

AI and Business Models: The Good, The Bad and The Ugly

**Other titles in Foundations and Trends® in Technology,
Information and Operations Management**

Service Industrialization, Employment and Wages in the US Information Economy

Hiranya Nath, Uday Apte and Uday Karmarkar

ISBN: 978-1-68083-694-3

Worker Productivity in Operations Management

Diwas KC

ISBN: 978-1-68083-666-0

Cultural Research in the Production and Operations Management Field

Richard Metters, Donna Marshall and Mark Pagell

ISBN: 978-1-68083-608-0

AI and Business Models: The Good, The Bad and The Ugly

Vania Sena

University of Sheffield
v.sena@sheffield.ac.uk

Manuela Nocker

Essex Business School
University of Essex
mnocker@essex.ac.uk

now

the essence of knowledge

Boston — Delft

Foundations and Trends® in Technology, Information and Operations Management

Published, sold and distributed by:

now Publishers Inc.
PO Box 1024
Hanover, MA 02339
United States
Tel. +1-781-985-4510
www.nowpublishers.com
sales@nowpublishers.com

Outside North America:

now Publishers Inc.
PO Box 179
2600 AD Delft
The Netherlands
Tel. +31-6-51115274

The preferred citation for this publication is

Vania Sena and Manuela Nocker. *AI and Business Models: The Good, The Bad and The Ugly*. Foundations and Trends® in Technology, Information and Operations Management, vol. 14, no. 4, pp. 324–397, 2021.

ISBN: 978-1-68083-795-7

© 2021 Vania Sena and Manuela Nocker

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, mechanical, photocopying, recording or otherwise, without prior written permission of the publishers.

Photocopying. In the USA: This journal is registered at the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923. Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by now Publishers Inc for users registered with the Copyright Clearance Center (CCC). The 'services' for users can be found on the internet at: www.copyright.com

For those organizations that have been granted a photocopy license, a separate system of payment has been arranged. Authorization does not extend to other kinds of copying, such as that for general distribution, for advertising or promotional purposes, for creating new collective works, or for resale. In the rest of the world: Permission to photocopy must be obtained from the copyright owner. Please apply to now Publishers Inc., PO Box 1024, Hanover, MA 02339, USA; Tel. +1 781 871 0245; www.nowpublishers.com; sales@nowpublishers.com

now Publishers Inc. has an exclusive license to publish this material worldwide. Permission to use this content must be obtained from the copyright license holder. Please apply to now Publishers, PO Box 179, 2600 AD Delft, The Netherlands, www.nowpublishers.com; e-mail: sales@nowpublishers.com

Foundations and Trends® in Technology, Information and Operations Management

Volume 14, Issue 4, 2021

Editorial Board

Editor-in-Chief

Panos Kouvelis

Washington University St. Louis
USA

Editors

Charles Corbett

UCLA, USA

Uday Karmarkar

UCLA, USA

Editors

Onur Bayabatli

Singapore Management University, Singapore

Jan Fransoo

Tilburg University, The Netherlands

Chuck Munson

Washington State University, USA

Nicholas Petruzzi

Pennsylvania State University, USA

Guillaume Roels

INSEAD, France

Nicola Secomandi

Carnegie-Mellon University, USA

Zuo-Jun Max Shen

University of California, Berkeley, USA

Sherri Xiaole Wu

Fudan University, China

Y. Karen Zheng

MIT, USA

Editorial Scope

Topics

Foundations and Trends® in Technology, Information and Operations Management publishes survey and tutorial articles in the following topics:

- B2B Commerce
- Business Process Engineering and Design
- Business Process Outsourcing
- Capacity Planning
- Competitive Operations
- Contracting in Supply Chains
- E-Commerce and E-Business Models
- Electronic markets, auctions and exchanges
- Enterprise Management Systems
- Facility Location
- Information Chain Structure and Competition
- International Operations
- Marketing/Manufacturing Interfaces
- Multi-location inventory theory
- New Product & Service Design
- Queuing Networks
- Reverse Logistics
- Service Logistics and Product Support
- Supply Chain Management
- Technology Management and Strategy
- Technology, Information and Operations in:
 - Automotive Industries
 - Electronics manufacturing
 - Financial Services
 - Health Care
 - Media and Entertainment
 - Process Industries
 - Retailing
 - Telecommunications

Information for Librarians

Foundations and Trends® in Technology, Information and Operations Management, 2021, Volume 14, 4 issues. ISSN paper version 1571-9545. ISSN online version 1571-9553. Also available as a combined paper and online subscription.

Contents

1	Introduction	2
2	What is AI?	7
2.1	Defining AI	7
2.2	AI-as-a-Platform	10
3	Impact of AI on Businesses:	
	What Do We Know So Far?	12
3.1	AI as a General Purpose Technology	12
3.2	The Impact of AI on Businesses and Economic Outcomes in General	13
3.3	Automation and Labour Market	13
3.4	What is the Impact of Automation on Economic Growth?	14
3.5	Defining Business Models	16
3.6	Value Migration and Business Model Innovation	18
3.7	Business Model Innovation and AI	19
3.8	Business Models Innovation and AI: A Taxonomy	21
3.9	General Considerations	24
3.10	Choosing a New Business Model	26

4 Business Model Innovation and AI: The Role of Platforms, Standards, Ethics	32
4.1 Platforms and Industrial Structure	33
4.2 Technical Standards	36
4.3 Ethical Framework	47
5 Conclusions	53
Appendix A	57
References	60

AI and Business Models: The Good, The Bad and The Ugly

Vania Sena¹ and Manuela Nocker²

¹*University of Sheffield, v.sena@sheffield.ac.uk*

²*Essex Business School, University of Essex, mnocker@essex.ac.uk*

ABSTRACT

Over the last five years, several scholars from a range of disciplines have started to analyse how Artificial Intelligence (AI) affects businesses outcomes. This research effort has produced many predictions on the expected impact of automation on labour demand and equilibrium employment. However, most of the expected results are dependent on how businesses change their behaviour due to adopting AI. We argue that, as AI diffuses across the economy, changing behaviour is a necessary outcome for incumbents: the argument is that the diffusion of AI across an industry generates the conditions for a process of value migration from incumbents to new entrants (Helper *et al.*, 2018); in these cases, the only mechanism available to incumbents to offset the negative impact of the migration process is by changing the architecture of their business, i.e., the business model. However, companies can choose from several AI-driven business models; their preference for one model is driven by many industry-level factors such as technical standards, the structure of the technology industry and the presence of an ethical framework for the use of AI. This monologue summarises the existing literature on business model innovation and AI; it then analyses the industry-level factors that may shape the business-level preference for specific business models. Finally, the monologue offers some suggestions for future research in the area.

1

Introduction

Interest in Artificial Intelligence (AI henceforth) has grown over the last five years. This interest has been spurred by many factors, including the availability of high volumes of data (both structured and unstructured), the dramatic fall of the costs of storing and processing large volumes of data, and cloud computing and platforms' availability. Unsurprisingly, several governments have started to invest substantial amounts of public funds into large AI research programmes.¹ What is AI exactly? In a nutshell, AI tries to simulate human intelligence through computer systems: more specifically, intelligent systems try to mimic the capability of humans to learn (or acquire new information), reason and self-correct (Calo, 2017). Importantly AI as a term covers a large variety of technologies ranging from machines that can recognise objects and make predictions to systems that have a sense of consciousness and can process their current state.

In economic terms, AI is modelled as a General Purpose Technology (GPT) that can improve productivity once deployed at scale (Brynjolfsson *et al.*, 2017). Most of our understanding of how AI can

¹For instance, the UK Industrial Strategy (2017) identifies AI as one of the grand challenges and the US American AI Initiative (2019).

affect economic outcomes is very much shaped by discussions on job losses and its impact on equilibrium employment (Acemoglu and Restrepo, 2019; Aghion *et al.*, 2019). Recently, researchers from several disciplines have tried to broaden the discussion by focusing on the impact that AI may have on organisations by changing their internal processes, core capabilities and eventually their business models (Agrawal *et al.*, 2017; van der Meulen, 2018). According to some authors, AI's impact on business outcomes may be rather sizable (see, for instance, Brynjolfsson and McAfee, 2014). In reality, given the emerging nature of the technology, it is not easy to quantify these impacts and the mechanisms through which AI will affect their performance (Brynjolfsson *et al.*, 2017). At the moment, the primary thinking is that AI may affect business performance by allowing businesses to use resources more efficiently over time. This outcome is mostly achieved by having AI systems to perform routine tasks which can be learned by software agents (“bots”), which can then prioritise tasks, manage routine interactions with other teams (or other bots), and plan schedules (Acemoglu and Restrepo, 2019; Aghion *et al.*, 2019). AI can also help businesses to streamline their activities and enrich their offerings with new and “smart” products² and lead to the adoption of new business models like Uber and Airbnb.³ Eventually, increases in efficiency and improved products may translate into increases in productivity and profits. There are already examples of organisations that use AI to either minimise costs or launch new products: for instance, Amazon already uses AI to plan the most efficient routes for delivery while legal firms tend to use AI to search through documents and legal records.⁴

Most of the benefits that AI can generate to businesses (and eventually translating into macroeconomic performance) are contingent on changes that businesses make to their business models. Unsurprisingly,

²This point has been made by Varian (2019) and Aghion *et al.* (2019).

³See also Boitnott (2019).

⁴Semmler and Rose (2017) discuss the case of three companies that use AI. The first company, ROSS Intelligence, uses natural language processing to perform legal research and memo drafting. The next company, LawGeex, uses machine learning for contract drafting. It compares the draft to a library of contracts and identifies uncommon or problematic clauses and missing clauses. Finally, Beagle uses AI to draft contracts, and it is targeted at non-lawyers.

understanding how AI shapes new business models is key to understanding how it can influence future economic outcomes well beyond the existing narrative around job losses and technological unemployment (Acemoglu and Autor, 2011; Arntz *et al.*, 2016; Bessen, 2018; OECD, 2015). For this, it is worth starting from a business model definition. Business models are usually defined as the “design or architecture of the value creation, delivery and capture mechanisms” of a business (Teece, 2010). A business model is about the benefits business creates, how it organises itself to do so, and how it will capture value. Business models *per se* are not immutable but tend to change as the business environment changes (Chesbrough, 2007, 2010, 2013; Lindgardt *et al.*, 2012). In turn, this leads to the notion of business model innovation which is not about a new range of products or services offered by organisations, but it is a fundamental change of one of the elements of the current business model (Amit and Zott, 2015; Zott and Amit, 2010). This change can be in either the value proposition or the revenue model. In each case, the change has to provide the business with a new value source that can be used to sustain competitive advantage (Zott and Amit, 2010).

A typical driver of business model innovation is the emergence of a new technology that creates value migration conditions within industries (Foss and Saebi, 2017; Teece, 2010; Zott and Amit, 2010). In some cases, changing the architecture of their business (i.e., the business model) can be the only mechanism available to incumbents to offset the new technology’s negative impact on their performance (Zott and Amit, 2010). A new business model can help incumbents cope with the changing technological landscape and ensure that the new technology’s emergence does not compromise business outcomes. This fact applies to AI as well. In this case, businesses can choose from several new business models where AI is used to create and capture value, implying that AI’s adoption does not necessarily translate into net job losses.

Despite the relevance of the topic, not much is known about the relationship between business model innovation and AI. There is a small literature on business model innovation and AI that struggles to disentangle the interdependencies between technology development and business model innovation (Antonescu, 2018; Tongur and Engwall, 2014). In other words, AI developments are assumed to “be” the business

model innovation even if in reality, the two concepts are separated. The underlying issue here is that while there is a good understanding of how AI (as new and emerging technology) powers new businesses, it is more difficult to understand how the choice of a new business model is intertwined with technology development and how industry-level factors can explain the choice of specific business models. As a result, there are essential questions in this field whose answers are unclear: how do businesses choose new business models? What are the factors shaping their choices? However, it will not be possible to answer these questions until we have a deeper understanding of how AI drives business model innovation.

Against this background, this monologue summarises the literature on AI and business model innovation by highlighting the mechanisms that link the two key variables. Our fundamental hypothesis is that the deployment of AI across an industry creates new mechanisms for value creation in the industry; this may result in new firms generating value in an industry as incumbent firms may no longer be competitive as in the past. This is the so-called “**value migration**” phenomenon, and in these cases, changes to the incumbents’ business models are needed to generate value once more. We argue that incumbents have to change the business models once AI is adopted, but at the same time, the decision of what is changed (i.e., which component of the business model is changed) is up to the business. It is contingent on a mix of industry-level factors that can influence businesses’ capability to identify successful new business models. In other words, adopting AI does not exclusively imply that businesses generate profits through cost reduction, as suggested by much of the economics literature.

Our analysis will start from the concept of value migration and how AI’s deployment in an industry implies that the mechanism for value generation moves somewhere else in the industry; in this case, business model innovation is the only mechanism for businesses to try to generate value. We plan to discuss how AI systems are reshaping business models’ mechanisms, approaches and founding elements (such as organisation, infrastructures, customers or value propositions). We will then move to map the business model innovations we can identify from the literature and produce a taxonomy of emerging AI-driven business models that

will help understand how businesses decide to incorporate AI into their activities. Once we have laid out the different models that businesses can adopt when AI is deployed at scale in an industry, the analysis will focus on the industry-level factors that shape a specific business model's choice once an emerging technology is deployed. Our analysis will focus on many factors, including the role of technology standards, the technology industry's characteristics, and the ethical framework within which businesses operate. While the list is not exhaustive, we have chosen the list of important factors at this point given the nature of AI as an emerging technology.

The monologue wants to offer a summary of the existing literature in this area. It does not want to present new results but instead plans to highlight existing literature gaps, hoping these may spur new research in the topic. It is essential to highlight that lack of data on AI hampers empirical research in this area (Raj and Seamans, 2017); therefore, in our work, we will mostly refer to qualitative studies and grey literature that underpins most research in the field. In this respect, this work's vital purpose is to identify where formal research is needed to help us understand how business models change as AI diffusion across economies accelerates.

The structure of the monologue is as follows. Section 1 will provide a brief introduction to AI and its different varieties. Section 2 will then focus on value migration in industry and business models. Therefore, it will first define value migration and what it implies for existing business models. The discussion is conducted in the context of the AI and the implications of its diffusion for the whole industry. Section 3 provides a taxonomy of the new business models that have emerged due to AI and discusses these new business models' main features. Section 4 will then analyse the key factors that drive the emergence of new business models. Importantly, we will analyse a set of industry-level factors that may condition the new business model's choice. We will also discuss the role of an ethical framework on the emergence of the different business models. Finally, Section 5 offers some concluding remarks and some reflections on existing gaps in our knowledge of business models that can inform future research in the field.

References

- Abbott, K. W. and D. Snidal (2001). “International ‘standards’ and international governance”. *Journal of European Public Policy*. 8(3): 345.
- Acemoglu, D. and D. Autor (2011). “Skills, tasks and technologies: Implications for employment and earnings”. In: *Handbook of Labor Economics*. Ed. by O. Ashenfelter and D. Card. Vol. 4. Amsterdam: Elsevier. 1043–1171.
- Acemoglu, D. and P. Restrepo (2019). “Automation and new tasks: How technology displaces and reinstates labor”. *Journal of Economic Perspectives*. 33(2): 3–30.
- Achtenhagen, L., L. Melin, and L. Naldi (2013). “Dynamics of business models: Strategizing, critical capabilities and activities for sustained value creation”. *Long Range Planning*. 46(6): 427–442.
- Adner, R. and R. Kapoor (2010). “Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations”. *Strategic Management Journal*. 31(3): 306–333.
- Aghion, P., B. Jones, and C. Jones (2019). “Artificial intelligence and economic growth”. In: *The Economics of Artificial Intelligence: An Agenda*. Ed. by A. Agrawal, J. S. Gans, and A. Goldfarb. Chicago, IL: University of Chicago Press. 237–282.

- Agrawal, A., J. S. Gans, and A. Goldfarb (2017). "What to expect from artificial intelligence". *Sloan Management Review*. 7 February.
- Agrawal, A., J. S. Gans, and A. Goldfarb (2018). *Prediction Machines: The Simple Economics of Artificial Intelligence*. Cambridge, MA: Harvard Business Review Press.
- AlphaGo|Deepmind (2019). URL: <https://deepmind.com/research/alphago/> (accessed on 15 May 2019).
- American AI Initiative (2019). *White House Executive Order*. Washington, US.
- Amit, R. and C. Zott (2001). "Value creation in e-business". *Strategic Management Journal*. 22(6–7): 493–520.
- Amit, R. and C. Zott (2012). "Creating value through business model innovation". *MIT Sloan Management Review*. 53: 41–49.
- Amit, R. and C. Zott (2015). "Crafting business architecture: The antecedents of business model design". *Strategic Entrepreneurship Journal*. 9(4): 331–350.
- Andriopoulos, C. and M. W. Lewis (2009). "Exploitation-exploration tensions and organizational ambidexterity: Managing paradoxes of innovation". *Organization Science*. 20(4): 696–717.
- Antonescu, M. (2018). "Are business leaders prepared to handle the upcoming revolution in business artificial intelligence?" *Quality - Access to Success*. 19: 15–19.
- Armstrong, S., N. Bostrom, and C. Shulman (2013). "Racing to the precipice: A model of artificial intelligence development". Technical Report #2013-1, Future of Humanity Institute, Oxford University 1–8. URL: <https://www.fhi.ox.ac.uk/wp-content/uploads/Racing-to-the-precipice-a-model-of-artificial-intelligence-development.pdf>.
- Arntz, M., T. Gregory, and U. Zierahn (2016). "The risk of automation for jobs in OECD countries: A comparative analysis". OECD Social, Employment and Migration Working Papers, No. 189.
- Baden-Fuller, C. and M. S. Morgan (2010). "Business models as models". *Long Range Planning*. 43(2): 156–171.
- Baumol, W. J. (1967). "Macroeconomics of unbalanced growth: The anatomy of urban crisis". *American Economic Review*. 57: 415–426.

- Bekkers, R., E. Iversen, and K. Blind (2012). “Emerging ways to address the re-emerging conflict between patenting and technological standardization”. *Industrial and Corporate Change*. 21(4): 901–931.
- Berends, H., A. Smits, I. Reymen, and K. Podoyntsyna (2016). “Learning while (re)configuring: Business model innovation processes in established firms”. *Strategic Organization*. 14(3): 181–219.
- Berger, F., K. Blind, and N. Thumm (2012). “Filing behaviour regarding essential patents in industry standards”. *Research Policy*. 41(1): 216–225.
- Berliner, D. and A. Prakash (2013). “Signaling environmental stewardship in the shadow of weak governance: The global diffusion of ISO 14001”. *Law and Society Review*. 47: 345–373.
- Bessen, J. (2018). “AI and jobs: The role of demand”. National Bureau of Economic Research Working Paper No. 24235.
- Birkinshaw, J. and C. Gibson (2004). “Building ambidexterity into an organization”. *MIT Sloan Management Review*. 45: 47e55.
- Blind, K. (2002). “Driving forces for standardisation at standardisation development organisations”. *Applied Economics*. 34(16): 1985–1998.
- Blind, K. (2004). *The Economics of Standards: Theory, Evidence, Policy*. Cheltenham: Edward Elgar.
- Blind, K. (2006). “Explanatory factors for participation in formal standardisation processes: Empirical evidence at firm level”. *Economics of Innovation and New Technology*. 15(2): 157–170.
- Blind, K. (2013). “The impact of standardization and standards on innovation”. Nesta Working Paper 13/15.
- Blind, K., R. Bekkers, Y. Dietrich, E. Iversen, F. Köhler, B. Müller, T. Pohlmann, S. Smeets, and J. Verweijen (2011). *Study on the Interplay Between Standards and Intellectual Property Rights (IPRs)*. Luxembourg: European Commission.
- Blind, K. and S. Gauch (2009). “Research and standardisation in nanotechnology: Evidence from Germany”. *Journal of Technology Transfer*. 34(3): 320–342.
- Blind, K., S. S. Petersen, and C. A. F. Riillo (2017). “The impact of standards and regulation on innovation in uncertain markets”. *Research Policy*. 46: 249–264.

- Blind, K. and N. Thumm (2004). “Interrelation between patenting and standardisation strategies: Empirical evidence and policy implications”. *Research Policy*. 33(10): 1583–1598.
- Boden, M. (2016). *AI: Its Nature and Future*. Oxford: Oxford University Press.
- Boitnott, J. (2019). 7 innovative companies using A.I. to distrust their industries. URL: <https://www.inc.com/john-boitnott/7-innovative-companies-using-ai-to-disrupt-their-industries.html> (accessed on 1 June 2019).
- Bojovic, N., C. Genet, and V. Sabatier (2018). “Learning, signaling, and convincing: The role of experimentation in the business modelling process”. *Long Range Planning*. 51(1): 141–157.
- Boston Consulting Group (2019). *Business Model Innovation: When the Game Gets Tough, Change the Game*. Boston, MA: Boston Consulting Group.
- Bresnahan, T. and M. Trajtenberg (1995). “General purpose technologies ‘Engines of growth’?” *Journal of Econometrics*. 65(1): 83–108.
- Brunsson, N. and B. Jacobsson (2000). “The contemporary expansion of standardization”. In: *A World of Standards*. Oxford: Oxford University Press. 1–18.
- Brynjolfsson, E. and L. M. Hitt (2000). “Beyond computation: Information technology, organizational transformation and business performance”. *The Journal of Economic Perspectives*. 14(4): 23–48.
- Brynjolfsson, E. and A. McAfee (2014). *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. First ed. New York: W.W. Norton and Company.
- Brynjolfsson, E. and A. McAfee (2017). “What’s driving the machine learning explosion?” *Harvard Business Review*. 18: 3–11.
- Brynjolfsson, E., T. Mitchell, and D. Rock (2018). “What can machines learn, and what does it mean for occupations and the economy?” *AEA Papers and Proceedings*. 108: 43–47.
- Brynjolfsson, E., D. Rock, and C. Syverson (2017). “Artificial intelligence and the modern productivity paradox: A clash of expectations and statistics”. In: *The Economics of Artificial Intelligence*. Ed. by A. Agrawal, J. S. Gans, and A. Goldfarb. Chicago, IL: University of Chicago Press. 23–57.

- Bughin, J., E. Hazan, S. Ramaswamy, M. Chui, T. Allas, P. Dahlström, N. Henke, and M. Trench (2017a). “How artificial intelligence can deliver real value to companies”. McKinsey Global Institute. URL: <http://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/how-artificial-intelligence-can-deliver-real-value-to-companies>.
- Bughin, J., B. McCarthy, and M. Chui (2017b). “A survey of 3,000 executives reveals how businesses succeed with AI”. *Harvard Business Review*. URL: <https://hbr.org/2017/08/a-survey-of-3000-executives-reveals-how-businesses-succeed-with-ai>.
- Büthe, T. and W. Mattli (2011). *The New Global Rulers: The Privatization of Regulation in the World Economy*. Princeton, NJ: Princeton University Press.
- Calo, R. (2017). “Artificial intelligence policy: A primer and roadmap”. Available at SSRN: URL: <http://dx.doi.org/10.2139/ssrn.3015350>.
- Casadesus-Masanell, R. and J. E. Ricart (2010). “From strategy to business models and onto tactics”. *Long Range Planning*. 43(2–3): 195–215.
- Casadesus-Masanell, R. and J. E. Ricart (2011). “How to design a winning business model”. *Harvard Business Review*. 89(1/2): 100–107.
- Casadesus-Masanell, R. and J. Tarzijan (2012). “When one business model isn’t enough”. *Harvard Business Review*. 90: 1e2.
- Casadesus-Masanell, R. and F. Zhu (2013). “Business model innovation and competitive imitation: The case of sponsor-based business models”. *Strategic Management Journal*. 34(4): 464–482.
- Chesbrough, H. (2007). “Business model innovation: It’s not just about technology anymore”. *Strategy and Leadership*. 35(6): 12–17.
- Chesbrough, H. (2010). “Business model innovation: Opportunities and barriers”. *Long Range Planning*. 43(2/3): 354–363.
- Chesbrough, H. (2013). *Open Business Model Innovation: How to Thrive in the New Innovation Land Scape*. Boston, MA: Harvard Business School Press.
- Chesbrough, H. W. and M. M. Appleyard (2007). “Open innovation and strategy”. *California Management Review*. 50(1): 57–76.

- Christensen, C. M., T. Bartman, and D. van Bever (2016). “The hard truth about business model innovation”. *MIT Sloan Management Review*. 58(1): 30–40.
- Chung-Cheng, C., T. N. Sainath, Y. Wu, R. Prabhavalkar, P. Nguyen, Z. Chen, A. Kannan, R. J. Weiss, K. Rao, K. Gonina, N. Jaitly, B. Li, J. Chorowski, and M. Bacchiani (2018). “State-of-the-art speech recognition with sequence-to-sequence models”. In: *Proceedings of the 2018 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*. Calgary, AB, Canada. 15–20 April.
- Cihon, P. (2019). “Standards for AI governance: International standards to enable global coordination in AI research and development”. Technical Report. Oxford: Center for the Governance of AI, Future of Humanity Institute.
- Clarke, R. (2019). “Principles and business processes for responsible AI”. *Computer Law and Security Review*. 35(2019): 410–422.
- Cockburn, I., R. Henderson, and S. Stern (2017). “The impact of artificial intelligence on innovation”. In: *The Economics of Artificial Intelligence*. Ed. by A. Agrawal, J. S. Gans, and A. Goldfarb. Chicago, IL: University of Chicago Press. 115–146.
- Dahlander, L. and M. Magnusson (2008). “How do firms make use of open source communities?” *Long Range Planning*. 41(6): 629–649.
- De Vries, H. J. (1997). “Standardization—What’s in a name?” *Terminology*. 4(1): 55–83(29).
- Dean, J. (2014). *Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners*. Hoboken, NJ: John Wiley and Sons.
- Deng, J., W. Dong, R. Socher, L. Li, K. Li, and L. Fei-Fei (2009). “ImageNet: A large-scale hierarchical image database”. *2009 IEEE Conference on Computer Vision and Pattern Recognition*. Miami, FL. 248–255.
- DIN (2000). *Economic Benefits of Standardization*. Berlin: Beuth Verlag.
- DIN (2011). *The Economic Benefits of Standardization: An Update of the Study Carried Out by DIN in 2000*. Berlin: Beuth Verlag.
- Dinsdale, A., P. Willigmann, S. Corwin, and J. Glueck (2016). *The Future of Auto-Retailing. Preparing for the Evolving Mobility Ecosystem*. London: Deloitte University Press.

- Farrell, J. and P. Klemperer (2007). “Coordination and lock-in: Competition with switching costs and network effects”. In: *Handbook of Industrial Organization*. Ed. by M. Armstrong and R. Porter. Vol. 3. Amsterdam: Elsevier. 1967–2072.
- Farrell, J. and T. Simcoe (2012). “Choosing the rules for consensus standardization”. *The RAND Journal of Economics*. 43(2): 235–252.
- Foss, N. J. and T. Saebi (2017). “Fifteen years of research on business model innovation: How far have we come, and where should we go?” *Journal of Management*. 43(1): 200–227.
- Fountaine, T., B. McCarthy, and T. Saleh (2019). “Building the AI-powered organization”. *Harvard Business Review*. 97(4): 62–73.
- Frey, K., C. Lüthje, and S. Haag (2011). “Whom should firms attract to open innovation platforms? The role of knowledge diversity and motivation”. *Long Range Planning*. 44(5–6): 397–420.
- Furman, J. (2017). “Should we be reassured if automation in the future looks like automation in the past?” In: *The Economics of Artificial Intelligence*. Ed. by A. Agrawal, J. S. Gans, and A. Goldfarb. Chicago: University of Chicago Press. 317–328.
- Furman, J. and P. Orszag (2015). “A firm-level perspective on the role of rents in the rise in inequality”. Presentation at ‘A Just Society’ Centennial Event in Honor of Joseph Stiglitz at Columbia University.
- Gambardella, A. and A. M. McGahan (2010). “Business-model innovation: General purpose technologies and their implications for industry structure”. *Long Range Planning*. 43(2): 262–271.
- Garbuio, M. and N. Lin (2019). “Artificial intelligence as a growth engine for health care startups: Emerging business models”. *California Management Review*. 61: 59–83.
- Garcez, A., T. R. Besold, L. Raedt, P. Foldiak, P. Hitzler, T. Icard, K.-U. Kuhnberger, L. C. Lamb, R. Miikkulainen, and D. L. Silver (2015). “Neural-symbolic learning and reasoning: Contributions and challenges”. In: *Proceedings of the AAAI Spring Symposium on Knowledge Representation and Reasoning: Integrating Symbolic and Neural Approaches*. Palo Alto, CA, USA. 23–25 March.
- Garcez, A., S. D’Avila, L. C. Lamb, and D. M. Gabbay (2008). *Neural-Symbolic Cognitive Reasoning*. Berlin, Germany: Springer Science and Business Media.

- Garnelo, M., K. Arulkumaran, and M. Shanahan (2019). “Towards deep symbolic reinforcement learning”. URL: https://www.researchgate.net/publication/308320824_Towards_Deep_Symbolic_Reinforcement.
- Gassmann, O., K. Frankenberger, and R. Sauer (2017). “A primer on theoretically exploring the field of business model innovation”. *European Business Review*. 4: 45–48.
- Gawer, A. and M. A. Cusumano (2014). “Industry platforms and ecosystem innovation”. *Journal of Product Innovation Management*. 31(3): 417–433.
- Goluchowicz, K. and K. Blind (2011). “Identification of future fields of standardisation: An explorative application of the Delphi methodology”. *Technological Forecasting and Social Change*. 78(9): 1526–1541.
- Guasch, J. L., J.-L. Racine, I. Sánchez, and M. Diop (2007). *Quality Systems and Standards for a Competitive Edge*. Washington, DC: The World Bank.
- He, Z. L. and P. K. Wong (2004). “Exploration vs. exploitation: An empirical test of the ambidexterity hypothesis”. *Organization Science*. 15(4): 481–494.
- Helper, S., R. Martins, and R. Seamans (2018). “Value migration and industry 4.0: Theory, field evidence, and propositions”. University Working Paper, New York.
- Ho, Y., H. Fang, and M. Hsieh (2011). “The relationship between business-model innovation and firm value: A dynamic perspective”. *World Academy of Science, Engineering and Technology*. 77: 656–664.
- Hoffmann, C., E. Lesser, and T. Ringo (2012). *Calculating Success: How the New Workplace Analytics Will Revitalize Your Organization*. Boston, MA: Harvard Business Review Press.
- Ibarra, D., J. Ganzarain, and J. I. Igartua (2018). “Business model innovation through Industry 4.0: A review”. *Procedia Manufacturing*. 22: 4–10.
- Industrial Strategy: Building a Britain Fit for Future (2017). London: BEIS.

- ISO (2011). “Economic benefits of standards—International case studies”. Volume 1. Geneva: ISO.
- ISO (2012). “Economic benefits of standards—International case studies”. Volume 2. Geneva: ISO.
- Jacobides, M. G. and J. P. MacDuffie (2013). “How to drive value your way”. *Harvard Business Review*. 91: 92e100.
- Jacobsson, B. (2000). “Standardization and expert knowledge”. In: *A World of Standards*. Oxford: Oxford University Press. 40–50.
- Jia, K., M. Kenney, J. Mattila, and T. Seppala (2018). “The application of artificial intelligence at Chinese digital platform giants: Baidu, Alibaba and Tencent”. *ETLA Reports*. (81).
- Jovanovic, B. and P. L. Rousseau (2005). “General purpose technologies”. In: *Handbook of Economic Growth*. Ed. by P. Aghion and S. N. Durlauf. Vol. 1B. Amsterdam: Elsevier B.V. 1181–1224.
- Kafouros, M. I. and N. Forsans (2012). “The role of open innovation in emerging economies: Do companies profit from the scientific knowledge of others?” *Journal of World Business*. 47(3): 362–370.
- Katz, M. L. and C. Shapiro (1992). “Product introduction with network externalities”. *The Journal of Industrial Economics*. 40(1): 55–83.
- Kim, S. K. and S. Min (2015). “Business model innovation performance: When does adding a new business model benefit an incumbent?” *Strategic Entrepreneurship Journal*. 9(1): 34–57.
- Koen, P. A., H. M. Bertels, and I. R. Elsum (2011). “The three faces of business model innovation: Challenges for established firms”. *Research-Technology Management*. 54(3): 52–59.
- Kortmann, S. and F. Piller (2016). “Open business models and closed-loop value chains: Redefining the firm–consumer relationship”. *California Management Review*. 58(3): 88–108.
- Laursen, K. and A. Salter (2006). “Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms”. *Strategic Management Journal*. 27(2): 131–150.
- Lee, J., T. Suh, D. Roy, and M. Baucus (2019). “Emerging technology and business model innovation: The case of artificial intelligence”. *Journal of Open Innovation: Technology, Market, and Complexity*. 5(3): 44.

- Lindgardt, Z., M. Reeves, G. Stalk, and M. Deimler (2012). “Business Model Innovation: When the Game Gets Tough Change the Game”. In: *Own the Future: 50 Ways to Win from the Boston Consulting Group*. Ed. by M. Deimler, R. Lesser, R. D., and J. Sinha. Hoboken, NJ: Wiley. 291–298.
- Liu, Y., A. Gupta, P. Abbeel, and S. Levine (2017). “Imitation from observation: Learning to imitate behaviors from raw video via context translation”. arXiv preprint arXiv: 1707.03374.
- Magretta, J. (2002). “Why business models matter”. *Harvard Business Review*. 80(5): 86–92.
- Manyika, J., M. Chui, M. Miremadi, J. Bughin, K. George, P. Willmott, and M. Dewhurst (2017). “Harnessing automation for a future that works”. McKinsey Global Institute. URL: <https://www.mckinsey.com/featured-insights/digital-disruption/harnessing-automation-for-a-future-that-works>.
- March, J. G. (1991). “Exploration and exploitation in organizational learning”. *Organization Science*. 2(1): 71–87.
- Marcus, G. (2018). “Deep learning: A critical appraisal”. arXiv: 1801.00631.
- Markides, C. (2006). “Disruptive innovation: In need of better theory”. *Journal of Product Innovation Management*. 23(1): 19–25.
- Markides, C. C. (2013). “Business model innovation: What can the ambidexterity literature teach us?” *Academy of Management Perspectives*. 27: 313e323.
- Markides, C. C. and C. D. Charitou (2004). “Competing with dual business models: A contingency approach”. *The Academy of Management Executive*. 18: 22e36.
- Markides, C. C. and D. Oyon (2010). “What to do against disruptive business models (when and how to play two games at once)”. *MIT Sloan Management Review*. 51: 25e32.
- Marr, B. (2019). “The 10 best examples of how companies use artificial intelligence in practice”. Forbes. URL: <https://www.forbes.com/sites/bernardmarr/2019/12/09/the-10-best-examples-of-how-companies-use-artificial-intelligence-in-practice/>.

- Massa, L. and C. Tucci (2014). “Business model innovation”. In: *The Oxford Handbook of Innovation Management*. Ed. by D. Dodgson, M. Gann, and N. Phillips. New York: Oxford University Press. 420–441.
- Massa, L., C. Tucci, and A. Afuah (2017). “A critical assessment of business model research”. *Academy of Management Annals*. 11: 73–104.
- McCarthy, J. (2006). “A proposal for the Dartmouth summer research project on artificial intelligence”. *AI Magazine*. 27: 12.
- McCorduck, P. (2009). *Machines Who Think: A Personal Inquiry into the History and Prospects of Artificial Intelligence*. Boca Raton, FL: AK Peters/CRC Press.
- McGrath, R. (2010). “Business models: A discovery driven approach”. *Long Range Planning*. 43: 247–261.
- McGuire, J. (2019). “Top 100 artificial intelligence companies 2020”. URL: <https://www.datamation.com/artificial-intelligence/top-artificial-intelligence-companies.html>.
- Mitchell, T. and E. Brynjolfsson (2017). “Track how technology is transforming work”. *Nature*. 544(7650): 290–292.
- Narayanan, V. K. and T. Chen (2012). “Research on technology standards: Accomplishment and challenges”. *Research Policy*. 41(8): 1375–1406.
- O’Reilly III, C. A. and M. L. Tushman (2008). “Ambidexterity as a dynamic capability: Resolving the innovator’s dilemma”. *Research in Organizational Behavior*. 28: 185–206.
- Organization for Economic Cooperation and Development (2015). “The future of productivity”. URL: <https://www.oecd.org/eco/growth/OECD-2015-The-future-of-productivity-book.pdf>.
- Osiyevskyy, O. and J. Dewald (2015). “Explorative versus exploitative business model change: The cognitive antecedents of firm-level responses to disruptive innovation”. *Strategic Entrepreneurship Journal*. 9(1): 58–78.
- Osterwalder, A. and Y. Pigneur (2010). *Business Model Generation: A Hand Book for Visionaries, Game Changers, and Challengers*. New York: John Wiley and Sons.

- Osterwalder, A., Y. Pigneur, and C. L. Tucci (2005). “Clarifying business models: Origins, present, and future of the concept”. *Communications of the Association for Information Systems*. 16(1): 1–25.
- Palmer, K., W. E. Oates, and P. R. Portney (1995). “Tightening environmental standards: The benefit-cost or the no-cost paradigm”. *Journal of Economic Perspectives*. 9(4): 119–132.
- Pitelis, C. N. (2009). “The co-evolution of organizational value capture, value creation and sustainable advantage”. *Organization Studies*. 30(10): 1115–1139.
- Pitelis, C. N. and D. J. Teece (2009). “The (new) nature and essence of the firm”. *European Management Review*. 6(1): 5–15.
- Raisch, S., J. Birkinshaw, G. Probst, and M. L. Tushman (2009). “Organizational ambidexterity: Balancing exploitation and exploration for sustained performance”. *Organization Science*. 20(4): 685–695.
- Raj, M. and R. Seamans (2017). “AI, labor, productivity and the need for firm-level data”. In: *The Economics of Artificial Intelligence*. Ed. by A. Agrawal, J. S. Gans, and A. Goldfarb. Chicago, IL: University of Chicago Press. 553–565.
- Rayna, T. (2008). “Understanding the challenges of the digital economy: The nature of digital goods”. *Communications and Strategies*. 71: 13–26.
- Rayna, T. and L. Striukova (2009). “The curse of the first-mover: When incremental innovation leads to radical change”. *International Journal of Intelligent Collaborative Enterprise*. 1(1): 4–21.
- Reim, W., J. Åström, and O. Eriksson (2020). “Implementation of artificial intelligence (AI): A roadmap for business model innovation”. *AI*. 1(2): 180–191.
- Richards, N. M. and J. H. King (2013). “Three paradoxes of big data”. *Stanford Law Review Online*. 66: 41.
- Rochet, J.-C. and J. Tirole (2003). “Platform competition in two-sided markets”. *Journal of the European Economic Association*. 1(4): 990–1029.
- Rysman, M. and T. S. Simcoe (2008). “Patents and the performance of voluntary standard-setting organizations”. *Management Science*. 54(11): 1920–1934.

- Saon, G., G. Kurata, T. Sercu, K. Audhkhasi, S. Thomas, D. Dimitriadis, X. Cui, B. Ramabhadran, M. Picheny, L.-L. Lim, B. Roomi, and P. Hal (2017). “English conversational telephone speech recognition by humans and machines”. arXiv preprint arXiv: 1703.02136.
- Schalkoff, R. J. (1997). *Artificial Neural Networks*. Vol. 1. New York, NY: McGraw-Hill.
- Semmler, S. and Z. Rose (2017). “Artificial intelligence: Application today and implications tomorrow”. *Duke Law and Technology Review*. 16: 85.
- Serafini, L. and A. A. Garcez (2019). “Logic tensor networks: Deep learning and logical reasoning from data and knowledge”. URL: http://ceur-ws.org/Vol-1768/NESY16_paper3.pdf (accessed on 19 March 2019).
- Simcoe, T. S., S. J. H. Graham, and M. P. Feldman (2009). “Competing on standards? Entrepreneurship, intellectual property and platform technologies, in entrepreneurship: Strategy and structure”. *Journal of Economics and Management Strategy*. 18(3): 775–816.
- Sinfield, J. V., E. Calder, B. McConnell, and S. Colson (2012). “How to identify new business models”. *MIT Sloan Management Review*. 53(2): 85–90.
- Soni, N., E. K. Sharma, N. Singh, and A. Kapoor (2019). “Impact of artificial intelligence on businesses: From research, innovation, market deployment to future shifts in business models”. arXiv preprint arXiv: 1905.02092.
- Sorescu, A. (2017). “Data-driven business model innovation”. *Journal of Product Innovation Management*. 34(5): 691–696.
- Sosna, M., R. N. Trevinyo-Rodríguez, and S. R. Velamuri (2010). “Business model innovation through trial-and-error learning: The Naturhouse case”. *Long Range Planning*. 43: 383–407.
- Swann, G. M. P. (2000). *The Economics of Standardization: Final Report for Standards and Technical Regulations Directorate Department of Trade and Industry*. Manchester, UK: Manchester Business School.
- Swann, G. M. P. (2010). *The Economics of Standardization: An Update*. Manchester, UK: Innovative Economics Limited.

- Taigman, Y., M. Yang, M. A. Ranzato, and L. Wolf (2014). "Deepface: Closing the gap to human-level performance in face verification". In: *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*. Columbus, OH. 23–28 June.
- Tassey, G. (2000). "Standardization of technology-based markets". *Research Policy*. 29(4–5): 587–602.
- Teece, D. J. (2007). "Explicating dynamic capabilities: The nature and micro foundations of (sustainable) enterprise performance". *Strategic Management Journal*. 28: 1319–1350.
- Teece, D. J. (2010). "Business models, business strategy and innovation". *Long Range Planning*. 43: 172–194.
- Teece, D. J. (2018). "Profiting from innovation in the digital economy: Enabling technologies, standards, and licensing models in the wireless world". *Research Policy*. 47(8): 1367–1387.
- Teece, D. J., G. Pisano, and A. Shuen (1997). "Dynamic capabilities and strategic management". *Strategic Management Journal*. 18(7): 509–533.
- Tongur, S. and M. Engwall (2014). "The business model dilemma of technology shifts". *Technovation*. 34(9): 525–535.
- Urwin, R. (2017). *Artificial Intelligence: The Quest for the Ultimate Thinking Machine*. London, UK: Sirius Entertainment.
- Van Alstyne, M. W., G. G. Parker, and S. P. Choudary (2016). "Pipelines, platforms, and the new rules of strategy". *Harvard Business Review*. 94: 54–62.
- van der Meulen, R. (2018). "5 ways data science and machine learning impact business". Gartner. URL: <https://www.gartner.com/smarterwithgartner/5-ways-data-science-and-machi>.
- Varian, H. (2019). "Artificial intelligence, economics, and industrial organization". In: *The Economics of Artificial Intelligence*. Ed. by A. Agrawal, J. S. Gans, and A. Goldfarb. Chicago: University of Chicago Press. 399–419.
- Wirtz, B. W., A. Pistoia, S. Ullrich, and V. Göttel (2016). "Business models: Origin, development and future research perspectives". *Long Range Planning*. 49(1): 36–54.

- Wirtz, B. W., O. Schilke, and S. Ullrich (2010). “Strategic development of business models: Implications of the web 2.0 for creating value on the Internet”. *Long Range Planning*. 43(2–3): 272–290.
- Zeira, J. (1998). “Workers, machines, and economic growth”. *Quarterly Journal of Economics*. 113(4): 1091–1117.
- Zhu, F. and N. Furr (2016). “Products to platforms: Making the leap”. *Harvard Business Review*. 94: 73–78.
- Zhu, F. and M. Iansiti (2012). “Entry into platform-based markets”. *Strategic Management Journal*. 33(1): 88–106.
- Zott, C. and R. Amit (2007). “Business model design and the performance of entrepreneurial firms”. *Organization Science*. 18: 181–199.
- Zott, C. and R. Amit (2008). “The fit between product market strategy and business model: Implications for firm performance”. *Strategic Management Journal*. 29(1): 1–26.
- Zott, C. and R. Amit (2010). “Business model design: An activity system perspective”. *Long Range Planning*. 43(2–3): 216–226.
- Zott, C. and R. Amit (2013). “The business model: A theoretically anchored robust construct for strategic analysis”. *Strategic Organization*. 11(4): 403–411.
- Zott, C., R. Amit, and M. Massa (2011). “The business model: Recent developments and future research”. *Journal of Management*. 37: 1019–1042.