Process intangibles and agency conflicts

by Chen, Kakhbod, Kazemi, and Xing

Discussion by Nicolas Crouzet

Kellogg

Overview

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Measurement :

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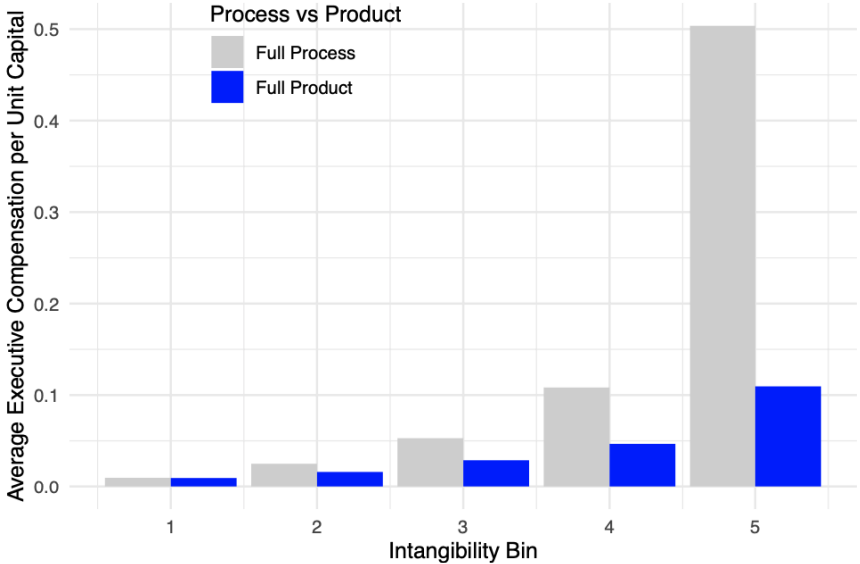
$\uparrow$ process intensity $\leftrightarrow$ $\uparrow$ managerial compensation

Process intensity and compensation



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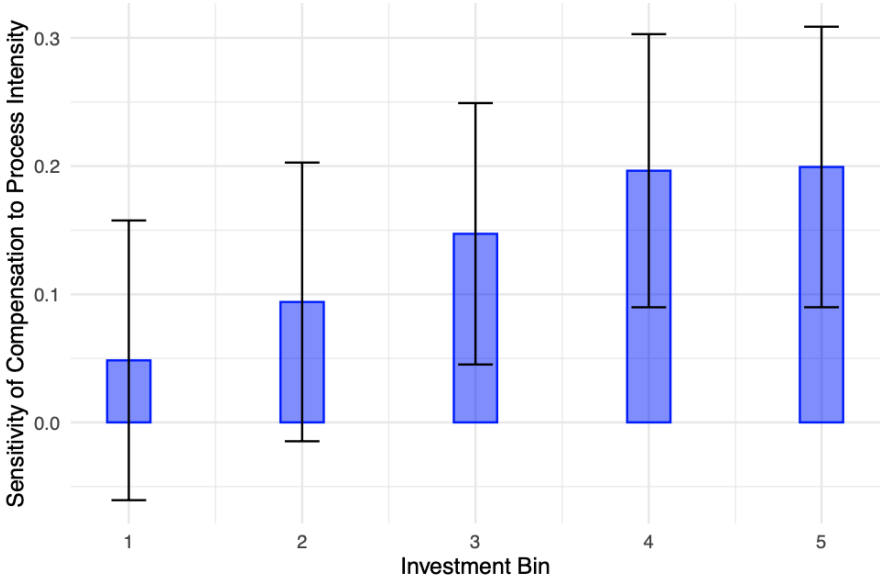
more so for firms with higher physical investment rates

Process intensity, compensation, and physical investment



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Roadmap

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2. Model

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Process innovation

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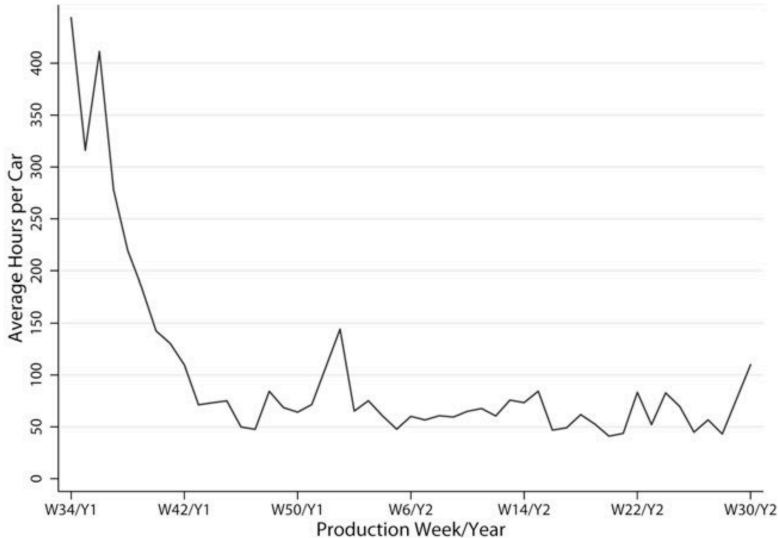
[Levitt, List, Syverson, 2013]



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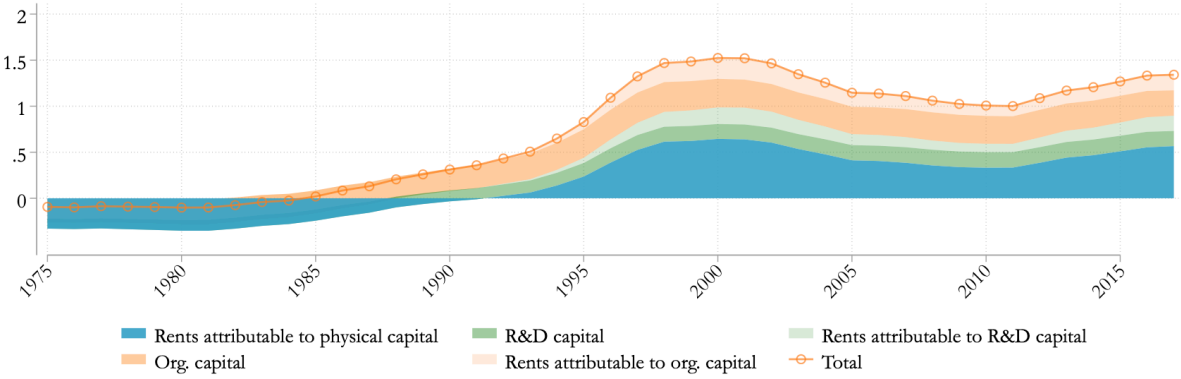
Process innovation contributes to firm value

[Crouzet, Eberly, 2023]



$$\text{Vertical axis} = \frac{\text{Enterprise value of public, non-financial US firms}}{\text{PPE replacement cost}} - 1$$

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Common thread: process innovation is about lowering unit costs, not necessarily changing $MRT(I \to K)$

This paper: process innovation is all about changing $MRT(I \to K)$; no direct impact on unit costs

Evidence on process innovation and physical investment

Fact 1: $cov\,(1-\theta, I_t/K_t) > 0, \quad$ but $\quad cov\,(1-\theta, S_t/K_t) = 0$

Fact 1

	Physical Investment / Physical Capital		Intangible Investment / Physical Capital	
	(1)	(2)	(3)	(4)
Process Intensity	0.027***	0.022***	0.008	0.003
	(0.009)	(0.008)	(0.007)	(0.006)
Intangibility	0.187***	0.124***	0.911***	0.903***
	(0.011)	(0.012)	(0.014)	(0.014)

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$$G^{(K)}_{f,t-1,t+i} = \alpha_f + \beta_f\left(1-\theta_{f,t}\right) \times (I/K)_{f,t} + \gamma_f (O/K)_{f,t} \times (I/K)_{f,t} + \varepsilon_{f,t}, \quad i = 1,3$$

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Fact 2

Ratio Regression	ProcIn.
$i = 1$	
Mean	0.0123
Median	0.144
$i = 3$	
Mean	0.027
Median	0.299

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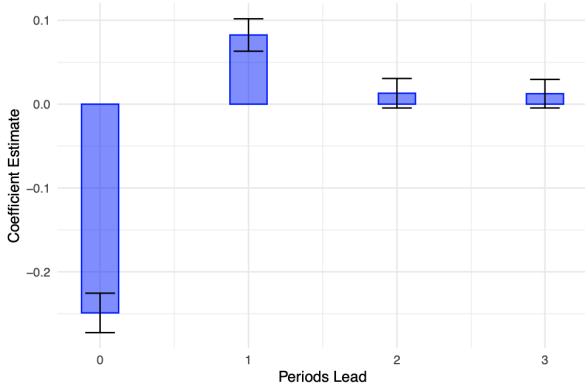
$1-\theta$ increase future sales/capital

Fact 3

Figure 10: Future Sales and Process Intensity



$$\text{Future sales}_{f,t+i} = \theta_{f,t} \times \frac{\text{Sales}_{f,t+i}}{O_{f,t+i}}$$

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Suggestion: How do process patents describe their goal? Does it involve K_t?

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Key facts: compensation and deferred compensation both increase with $1 - \theta$

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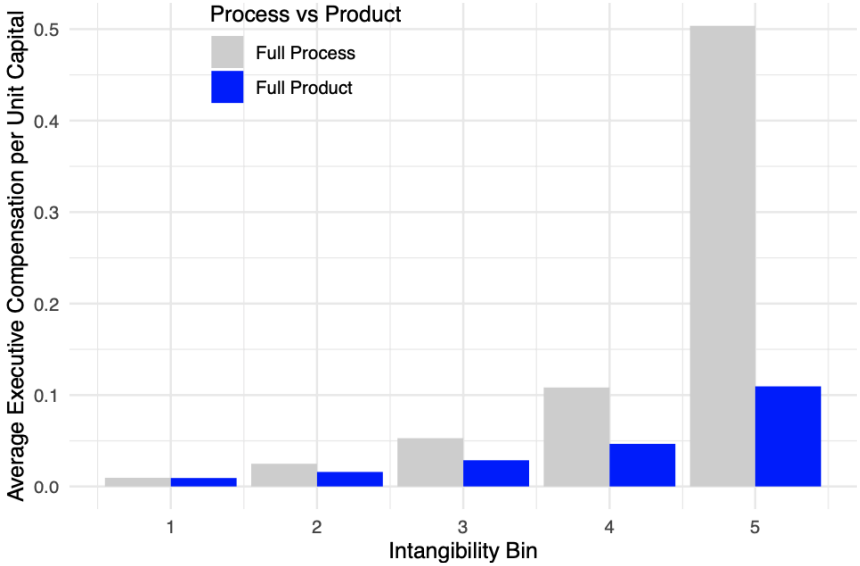
Conditional on O_t/K_t [Ward (2023)]

Process intensity and executive compensation

	Dependent variable:			
	Total Compensation / Physical Capital		Deferred Compensation / Physical Capital	
	(1)	(2)	(3)	(4)
Process Intensity	0.034*	0.066***	0.054**	0.076***
	(0.020)	(0.011)	(0.025)	(0.019)
Intangibility	0.896***	0.717***	0.912***	0.828***
	(0.029)	(0.020)	(0.033)	(0.031)

Process intensity and executive compensation



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Edmans, Gabaix, Jenter (2017): size; volatility; CEO tenure; CEO age

Cross-sectional variation in executive compensation

[Edmans et al. (2017)]

	ln(Total Pay$_t$)				
	(1)	(2)	(3)	(4)	(5)
ln(Firm value$_{t-1}$)	0.426***	0.459***	0.456***	0.455***	0.303***
	[0.008]	[0.008]	[0.008]	[0.009]	[0.017]
Volatility$_{t-1}$	2.842***	1.488***	1.606***	1.527***	0.00727
	[0.177]	[0.185]	[0.199]	[0.197]	[0.233]
ln(Age$_t$)				−0.163*	0.950
				[0.083]	[0.864]
ln(Tenure$_t$)				0.00854	0.0365*
				[0.011]	[0.017]
Female$_t$				0.0404	
				[0.056]	

Note: column 5 contains CEO fixed effects.

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Incremental effect of $1 - \theta$ in sample of switching CEOs, controlling for CEO fixed effects?

2. Model

Model overview

Key agency conflict involves accumulation of K_t

$$dK_t = \left(I_t - \delta_K K_t \right) dt + \sigma K_t dZ_t$$

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Key agency conflict involves accumulation of K_t

$$dK_t = \left(\left(I_t^{\rho} + \frac{1-a}{a} e_t \left((1-\theta) O_t \right)^{\rho} \right)^{\frac{1}{\rho}} - \delta_K K_t \right) dt + \sigma K_t dZ_t$$

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$$
\begin{aligned}
dK_t &= \left(\left(I_t^{\rho} + \frac{1-a}{a} e_t \left((1-\theta) O_t \right)^{\rho} \right)^{\frac{1}{\rho}} - \delta_K K_t \right) dt + \sigma K_t dZ_t \\
e_t &\in \{0, 1\} \quad \text{managerial effort}
\end{aligned}
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$$\begin{aligned} dK_t &= \left(\left(I_t^\rho + \frac{1-a}{a} e_t \left((1-\theta) O_t \right)^\rho \right)^{\frac{1}{\rho}} - \delta_K K_t \right) dt + \sigma K_t dZ_t \\ e_t &\in \{0,1\} \quad \text{managerial effort} \end{aligned}$$

O_t also enters the production function

$$Y_t = \mu \left((1-\phi) K_t^\psi + \phi \left(\theta O_t \right)^\psi \right)^{\frac{1}{\psi}}$$

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$$\begin{aligned} dK_t &= \left(\left(I_t^\rho + \frac{1-a}{a} e_t \left((1-\theta) O_t \right)^\rho \right)^{\frac{1}{\rho}} - \delta_K K_t \right) dt + \sigma K_t dZ_t \\ e_t &\in \{0,1\} \quad \text{managerial effort} \end{aligned}$$

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Optimal contract exposes manager to dK_t, and:

Model overview

Key agency conflict involves accumulation of K_t

$$\begin{aligned} dK_t &= \left(\left(I_t^\rho + \frac{1-a}{a} e_t \left((1-\theta) O_t \right)^\rho \right)^{\frac{1}{\rho}} - \delta_K K_t \right) dt + \sigma K_t dZ_t \\ e_t &\in \{0,1\} \quad \text{managerial effort} \end{aligned}$$

O_t also enters the production function

$$Y_t = \mu \left((1-\phi) K_t^\psi + \phi \left(\theta O_t \right)^\psi \right)^{\frac{1}{\psi}}$$

Optimal contract exposes manager to dK_t, and:

defers compensation, i.e. only pays out when $u_t = \overline{u}(O_t/K_t)$

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- $\uparrow \quad 1-\theta \quad \Longrightarrow$ more deferred compensation

Model suggestions

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Main issue: O_t two has separate purposes; but firm can't control θ.

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2. Why is θ a measure of process intensity, as opposed to a?

   $a = 1$: no agency conflict; $a \to 0$: large hold-up problem

   Are comparative statics of compensation w.r.t. a different?

Model vs. data

Calibration + qualitative comparison to data

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2. Does the model replicate well estimates of performance-pay sensitivity

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   is that true in the data? how close are model and data elasticities?

3. Data: no relationship between $1 - \theta$ and intangible investment rates

   Is that true in the model?

   Again, case $\phi = 0$ might be clearer

Conclusion

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Very interesting paper, with original take on what process innovation is

- Investment that improves $MRT(I \to K)$

Provide more empirical support for this take

Focus the model on process innovation only

Clarify the quantitative implications of the agency conflict

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