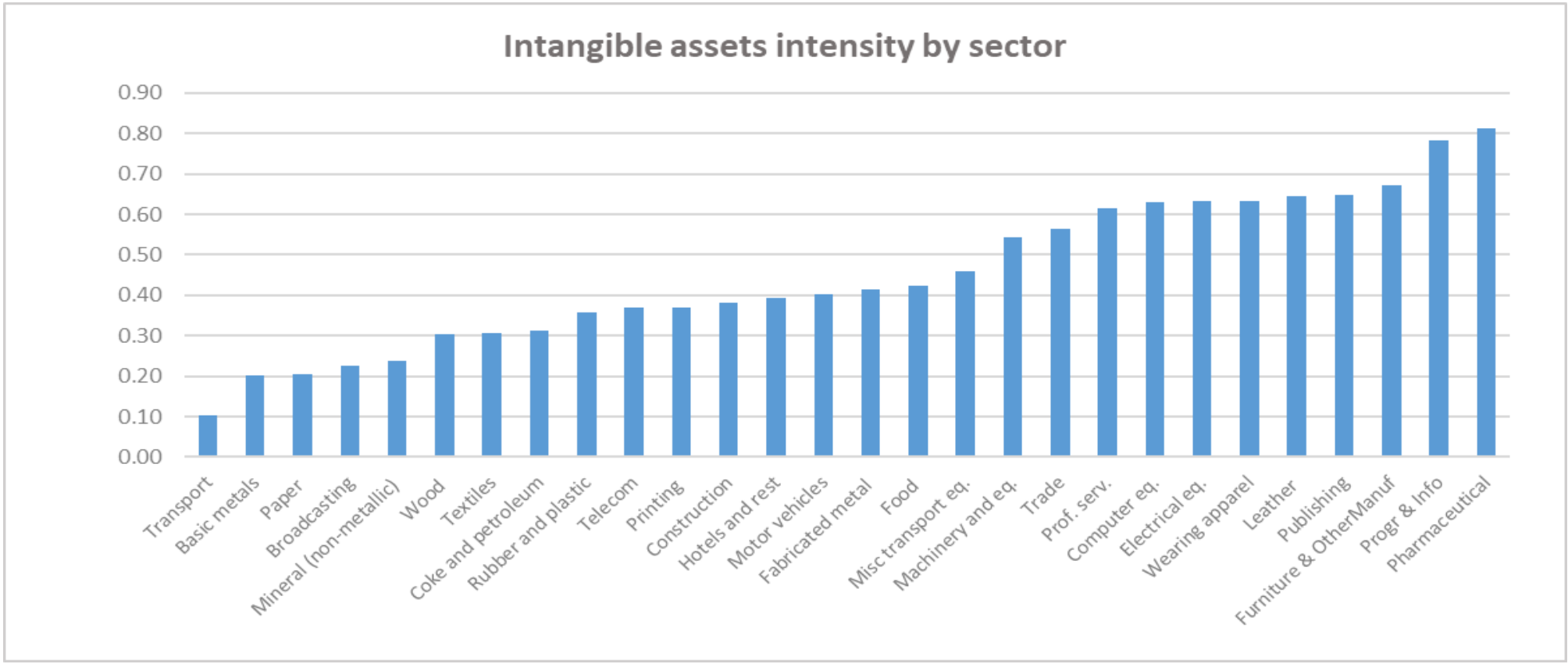
Intangible intensity: measurement

- We build our **sector-level intangible intensity** measure (ratio of intangible assets to total assets) from Compustat data on U.S. listed firms.
  - For each firm, the ratio of the sum of intangible assets over the sum of total assets over the 1990-2006 period.
  - For each industry, median value across firms.

- Applying Peter and Taylor (2017) methodology, intangible assets at the firm-level are derived capitalizing the following firms' expenses:
  - **Knowledge capital**: R&D, patents, licenses, designs, copyrights.
  - **Organizational capital**: firm-specific human capital, distribution networks, organizational structure.

Intangible intensity: descriptives

- Intangible assets intensity varies substantially across sectors.



Notes: OECD calculations based on Compustat data.

Firm level data: sources and coverage

- **Orbis database:** balance sheets data from administrative sources on companies worldwide.
  - It has an advantage over “Compustat type” data given the non listed firm coverage.
  - It has an advantage over “Census type” data given the links between production and financial data.

- **Comprehensive data cleaning procedures** - Gal (2013), Kalemli-Ozcan et al. (2015) - to ensure comparability across countries and sectors.

- **Unbalanced panel of 1.7 mln unique firms:**
  - Tracked during the 1995-2015 period;
  - Located in 29 countries;
  - Operating both manufacturing and services industries.

Financial constraints at the firm level: financial ratios

- We initially proxy financing constraints with simple financial ratios that are widely used in the literature:
  - **Financial leverage ratio** (financial debt over total assets)
  - **Cash holdings over total assets.**
  - **Cash flow over total assets**.
  - **Interest coverage ratio** (ebitda over interest payments)

- Yet, each of these ratios taken singularly may not allow to **comprehensively assess firms financing conditions**:
  - A highly leveraged firm could be liquid, and so able to catch investment opportunities.
  - An illiquid firm could have strong fundamentals that allow to access external capital.

Financial constraints at the firm level: DFS indices

- We propose a **new index (DFS)**, in the spirit of Musso and Schiavo (2008) and Mulier et al. (2016).

- DFS collapses **information from eight variables:** size, age, *financial leverage ratio*, return on assets, current ratio, *cash to assets ratio*, *interest coverage ratio* and the ratio of shareholder funds over total liabilities.
- It is built as follows:
  1. For each variable, deviation from the country-sector-(year) median.
  2. Quintiles of deviations from the median, assigning a score (1 to 5).
  3. Aggregate scores in 3 ways: sum of the scores, number of variables that scores 5, principal component analysis.
  4. Results are rescaled (1-10) and higher value reflects stronger constraints

Financial constraints at the firm level: “traditional indices”

- Ferrando et al. (2015) index, based on **ECB SAFE** survey:

$$\boldsymbol{SAFE} = -1.88 + (0.71 * LeverageRatio) + (-0.51 * ROA) + (-0.28 * InterestCoverageRatio) \\ +(-1.20 * CashHoldings) + (-0.21 * TangibleFixedAssets) + (-0.05 * LogTotAssets)$$

- **Whited and Wu (2006)** index:

$$\boldsymbol{WW} = (-0.091 * CashFlowOverTotAssets) + (-0.044 * LogTotalAssets) + (-0.062 * DummyProfits) \\ +(0.021 * LongDebtOverTotAssets) + (-0.035 * FirmSalesGrowth) + (0.102 * AverageSalesGrowth)$$

- To reduce concerns about coefficients out-of-sample extrapolation and account for country-sector heterogeneity, we also calculate deciles of:
  - Distribution of the index.
  - Distribution of deviations from country-sector median.

Firm level productivity

- All measures are revenue based, as we do not observe firm-specific prices, but only 2-digits industry deflators.

- Log of **total factor productivity**, estimated through the GMM **Wooldridge (2009)** value added based methodology.

- Labor productivity, calculated as the log of value added per employee.
  - Highly correlated with TFP, both in levels and growth rates.

Results (1). Baseline, financial ratios

	Dependent Variable: Log TFP			
Intangible Intensity Measure: IntK_cat (0-1)	(1)	(2)	(3)	(4)
Financial Indicator	Financial Leverage Ratio	Interest Coverage Ratio	Cash Holdings over TotAssets	Cash Flow over TotAssets
Financial Indicator	**-0.026*** **	**0.007*** **	**0.142*** **	**0.337*** **
	(-10.1)	**(17.5)**	**(45.1)**	**(95.8)**
Financial Indicator * Intangible Intensity	**-0.057*** **	**0.002*** **	**0.065*** **	**0.163*** **
	(-17.4)	**(3.5)**	**(16.1)**	**(34.1)**
Observations	10,443,551	10,443,551	10,040,817	10,428,942
R-squared	0.806	0.806	0.809	0.807
Firm Controls (Size, Age, Profitability) & Interactions	YES	YES	YES	YES
Country * Sector * Year FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES

T-statistics in parentheses; standard errors clustered at the firm level.

Significance Level: $^{+}$15%, *10%, **5%, *** 1%.

Results (2). Baseline, financial constraints indices

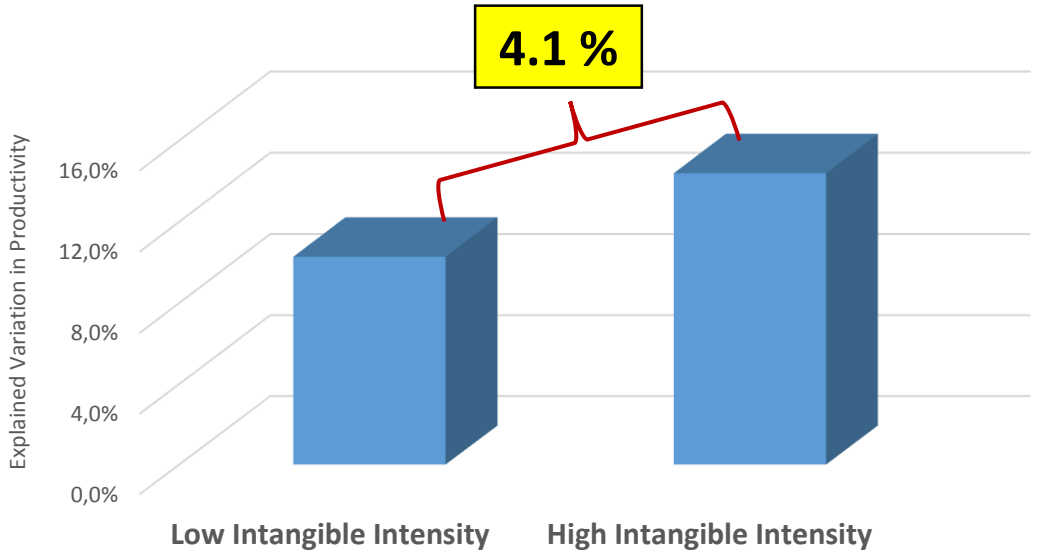
	Dependent Variable: Log TFP						
Intangible Intensity Measure: IntK_cat (0-1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Financial Constraints Index	DFS_vB	DFS_vB2	DFS_PCA	WW_num	WW_cat	SAFE_v1	SAFE_v2
Financial Constraints Index	**-0.030*** **	**-0.019*** **	**-0.034*** **	**-0.915*** **	**-0.024*** **	**-0.012*** **	**-0.009*** **
	(-94.3)	**(-68.3)**	**(-103.1)**	**(-91.9)**	**(-104.4)**	**(-40.8)**	**(-37.9)**
Financial Constraints Index * Intangible Intensity	**-0.012*** **	**-0.007*** **	**-0.013*** **	**-0.375*** **	**-0.008*** **	**-0.002*** **	**-0.001** **
	(-30.1)	**(-20.1)**	**(-30.9)**	**(-28.9)**	**(-26.0)**	**(-5.2)**	**(-2.4)**
Observations	8,098,713	8,098,713	8,098,713	7,459,986	7,459,986	10,008,230	10,008,230
R-squared	0.816	0.807	0.816	0.819	0.818	0.809	0.809
Firm Controls (Size, Age, Profitability) & Interactions	YES	YES	YES	YES	YES	YES	YES
Country * Sector * Year FE	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES

T-statistics in parentheses; standard errors clustered at the firm level.

Significance Level: $^{+}$15%, *10%, **5%, *** 1%.

Results (3). Baseline findings, magnitude of the effect (DFS index)

- Compare two firms, one at the 75th and one at the 25th percentile of the financial constraints distribution. Their difference in terms of financial constraints explains:



- **14.4%** of the variation in productivity in **highly intangible intensive** sectors.
- **10.3%** of the variation in productivity in **low intangible intensive** sectors.

Results (4). Robustness, alternative intangible intensity measures

Dependent Variable: Log TFP			
Financial Constraints Index: DFS_vB	(1)	(2)	(3)
Intangible Intensity Measures	IntK_cont	IntK_Know	IntK_Org
Financial Constraints Index	**-0.029*** **	**-0.037*** **	**-0.023*** **
	(-48.1)	**(-172.1)**	**(-49.6)**
Financial Constraints Index * Intangible Intensity	**-0.018*** **	**-0.027*** **	**-0.050*** **
	(-15.1)	**(-9.5)**	**(-32.1)**
Observations	8,098,713	8,098,713	8,098,713
R-squared	0.816	0.816	0.816
Firm Controls (Size, Age, Profitability) & Interactions	YES	YES	YES
Country * Sector * Year FE	YES	YES	YES
Firm FE	YES	YES	YES

T-statistics in parentheses; standard errors clustered at the firm level.

Significance Level: $^{+}$15%, *10%, **5%, *** 1%.

Results (5). Further robustness checks on the baseline model

- Labor productivity as dependent variable.
- All combinations of the various measures for firms' financial constraints and intangible intensity.
- Exclude poorly covered countries in Orbis, as well as the largest ones.
- Sample splits over time (e.g., pre vs post GFC).
- Alternative data cleaning strategies (e.g., different thresholds for min firms’ size).
- Alternative clustering strategies.

Tables

Results (6). Robustness, cross-sectional regressions

- In the spirit of Fama and MacBeth (1973) and Kashyap and Stein (2000), we check the cross-sectional stability of the relation of interest.

- We run, **separately for each year**, the following regression:

$$\Delta Prod_{ics} = \beta_0 + \beta_1 FinConstr_{ics} + \beta_2 (FinConstr_{cs} * IntangIntens_s) + \beta_3 Prod_{ics} + \beta_4 \boldsymbol{X}_{ics} + \beta_5 (\boldsymbol{X}_{ics} * IntangIntens_s) + \delta_{cs} + \epsilon_{ics}$$

- All explanatory variables, including TFP levels to control for convergence effects, enter the equation with a lag.

- Identification occurs exclusively through **cross-sectional variation across firms within country-sector cells** due to the inclusion of country by sector (δ_{cs}) fixed effects.

Results (6). Robustness, cross-sectional regressions (cont'd)

Dependent Variable: Δ of Log TFP -- Intangible Intensity Measure: IntK_cat (0-1)										
FC Index: DFS_vB	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
FC	**0.000**	**-0.003****	**-0.007*****	**-0.012*****	**-0.008*****	**-0.009*****	**-0.009*****	**-0.002**	**-0.003**	**-0.003**
	(0.0)	**(-2.0)**	**(-3.0)**	**(-5.5)**	**(-2.9)**	**(-3.5)**	**(-5.2)**	**(-1.0)**	**(-1.1)**	**(-1.1)**
FC * IntK	**-0.007****	**-0.007*****	**-0.013*****	**-0.009*****	**-0.012*****	**-0.008*****	**-0.007*****	**-0.010*****	**-0.012*****	**-0.012*****
	(-2.0)	**(-2.7)**	**(-3.9)**	**(-2.8)**	**(-4.2)**	**(-2.8)**	**(-2.9)**	**(-2.9)**	**(-2.9)**	**(-2.9)**
Observations	106,761	168,369	203,425	242,635	285,490	319,156	344,915	376,592	364,629	412,501
R-squared	0.217	0.172	0.196	0.217	0.213	0.205	0.173	0.158	0.150	0.157
Set of Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country * Sector FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Dependent Variable: Δ of Log TFP -- Intangible Intensity Measure: IntK_cat (0-1)										
FC Index: DFS_vB	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
FC	**-0.003**	**-0.004***	**-0.008*****	**-0.012*****	**-0.008*****	**-0.011*****	**-0.014*****	**-0.009*****	**-0.010*****	**-0.006*****
	(-1.0)	**(-1.7)**	**(-3.5)**	**(-6.7)**	**(-4.3)**	**(-5.7)**	**(-6.5)**	**(-5.5)**	**(-5.6)**	**(-3.3)**
FC * IntK	**-0.014*****	**-0.012*****	**-0.010*****	**-0.010*****	**-0.009*****	**-0.009*****	**-0.008*****	**-0.008*****	**-0.009*****	**-0.008*****
	(-2.9)	**(-3.0)**	**(-3.0)**	**(-4.5)**	**(-3.6)**	**(-4.0)**	**(-3.6)**	**(-3.8)**	**(-4.2)**	**(-3.6)**
Observations	418,664	509,805	506,370	521,925	516,039	539,399	646,810	641,605	589,348	474,698
R-squared	0.151	0.159	0.161	0.172	0.169	0.146	0.145	0.143	0.158	0.137
Set of Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country * Sector FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

T-statistics in parentheses; standard errors clustered at the country-sector level.

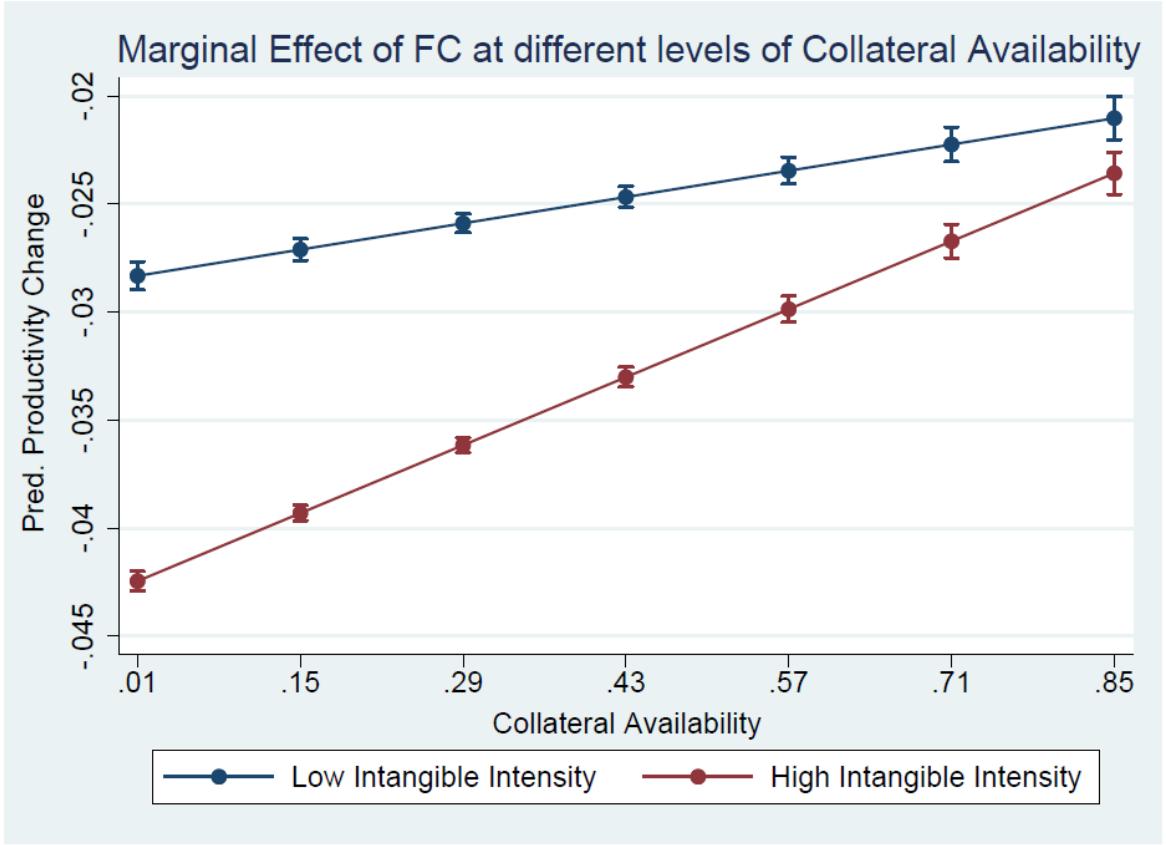
Significance Level: $^{+}$15%, *10%, **5%, *** 1%.

Results (7). Exploratory evidence on the collateral channel

Dependent Variable: Log TFP	
Intangible Intensity Measure: IntK_cat (0-1)	(1)
Financial Constraints Index: DFS_vB	Collateral Channel
Financial Constraints	**-0.030*** **
	(-61.6)
Financial Constraints * Intangible Intensity	**-0.014*** **
	(-22.7)
Financial Constraints * Intangible Intensity * Collateral	**0.013*** **
	(7.8)
Financial Constraints * Collateral	0.014***
	(11.1)
Collateral	-0.369***
	(-31.8)
Collateral * Intangible Intensity	-0.052
	(-1.2)
Observations	8,077,514
R-squared	0.816
Firm Level Controls (Interacted with IntK and CFC)	YES
Country * Sector * Year Fixed Effects	YES
Firm FE	YES

T-statistics in parentheses; standard errors clustered at the firm level.

Significance Level: +15%, *10%, **5%, *** 1%.



Results (8). Exploratory evidence on framework conditions

Dependent Variable: Log TFP -- Intangible Intensity Measure: IntK_cat (0-1)		
Financial Constraints Index: DFS_vB	(1)	(2)
Framework Conditions	CreditGDP	Contr. Enf.
Financial Constraints	**-0.032*** **	**-0.047*** **
	(-43.5)	**(-26.4)**
Financial Constraints * Intangible Intensity	**-0.014*** **	**-0.013*** **
	(-15.2)	**(-6.1)**
Financial Constraints * Intangible Intensity * Framework Conditions	**0.002** **	**0.005***
	(2.4)	**(1.8)**
Financial Constraints * Framework Conditions	0.003***	0.038***
	(5.3)	(13.8)
Observations	7,018,716	5,886,789
R-squared	0.818	0.825
Firm Level Controls (Interacted with IntK and CFC)	YES	YES
Country * Sector * Year Fixed Effects	YES	YES
Firm FE	YES	YES

T-statistics in parentheses; standard errors clustered at the firm level.

Significance Level: $^{+}$15%, *10%, **5%, *** 1%.

Detail

Concluding remarks

- Building on a broad definition of intangible assets, we develop a novel approach based on sector level **intangible intensity to proxy for industries exposure to financing frictions** in the new digital economy.

- Financial frictions are even **more binding for productivity growth in the innovative sectors** in which intangibles have become a pivotal component in firms production function.

- During the last two decades, **financial frictions** acted as a **drag on productivity growth** in OECD countries.

EXTENSION

Exploratory evidence on finance, intangibles and misallocation

- We use two alternative measures to assess the **extent of misallocation** in each country-sector-year.
  - **Olley and Pakes** decomposition (*higher covariance term, lower misallocation*).
  - **Dispersion** in the marginal revenue product of labor (*higher dispersion, higher misallocation*).

- Orbis has coverage and **representativeness issues** when aggregating at higher levels; we *temporarily* deal with them as follows:
  1. Select only relatively well covered countries.
  2. Focus on a permanent sample of firms: keep only firms that we observe each year from 2006 to 2015. (spurious entry and exit)
  3. Keep only country-sector-year cells with more than 5 observations.

Exploratory evidence on finance, intangibles and misallocation

$$Alloc_{cst} = \beta_0 + \beta_1\left(FinDev_{c,(t-1)} * IntangIntens_s\right) + \beta_4\left(\boldsymbol{X}_{c,(t-1)} * IntangIntens_s\right) + \delta_{cs} + \delta_{ct} + \delta_{st} + \epsilon_{cst}$$

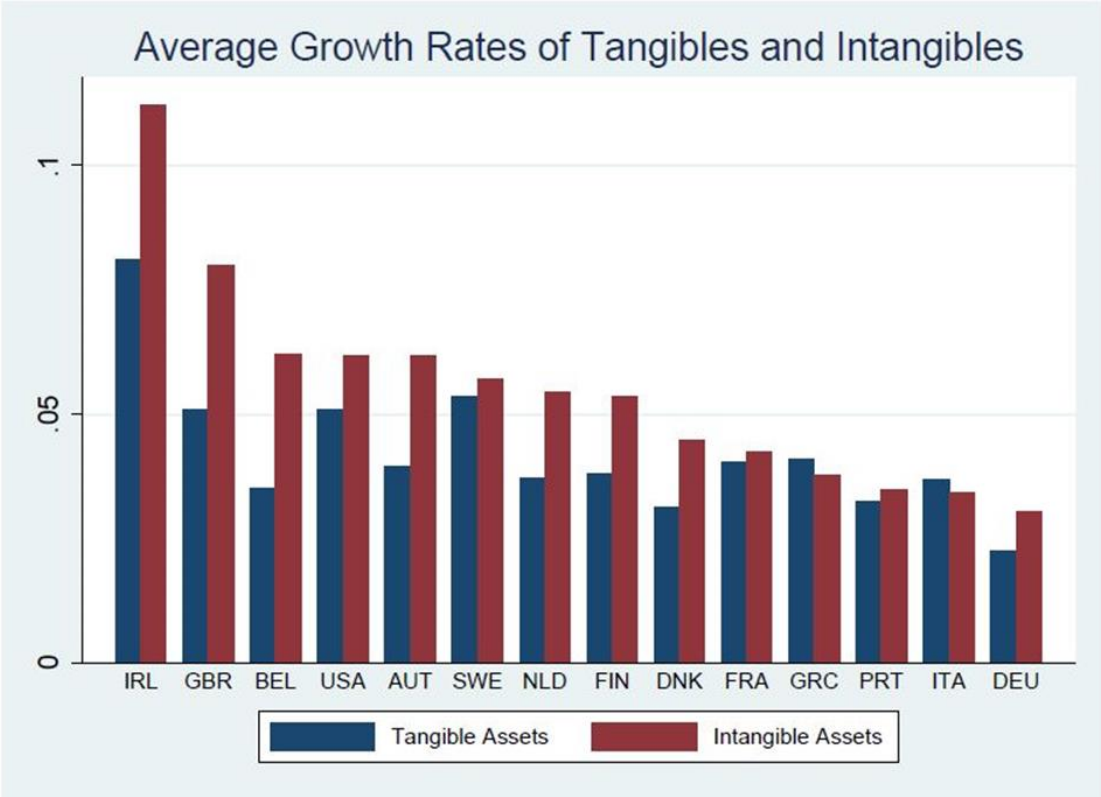
Dependent Variable: Allocative Efficiency / Misallocation								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	**Olley and Pakes Covariance Term**				**Dispersion in MRPL**			
Intangible Intensity	IntK_cat (0-1)		IntK_cont		IntK_cat (0-1)		IntK_cont	
Financial Development * Intangible Intensity	**0.440****	**0.403****	**1.158*****	**1.156*****	**-0.226****	**-0.144^{+}**	**-0.150**	**-0.014**
	(2.4)	**(2.4)**	**(2.6)**	**(2.7)**	**(-2.3)**	**(-1.5)**	**(-0.6)**	**(-0.1)**
Observations	5,430	5,400	5,430	5,400	5,426	5,396	5,426	5,396
R-squared	0.921	0.922	0.921	0.922	0.840	0.840	0.839	0.840
Aggregate Controls Interacted with IntK	NO	YES	NO	YES	NO	YES	NO	YES
Country-Sector FE	YES	YES	YES	YES	YES	YES	YES	YES
Country-Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Sector-Year FE	YES	YES	YES	YES	YES	YES	YES	YES

T-statistics in parentheses; standard errors clustered at the country-sector level.

Significance Level: +15%, *10%, **5%, *** 1%.

ANNEX

Stylized Fact 1. Tangibles vs Intangibles



Notes: OECD calculations based on Corrado et al. (2016) and OECD National Accounts datasets.

- The growth rate of intangible investment has often exceeded that of tangible investment.
- New technologies have seen unprecedented development, and investment into software, patenting, organization and distribution networks have generated new intangible assets

BACK

Main findings of the sector level analysis

$$Prod_{cst} = \beta_0 + \beta_1\left(FinDev_{c,(t-1)} * Z_s\right) + \beta_2\, TechChange_{st} + \left[\beta_3\, Kstock_{cs,t-1}\right] + \delta_{cs} + \delta_{ct} + \epsilon_{cst}$$

Dependent Variable: Sector Level Productivity				
	(1)	(2)	(3)	(4)
Dependent Variable	***Total Factor Productivity***		***Labor Productivity***	
Intangible Intensity	IntK_cat (0-1)	IntK_cont	IntK_cat (0-1)	IntK_cont
Financial Development * Intangible Intensity	**0.214****	**0.706*****	**0.249****	**0.751*****
	(2.2)	**(3.1)**	**(2.3)**	**(3.1)**
Technical change (Frontier Growth)	0.049**	0.050**	0.011	0.012
	(2.2)	(2.2)	(0.5)	(0.5)
Lagged capital stock			0.107***	0.105***
			(6.5)	(6.4)
Observations	13,867	13,867	13,484	13,484
R-squared	0.884	0.884	0.916	0.916
Country-Sector FE	YES	YES	YES	YES
Country-Year FE	YES	YES	YES	YES

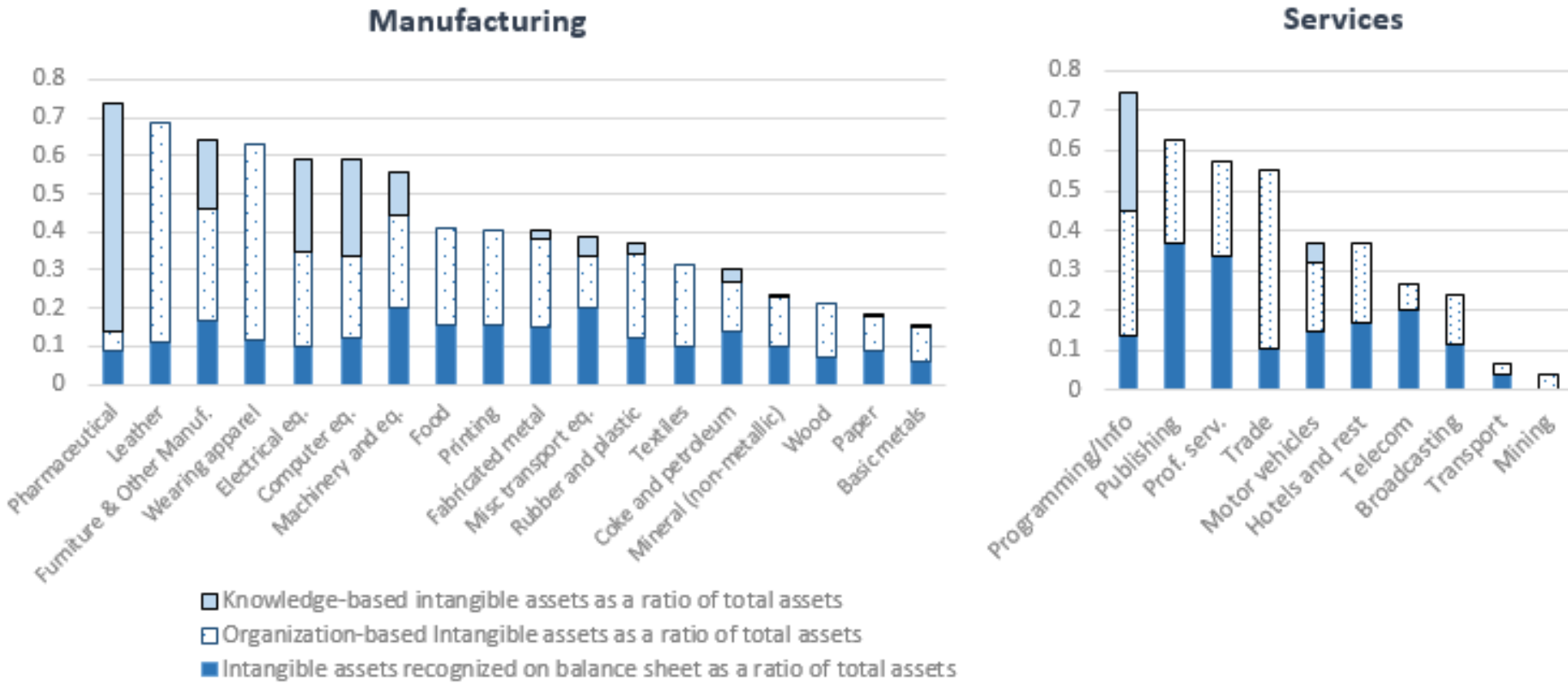
T-statistics in parentheses; standard errors clustered at the country-sector level.

Significance Level: +15%, *10%, **5%, *** 1%.

BACK

Intangible intensity: descriptives (cont'd)

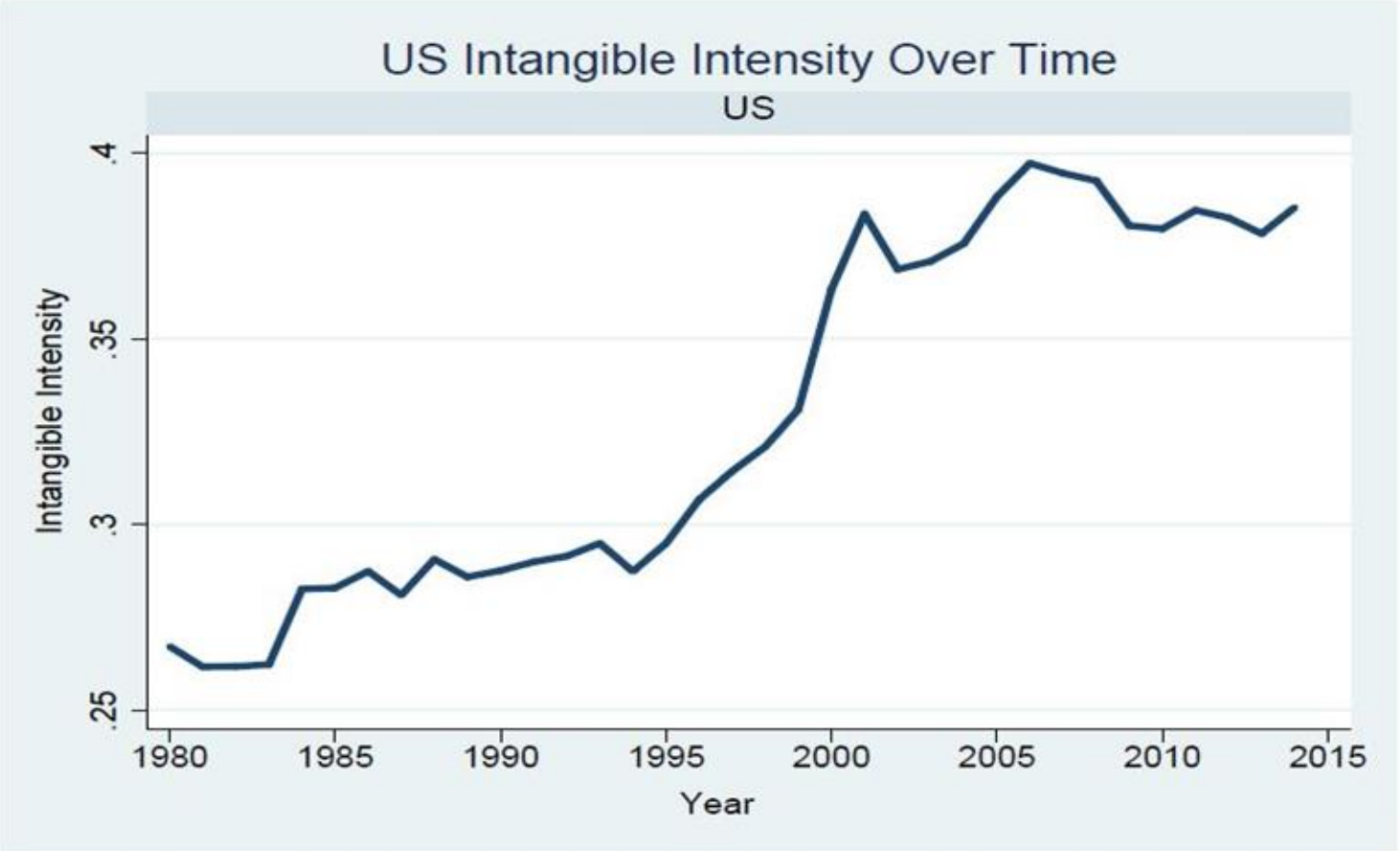
- The composition of intangible assets intensity varies substantially across sectors.



Notes: OECD calculations based on Compustat data.

BACK

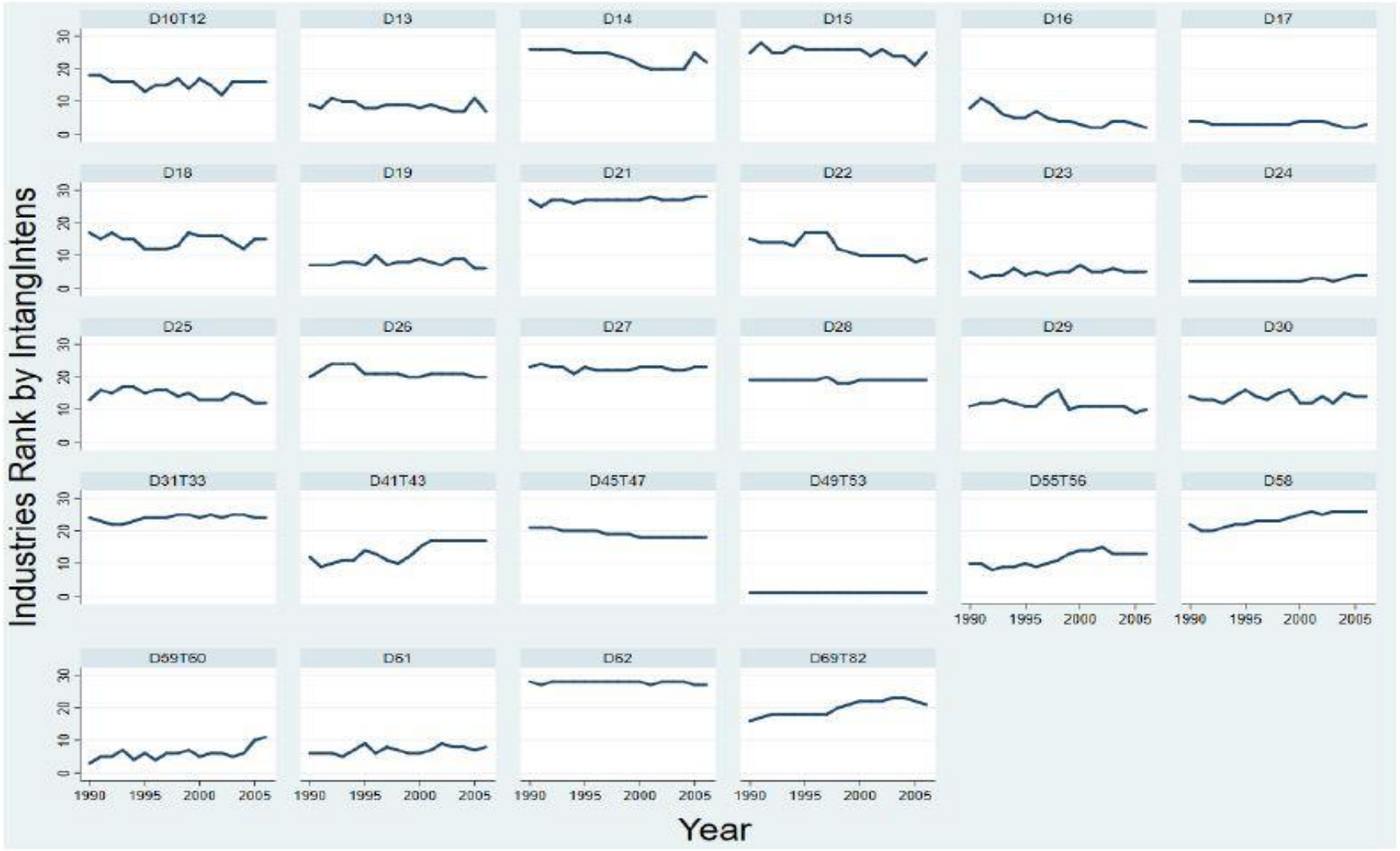
Intangible intensity: descriptives (cont'd)



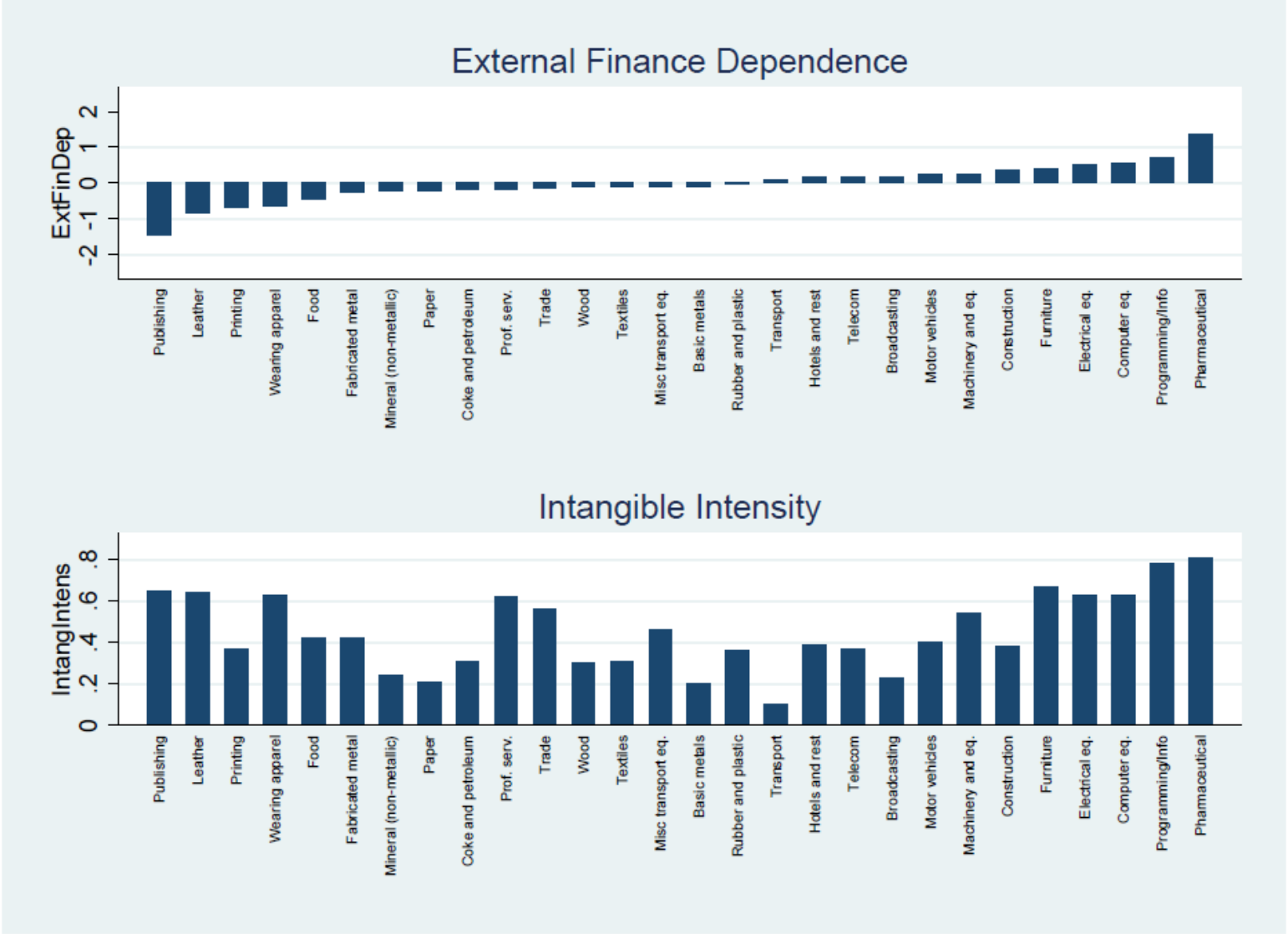
BACK

Intangible intensity: descriptives (cont'd)

BACK



Intangible intensity vs external finance dependence



BACK

Intangible intensity: summary

BACK

Intangible Intensity Index	Included components	Type	Calculation details
IntK_cat (Baseline)		0-1 dummy variable, with respect to the median across industries of IntK_cont	
IntK_cont	Knowledge-based and organizational-based capital	continuous	Sum of intangible assets over the sum of total assets over the period for each firm; for each industry, median across firms
IntK_median		continuous	Ratio of intangibles over total assets for each firm-year; for each firm, the median value over the period; for each industry, median across firms
IntK_Know	Knowledge-based capital	continuous	Sum of knowledge-based intangibles over the sum of total assets over the period for each firm; for each industry, median across firms
IntK_Org	Organizational-based capital	continuous	Sum of organizational-based intangibles over the sum of total assets over the period for each firm; for each industry, median across firms

Firm-level data: observations by year

Year	Frequency	Perc. Obs	Year	Frequency	Perc. Obs
1995	135,001	1.07	2006	782,136	6.22
1996	210,231	1.67	2007	797,333	6.34
1997	273,642	2.18	2008	817,864	6.51
1998	330,411	2.63	2009	812,892	6.47
1999	389,235	3.10	2010	787,521	6.26
2000	442,777	3.52	2011	892,008	7.10
2001	507,908	4.04	2012	878,544	6.99
2002	545,076	4.34	2013	861,666	6.85
2003	572,405	4.55	2014	720,410	5.73
2004	610,461	4.86	2015	573,805	4.56
2005	629,034	5.00	Total	12,570,360	100

BACK

Firm-level data: observations by country

Country	Frequency	Percent Obs	Country	Frequency	Percent Obs
AUS	1,002	0.01	IRL	9,622	0.08
AUT	15,283	0.12	ITA	2,865,430	22.8
BEL	185,343	1.47	JPN	115,820	0.92
CHN	944	0.01	KOR	406,938	3.24
DEU	182,079	1.45	LUX	3,503	0.03
DNK	5,033	0.04	LVA	3,017	0.02
ESP	4,450,251	35.4	NLD	8,648	0.07
EST	6,904	0.05	POL	4,498	0.04
FIN	246,698	1.96	PRT	917,382	7.3
FRA	1,734,075	13.79	RUS	1,403	0.01
GBR	399,365	3.18	SVN	78,420	0.62
GRC	970	0.01	SWE	877,171	6.98
HUN	45,778	0.36	TUR	1,130	0.01
IDN	2,256	0.02	ZAF	727	0.01
IND	670	0.01	*Total*	*12,570,360*	*100*

BACK

Firm-level variables: basic descriptives

Variable	Obs (mln)	Mean	SD	P5	P25	P50	P75	P95
Labor Productivity	12.6	10.70	0.78	9.50	10.27	10.70	11.14	11.91
Total Factor Productivity	12.4	10.40	0.82	9.13	9.94	10.40	10.88	11.71
Labor Productivity Growth	10.8	-0.00	0.51	-0.71	-0.17	0.00	0.17	0.70
Total Factor Productivity Growth	10.6	-0.00	0.48	-0.63	-0.15	0.00	0.16	0.62
Labor (Number of employes)	12.6	71	1816.51	2	4	8	21	129
Age	12.5	16	12.91	3	7	13	21	41
Total Assets (mln, 2005 US \$)	12.6	11.70	346.00	0.09	0.35	1.02	3.65	31.80
Tangible Fixed Assets (mln, 2005 US \$)	12.5	3.02	371.00	0.003	0.03	0.13	0.59	6.52
Ebitda (mln, 2005 US \$)	12.6	1.07	40.40	-0.05	0.02	0.07	0.29	2.71
Financial Leverage Ratio	12.6	0.19	0.23	0.00	0.01	0.15	0.31	0.64
Interest Coverage Ratio	12.6	91.74	825.12	-9.86	1.91	5.62	19.97	256.41
Cash Holdings over Total Assets	12.1	0.12	0.15	0.00	0.01	0.06	0.18	0.46
Current Ratio	12.5	1.83	3.03	0.41	0.95	1.25	1.86	4.67
Equity over Non-Current Liab.	10.2	13.38	57.26	-0.30	0.45	1.63	5.69	49.49
ROA	12.6	0.04	0.13	-0.17	0.00	0.03	0.09	0.25
Cash Flow over Total Assets	12.5	0.06	0.12	-0.10	0.02	0.06	0.11	0.25
Long Term Debt over Total Assets	12.6	0.12	0.19	0.00	0.00	0.02	0.17	0.53
Tangible Fixed Assets over Total Assets	12.5	0.23	0.23	0.01	0.05	0.15	0.35	0.72
Firms Sales (Yearly) Growth Rates	11.0	0.06	0.44	-0.38	-0.11	0.01	0.15	0.65

BACK

Financial constraints indices: summary

BACK

Financial constraints index	Included components	Components' weight	Reference group	Relative/Absolute values	Calculation details
DFS_B (Baseline)			Country-Sector		Sum of the scores (rescaled 0-10)
DFS_A	• Total assets • Age • Financial leverage ratio • Cash to assets ratio • Interest coverage ratio • Returns on assets • Current ratio • Equity over liabilities ratio	All components have the same weight	Country-Sector-Year		Sum of the scores (rescaled 0-10)
DFS_B2			Country-Sector	Deviation from the median of the reference group	Number of variables for which the firm is in the more constrained category (rescaled 0-10)
DFS_A2			Country-Sector-Year		Number of variables for which the firm is in the more constrained category (rescaled 0-10)
DFS_PCA			Country-Sector		Principal components analysis of the scores (rescaled 0-10)
WW_num	• Cash flow over total assets • Total assets • Long term debt over total assets • Profitability (0-1 dummy) • Sales growth • Average sales growth in industry	Components are weighted extrapolating out of sample coefficients from Whited and Wu (2006)	No reference group	Absolute value	The value as it is
WW_cat			Country-Sector	Deviation from the median of the reference group	Deciles of the distribution
SAFE_vA	• Total assets • Leverage ratio • Cash holdings • Interest coverage ratio • Tangible fixed assets	Components are weighted extrapolating out of sample coefficients from Ferrando and Ruggeri (2016)	No reference group	Absolute value	Deciles of the distribution
SAFE_vB			Country-Sector	Deviation from the median of the reference group	Deciles of the distribution

Financial constraints indices: descriptives

	DFS, vA	DFS, vB	DFS, vA2	DFS, vB2	DFS, pca	WW, num	WW, cat	WW, norm	SAFE, vA	SAFE, vB
DFS Index, vA	1.00									
DFS Index, vB	0.97	1.00								
DFS Index, vA2	0.78	0.74	1.00							
DFS Index, vB2	0.75	0.78	0.90	1.00						
DFS Index, pca	0.91	0.93	0.69	0.72	1.00					
WW Index, num	0.40	0.42	0.33	0.35	0.27	1.00				
WW Index, cat	0.45	0.47	0.41	0.44	0.29	0.81	1.00			
WW Index, norm	0.45	0.46	0.42	0.44	0.29	0.85	0.95	1.00		
SAFE Index, cat1	0.42	0.43	0.26	0.28	0.27	0.72	0.60	0.59	1.00	
SAFE Index, cat2	0.43	0.45	0.33	0.35	0.24	0.52	0.65	0.63	0.76	1.00

BACK

Robustness, labor productivity as dependent variable

	Dependent Variable: Log LP						
Intangible Intensity Measure: IntK_cat (0-1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Financial Constraints Index	DFS_vB	DFS_vB2	DFS_PCA	WW_num	WW_cat	SAFE_v1	SAFE_v2
Financial Constraints Index	**-0.019*** **	**-0.012*** **	**-0.023*** **	**-0.720*** **	**-0.019*** **	**-0.010*** **	**-0.008*** **
	(-57.4)	**(-39.4)**	**(-66.7)**	**(-70.2)**	**(-79.5)**	**(-34.4)**	**(-31.0)**
Financial Constraints Index * Intangible Intensity	**-0.012*** **	**-0.007*** **	**-0.013*** **	**-0.397*** **	**-0.009*** **	**-0.003*** **	**-0.001*** **
	(-27.8)	**(-18.7)**	**(-29.3)**	**(-29.7)**	**(-27.7)**	**(-6.8)**	**(-3.6)**
Observations	8,153,060	8,153,060	8,153,060	7,514,943	7,514,943	10,085,411	10,085,411
R-squared	0.757	0.756	0.757	0.761	0.761	0.756	0.756
Firm Controls (Size, Age, Profitability) & Interactions	YES	YES	YES	YES	YES	YES	YES
Country * Sector * Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES

T-statistics in parentheses; standard errors clustered at the firm level.

Significance Level: $^{+}$15%, *10%, **5%, *** 1%.

BACK

Robustness, financial ratios and continuous intangible intensity

	Dependent Variable: Log TFP			
Intangible Intensity Measure: IntK_cont	(1)	(2)	(3)	(4)
Financial Indicator	Financial Leverage Ratio	Interest Coverage Ratio	Cash Holdings over TotAssets	Cash Flow over TotAssets
Financial Indicator	**-0.013****	**0.006*****	**0.123*****	**0.418*****
	(-2.5)	**(8.2)**	**(18.5)**	**(56.9)**
Financial Indicator * Intangible Intensity	**-0.100*****	**0.005*****	**0.121*****	**0.026***
	(-9.9)	**(3.8)**	**(9.3)**	**(1.8)**
Observations	10,443,551	10,443,551	10,040,817	10,428,942
R-squared	0.806	0.806	0.809	0.807
Firm Controls (Size, Age, Profitability) & Interactions	YES	YES	YES	YES
Country * Sector * Year Fixed Effects	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES

T-statistics in parentheses; standard errors clustered at the firm level.

Significance Level: $^{+}$15%, *10%, **5%, *** 1%.

BACK

Robustness, financial ratios in quintiles

Dependent Variable: Log TFP								
Balance Sheet Financial Item, Quintiles	*Financial Leverage*		*Interest Coverage*		*Cash to Total Assets*		*Cash Flow to Total Assets*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intangible Intensity Measures	IntK_cat	IntK_cont	IntK_cat	IntK_cont	IntK_cat	IntK_cont	IntK_cat	IntK_cont
Financial Indicator	**-0.004*** **	**-0.001**	**0.036*** **	**0.039*** **	**0.019*** **	**0.017*** **	**0.042*** **	**0.046*** **
	(-12.5)	**(-1.4)**	**(121.3)**	**(67.0)**	**(62.8)**	**(29.0)**	**(150.8)**	**(82.5)**
Financial Indicator * Intangible Intensity	**-0.007*** **	**-0.016*** **	**0.010*** **	**0.006*** **	**0.004*** **	**0.009*** **	**0.012*** **	**0.007*** **
	(-17.3)	**(-12.5)**	**(26.7)**	**(5.1)**	**(10.6)**	**(7.8)**	**(34.0)**	**(6.3)**
Observations	10,443,551	10,443,551	10,443,551	10,443,551	10,040,817	10,040,817	10,428,942	10,428,942
R-squared	0.806	0.806	0.808	0.808	0.809	0.809	0.809	0.809
Set of Controls (Singularly and Interacted with IntK)	YES	YES	YES	YES	YES	YES	YES	YES
Country * Sector * Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES

T-statistics in parentheses; standard errors clustered at the firm level.

Significance Level: +15%, *10%, **5%, *** 1%.

BACK

Robustness, alternative financial constraints indices and continuous intangible intensity

	Dependent Variable: Log TFP					
Intangible Intensity Measure: IntK_cont	(1)	(2)	(3)	(4)	(5)	(6)
Financial Constraints Indexes	DFS_vB2	DFS_PCA	WW_num	WW_cat	SAFE_vA	SAFE_vB
Financial Constraints Index	**-0.020*** **	**-0.033*** **	**-0.937*** **	**-0.024*** **	**-0.010*** **	**-0.007*** **
	(-37.3)	**(-53.6)**	**(-49.4)**	**(-54.4)**	**(-18.8)**	**(-16.4)**
Financial Constraints Index * Intangible Intensity	**-0.008*** **	**-0.018*** **	**-0.400*** **	**-0.011*** **	**-0.005*** **	**-0.005*** **
	(-7.8)	**(-14.4)**	**(-10.5)**	**(-12.2)**	**(-4.3)**	**(-5.7)**
Observations	8,098,713	8,098,713	7,459,986	7,459,986	10,008,230	10,008,230
R-squared	0.807	0.816	0.818	0.818	0.809	0.809
Firm Controls (Size, Age, Profitability) & Interactions	YES	YES	YES	YES	YES	YES
Country * Sector * Year Fixed Effects	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES

T-statistics in parentheses; standard errors clustered at the firm level.

Significance Level: $^{+}$15%, *10%, **5%, *** 1%.

BACK

Robustness, sample checks

Dependent Variable: Log TFP -- Intangible Intensity Measure: IntK_cat (0-1)					
Financial Constraints Index: DFS_vB	(1)	(2)	(3)	(4)	(5)
Sample Checks	ExclCou	NoESP	T>2000	T>2007	T<2008
Financial Constraints	**-0.029*** **	**-0.025*** **	**-0.027*** **	**-0.011*** **	**-0.012*** **
	(-109.3)	**(-67.3)**	**(-79.2)**	**(-23.4)**	**(-27.0)**
Financial Constraints * Intangible Intensity	**-0.013*** **	**-0.014*** **	**-0.011*** **	**-0.008*** **	**-0.015*** **
	(-38.2)	**(-28.5)**	**(-24.7)**	**(-13.7)**	**(-27.1)**
Observations	8,093,047	5,402,954	7,073,708	4,316,865	3,574,728
R-squared	0.816	0.839	0.820	0.842	0.845
Firm Controls (Size, Age, Profitability) & Interactions	YES	YES	YES	YES	YES
Country-Sector-Year FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES

T-statistics in parentheses; standard errors clustered at the firm level.

Significance Level: +15%, *10%, **5%, *** 1%.

BACK

Robustness, clustering standard errors

Dependent Variable: Log TFP -- Intangible Intensity Measure: IntK_cat (0-1)							
Financial Constraints Index: DFS_vB	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Stats Check	No Clu	Clu (cst)	Clu (ct)	Clu(st)	Clu(cs)	Clu(s)	Clu(c)
Financial Constraints	**-0.030*** **	**-0.030*** **	**-0.030*** **	**-0.030*** **	**-0.030*** **	**-0.030*** **	**-0.030*** **
	(-113.2)	**(-31.6)**	**(-16.8)**	**(-25.1)**	**(-12.1)**	**(-8.0)**	**(-6.3)**
Financial Constraints * Intangible Intensity	**-0.012*** **	**-0.012*** **	**-0.012*** **	**-0.012*** **	**-0.012*** **	**-0.012** **	**-0.012*** **
	(-36.6)	**(-10.2)**	**(-16.0)**	**(-7.8)**	**(-3.6)**	**(-2.5)**	**(-8.8)**
Observations	8,098,713	8,098,713	8,098,713	8,098,713	8,098,713	8,098,713	8,098,713
R-squared	0.816	0.816	0.816	0.816	0.816	0.816	0.816
Firm Controls (Size, Age, Profitability) & Interactions	YES	YES	YES	YES	YES	YES	YES
Country-Sector-Year FE	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES

T-statistics in parentheses; standard errors clustered at the firm level.

Significance Level: +15%, *10%, **5%, *** 1%.

BACK

Robustness, cross-sectional regressions

Dependent Variable: Δ of Log TFP -- Intangible Intensity Measure: IntK_cont										
FC Index: DFS_vB	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
FC	**0.001**	**-0.002**	**0.000**	**-0.006**	**-0.003**	**-0.005**	**-0.009*** **	**-0.002**	**-0.000**	**-0.000**
	(0.2)	**(-0.7)**	**(0.1)**	**(-1.3)**	**(-0.9)**	**(-1.5)**	**(-3.5)**	**(-0.6)**	**(-0.1)**	**(-0.1)**
FC * IntK	**-0.011**	**-0.012****	**-0.032*****	**-0.025*****	**-0.026*****	**-0.019*****	**-0.009***	**-0.014***	**-0.021****	**-0.021****
	(-1.6)	**(-2.2)**	**(-3.4)**	**(-2.6)**	**(-4.0)**	**(-3.1)**	**(-1.7)**	**(-1.9)**	**(-2.5)**	**(-2.6)**
Observations	106,761	168,369	203,425	242,635	285,490	319,156	344,915	376,592	364,629	412,501
R-squared	0.217	0.172	0.196	0.217	0.214	0.205	0.173	0.158	0.150	0.157
Set of Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country * Sector FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

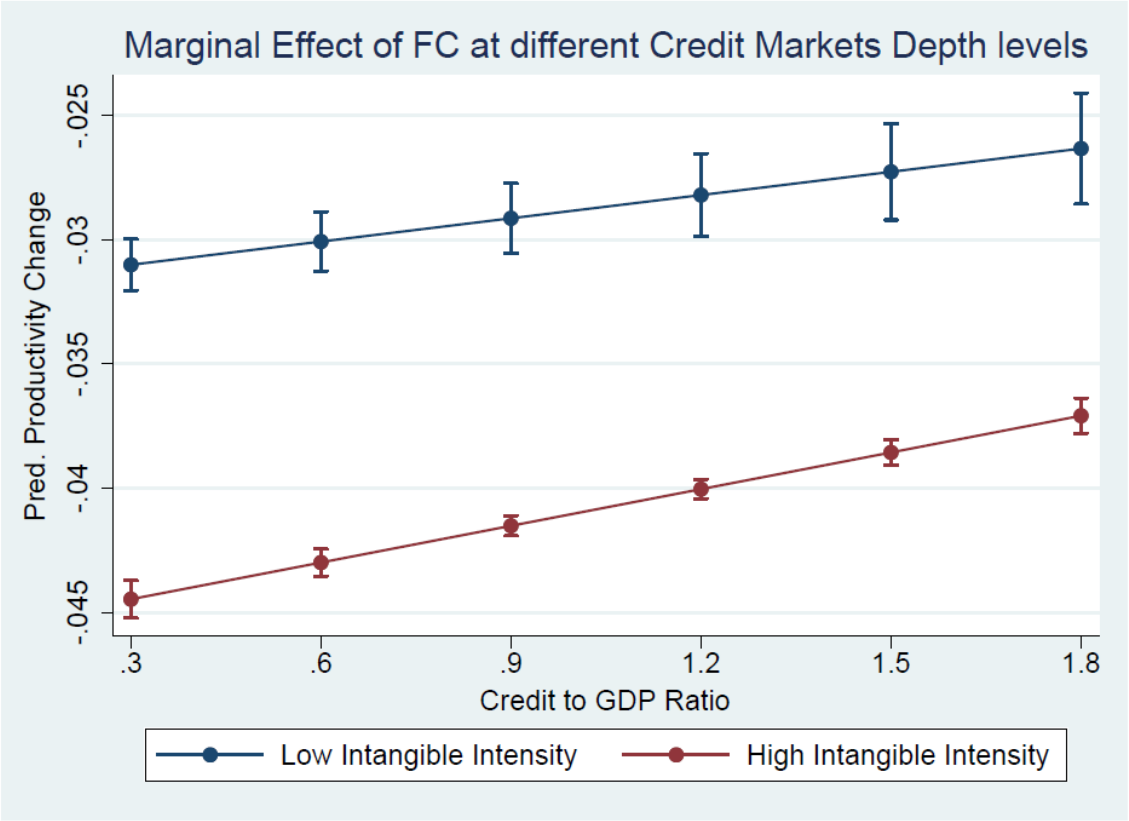
Dependent Variable: Δ of Log TFP -- Intangible Intensity Measure: IntK_cont										
FC Index: DFS_vB	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
FC	**0.001**	**0.000**	**-0.005**	**-0.006****	**-0.003**	**-0.007*****	**-0.010*****	**-0.008*****	**-0.008****	**-0.004**
	(0.3)	**(0.0)**	**(-1.5)**	**(-2.3)**	**(-1.1)**	**(-2.6)**	**(-3.6)**	**(-3.0)**	**(-2.5)**	**(-1.5)**
FC * IntK	**-0.028*****	**-0.025*****	**-0.019*****	**-0.024*****	**-0.021*****	**-0.019*****	**-0.018*****	**-0.013****	**-0.017*****	**-0.015*****
	(-3.2)	**(-3.2)**	**(-3.0)**	**(-4.3)**	**(-3.2)**	**(-3.3)**	**(-3.4)**	**(-2.4)**	**(-2.8)**	**(-2.8)**
Observations	418,664	509,805	506,370	521,925	516,039	539,399	646,810	641,605	589,348	474,698
R-squared	0.150	0.159	0.161	0.172	0.169	0.146	0.145	0.143	0.157	0.137
Set of Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country * Sector FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

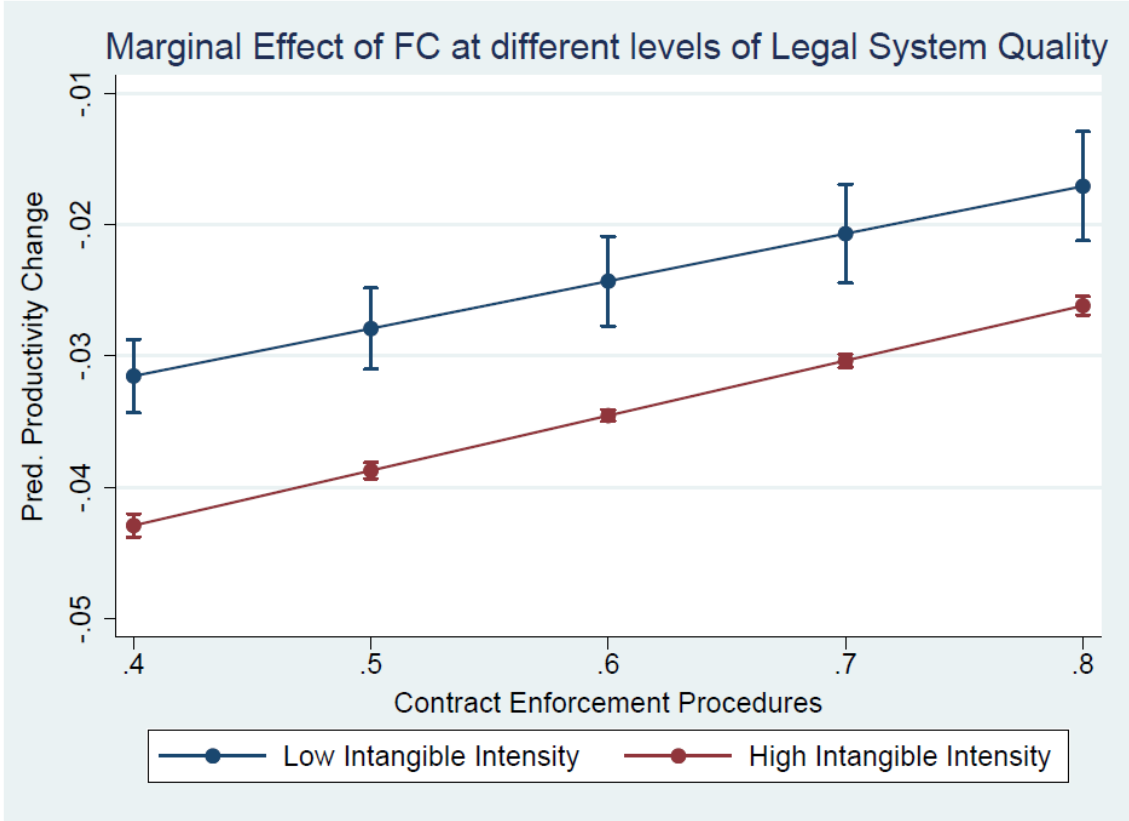
T-statistics in parentheses; standard errors clustered at the country-sector level.

Significance Level: +15%, *10%, **5%, *** 1%.

BACK

Marginal effect of framework conditions





BACK