

Knowledge Generation and the Speed of Knowledge Obsolescence in the Era of the Digital Transformation

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Summary & Research Context

This study provides estimates based on US patent data from 1973-2012 for both the rate of generation and the rate of obsolescence of technological knowledge. It confirms the indication from previous research that the emergence of the digital transformation around the early 1990's coincides with higher rates of technical knowledge generation as well as obsolescence. The four main findings are:

- There is an increase in the speed of technological knowledge generation on the aggregate & on the sectoral level.
- There is an incline in the speed at which technological knowledge becomes obsolete on the aggregate level & for the sectors electrical engineering, mechanical engineering, and 'others'.
- The sector electrical engineering exhibits the highest rates of both technological knowledge generation & obsolescence.
- There is indication that on a five-year-basis changes in the rates of technical knowledge generation & obsolescence positively correlate with each other.

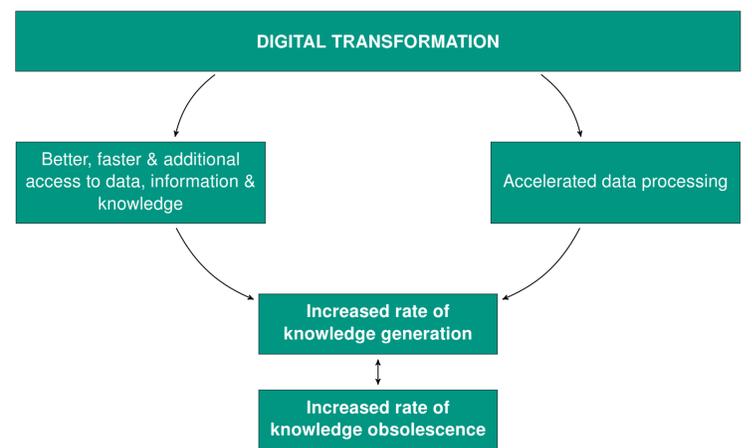


Figure 1: The Research Context

1. Motivation

The pervasive use of digital technologies since the emergence of the digital transformation has been persistently enhancing storage, processing and transmission of knowledge. Especially with the launch of the graphics-capable web browser *MOSAIC* in 1993, a large number of people were given access to information and knowledge at relatively low costs. This suggests a boost in the rate of knowledge generation.

The expansion of specifically the stock of technical knowledge plays a crucial role for economic growth in the context of endogenous growth theory. The models by Romer (1990) and Aghion & Howitt (1992) imply that a faster shift of the technological frontier – *ceteris paribus* – should accelerate economic growth. In order to study this expansion and the effects thereof, not only is it important to analyse at what rate technical knowledge is generated but also how fast it becomes obsolete. Yet, there is no study which covers a reasonable time span after the emergence of the digital transformation.

2. Methods

- Rate of technological knowledge generation
 - Estimation based on Romer's (1990) model
 - Technical ideas/knowledge assumed to be proportional to the number of blueprints
 - Extraction of granted patents per application year on the aggregate and sectoral level

- Rate of technological knowledge obsolescence

- Estimation based on framework of Caballero & Jaffe (1993) and Jaffe & Trajtenberg (1996)
- Backward citations of patents assumed to correspond to the usage of ideas
- Rate of decline in citations corresponds to rate of obsolescence of technical knowledge
- Extraction of average citation distributions (ACD) on the aggregate and sectoral level for the periods 1973-1992 & 1993-2012
- Average citation functions (ACF) estimated by the model

$$avgcit(lag) = \alpha \cdot e^{-\beta_1 \cdot lag} \cdot (1 - e^{-\beta_2 \cdot lag}) + \varepsilon, \quad (1)$$

$$\alpha, \beta_1, \beta_2 \geq 0, \quad \varepsilon \in \mathbb{R}, \quad lag \in [0, \infty).$$

- Average rate of obsolescence $r_o = 1 - e^{-\beta_1 \cdot 1}$
- Average mean citation lags are assumed to correspond to the average lifespan of patents

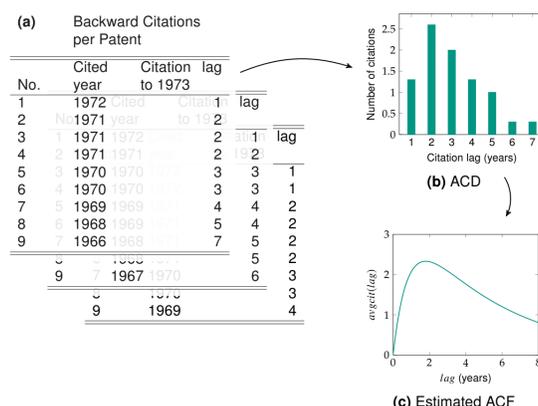


Figure 2: Estimation Procedure of ACFs

3. Results

- Rates of technological knowledge generation

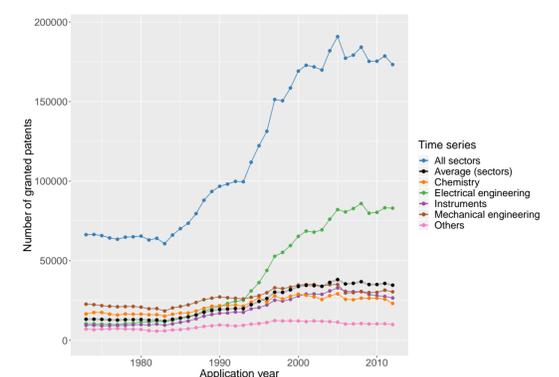


Figure 3: Annual Patent Grants Overall and per Sector (1973-2012)

- Rates of technological knowledge obsolescence

Level/Sector	Average rate of obsolescence r_o (%)		Inverse of mean citation lag (%)	
	1973-'92	1993-2012	1973-'92	1993-2012
Aggregate level	8.91	11.08	7.04	9.17
Electrical engineering	13.49	16.46	10.30	14.33
Instruments	11.01	10.60	8.53	10.02
Chemistry	9.21	8.77	8.10	8.24
Mechanical engineering	6.75	7.38	5.74	6.28
Others	5.28	6.64	4.71	5.20

4. Discussion & Implications

- Coincidence of the digital transformation, increase in the number of annually granted patents & incline in the rate of obsolescence
- High dynamics in electrical engineering support relationship between digital transformation & speed of technical knowledge generation and obsolescence
- Comparison with US per-capita GDP & developments in the patent system suggest, however, that discoveries are not exclusively the result of the digital transformation
- Study design does not allow to draw causal conclusions
- If matched with data about the R&D sector, the findings provide potential for the investigation of the relationship between technological knowledge generation, obsolescence, and economic growth