HAL open science

Towards an Economic Theory of Lean

Eivind Reke, Daryl Powell, Kodo Yokozawa

To cite this version:

Eivind Reke, Daryl Powell, Kodo Yokozawa. Towards an Economic Theory of Lean. IFIP International Conference on Advances in Production Management Systems (APMS), Sep 2021, Nantes, France. pp.712-720, 10.1007/978-3-030-85874-2_78 . hal-04030420

HAL Id: hal-04030420

https://inria.hal.science/hal-04030420v1

Submitted on 16 Mar 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Distributed under a Creative Commons Attribution 4.0 International License

This document is the original author manuscript of a paper submitted to an IFIP conference proceedings or other IFIP publication by Springer Nature. As such, there may be some differences in the official published version of the paper. Such differences, if any, are usually due to reformatting during preparation for publication or minor corrections made by the author(s) during final proofreading of the publication manuscript.

Towards an economic theory of lean

Eivind Reke[1], Daryl Powell[1,2] and Kodo Yokozawa[3]

[1] SINTEF Manufacturing, Trondheim, Norway
[2] Norwegian University of Science and Technology, Trondheim, Norway
[3] Yokohama National University,Yokohama, Japan
eivind.reke@sintef.no

Abstract. For more than 40 years, researchers have studied the operations management practices of Toyota and their application in different companies and industries, most notably under the heading of lean operations. Even though lean has become an integral part of the operations management curriculum and corporations such as Danaher have embraced it as their "way of doing business", lean has yet to truly breach the executive echelons of most firms and as such fails to reach its true potential as an alternative, people-centric, and sustainable business model. To address this gap, we have carried out an extensive literature search on the subject and conducted several interviews with C-suite executives from lean firms. Our findings point us in the direction of an underlying economic theory of lean, based on the business model and associated practices of the Toyota Motor Corporation. Furthermore, we present three exemplary case companies which have adapted some or all of these practices under the guise of lean production.

Keywords: Lean Product and Process Development, Lean Business Model, Company Economic Performance.

1 Introduction

Lean Production has been an area of interest for academics and industry practitioners alike. Ever since the findings of the International motor vehicle program (IMVP), demonstrated to the western auto companies that their business model was being outcompeted by Japanese automotive companies, with Toyota leading the way [1]. As such, lean could be defined as the application of Toyota's business model (most notably the Toyota Production System (TPS)), outside of Toyota. Much has been made of the production techniques, the thinking behind them and the operational results that these may lead to if implemented. However, less is understood of the business model that drives the thinking of Toyota, a company that over the course of 70 years has gone from plucky start-up to industry leader in terms of volume, revenue, profits, and model variety through debt-free growth funded by its attention to detail and relentless pursuit of waste- and cost-reductions, from design to manufacture, to sales and services.

Incidentally, at the time of the IMVP benchmarking study, General Motors (GM) was the largest car manufacturer in the world, with Toyota still a growing company -

having only started to develop its manufacturing capabilities in Europe and North America in the early 80s (in the late 90s they also developed product development capabilities on these continents). At the time of writing, the tables have turned, and Toyota has been one of (if not the) largest and most profitable car manufacturer in the world, since it overtook GM in 2007 (delivering steady operating margins of about 8-10% the last 8 years). The continued research interest into Toyota's business practices is linked to this story, and even though we now know a great deal more about the inner workings of the Toyota Production System, with a few exceptions, western scholars have not studied at depth the economic theory that underpins Toyota's business model; rather relying on established economic theories and thus missing an opportunity to open a new branch of research into lean thinking and practice. However, to establish an economic theory of lean, we must first understand the fundamental differentiators that lies behind this successful, alternative business model.

As such, this paper is an attempt to explore and establish a path towards an economic theory of lean. First, we present a literature review to define the gaps in current research on the topic. Thereafter, we developed a set of research questions to address these gaps, before exploring these research questions by collecting publicly available operational- and financial data and interviewing former executives from select case companies that have experienced sustained business success through lean thinking and practice in the form of market share and above industry average returns. Two out of three case companies have also received recognition from industry peers in the form of national lean prizes. Finally, we suggest areas for further research based on the findings presented in this paper.

2 Background

To develop an economic theory of lean, one must first understand the assumptions behind Toyota's business model. [2] defines a business model as *"a representation of a firm's underlying core logic and strategic choices for creating and capturing value within a value network"*. As such, how a company generates wealth and what it chooses to do with it stems from its business model. The Value Added (VA) of any activities (in Toyota's case, designing and building cars), is the revenue the company takes in less the services and goods it pays for in doing so. Thus, for whom a company creates wealth and what it does with its VA stems from its business model. Toyota's business model, the underlying core logic, and strategic choices for creating and capturing wealth, have been studied for over 40 years, and for the last 30 years under the lean heading. Even though some now seek to dismiss the role and impact Toyota has had on the continuous development of lean as a research theme [3], we believe it would be a mistake to simply reduce lean to the study of efficient manufacturing practices. The real strategic potential of lean is *"half the bad, double the good"* [4]. As such, we suggest that to better understand how this potential is realized, we must take a broader approach.

3 Literature Review

Ever since Toyota started to compete on the global market in the 70s, the company has been of interest to researchers and academics. By the time the company became industry leader, the interest had exploded with books [eg 4, 5] and articles [eg 6, 7] trying to explain the reason for its successful growth. Attempts have also been made to explain the financial performance and operational performance impact of lean (sometimes under the heading of just-in-time (JIT)). Proving the link between lean operations and improved (or superior) financial performance has however been elusive, though some indications have been found. In a study covering over 250 US manufacturing companies, [9] found that JIT practices impacted overall profitability, but that quality practices did not. Furthermore, [10] found that leanness in terms of inventory positively impacts credit ratings. In the automotive industry, the adoption of Toyota's production practices has been carried out to such a degree that practitioners now don't necessarily distinguish between them, i.e., lean is "done in car manufacturing".

As documented by [11], Lean production (in some form or other) has over the last 30 years been widely adopted by many global companies, either through business systems or so called company specific production systems (XPS) [12]. With regards to the operations management practices of Toyota and adopters of lean operations, one finds studies on best practices [13], as well as implementation success factors [14] and barriers [15–17]. One also finds a variety of definitions of lean production summed up by [18] and [19], and what to expect when implementing said practices, concepts and tools [20]. While these are all worthwhile endeavors, most of these studies fail in explaining the growth in market share, revenue, and margin that Toyota experienced from the late 50s through to the present day (delivering steady profits and growth and mostly financing their overseas growth organically). A notable exception is [21] which suggests the changes one might experience, but do not discuss what to do with said changes and the potential productivity and thus economic gains derived from these changes.

Based on our review of the extant literature, we propose four differentiating factors underpinning Toyota's business model that point towards an economic theory of lean: 1) Better quality by applying the Toyota Production System and kaizen without paying a quality premium, 2) a learning curve on flexibility to offer customers a steady growth of new models without the capital investment normally associated with an expanding product range, 3) Re-investment of productivity gains fostering the long-term development of engineers and operators and 4) Financial self-reliance to support steady growth organically or through acquisitions.

3.1 Better quality through TPS + Kaizen

Hard to pin-point but easy to observe is the effect on quality and lead-time that can be experienced in kaizen or continuous improvement activities. Toyota adopted their version of the Ford suggestion system in the 50s (which was later abandoned in Ford), and with it the slogan: "Good Thinking, Good Products", have continued to reap the rewards from their employees' improvement suggestions. One could even argue that Toyota's

manufacturing practices today is the sum of the improvement suggestions and countermeasures that have been implemented over the past 70 years. For instance, the first quality measure put in place, the Jidoka device of the automatic loom, was responsible for creating better quality products (no broken treads) and at the same time increased productivity 10-fold by allowing an individual operator to monitor multiple looms. According to [22] there are three types of kaizen activities carried out on the shop floor; 1) those carried out by supervisors, managers and production engineers, 2) those carried out by quality circles and 3) those that come from the suggestion system itself. It is sometimes referred to by Toyota as weak point management system [23] . Furthermore, [24] argue that TPS is also an education system that shows engineers and designers how design and engineering can contribute to quality engineering without paying quality premiums through thorough cost planning [25].

3.2 Learning curve on flexibility

According to [26], "*achieving optimal product variety is one of the most strategic decision making processes of the firm".* Toyota realized early on that the trade-off between flexibility and efficiency was not fixed, and was able to develop the capability to move beyond this trade-off [27]. One of the early famous lean stories is that of Taiichi Ohno, according to legend, picking up, in a fire-sale, small and versatile presses and other machinery from a soon-to-be bankrupt American machine maker on a field trip to the U.S. in the 50s. These quick-change die-presses are now exhibited in the Toyota museum in Nagoya, Japan [28]. Toyota realized early that they could not rely on the American one-car-per-factory business model. At the time, they simply did not have the financial muscle of their American counterparts. The learning curves first steps where to produce more than one variant on one line, with TPS. According to Toyota themselves, flexibility is also a global strategy with factories in Japan able to flexibly adjust model variants to adjust for fluctuations in the global market, allowing less advanced plants around the globe to move more slowly through the learning curve, while at the same time allowing for high yields and plant utilization. In fact, Toyota's most advanced line has been dubbed *"the most flexible line in the world"* by industry experts [29].

3.3 Re-invest of productivity gains into the development of people

Some version of "before we make cars, we make people" can be found quoted in different studies of Toyota's approach to people development. An example of this re-investment in people can be found as early as 1961, when Eiji Toyoda identified the lack of training of new employees as one of the root causes of the quality crisis Toyota experienced with the roll out of the second-generation Corolla. The countermeasure was heavy investment in training and education in quality, while also supporting the previous point of better quality through kaizen as the company aimed to half the number of defects. This re-investment in training programs has since periodically happened in both manufacturing and engineering with KanPro in the late 70s, statistical quality control (SQC) renaissance in the late 80s, total quality management (TQM) in the mid-90s

and global quality control in the 2000s [30]. [31] presents the methodical and systematical efforts put into the development of engineers and designers for as long as 30 years, while [32] discusses in detail how leadership training is carried out. Finally, [33] shows how Toyota have built on and adjusted the Training Within Industry (TWI) system to thoroughly train operators and supervisors in both the skills required to carry out the job at a high level, as well as the skills required to maintain and improve the job through Kaizen. This people-first thinking has been a mainstay of Toyota's business model regardless of factory location [34]. [35] argues that this continuous re-investment in people is key to reducing the transaction cost normally associated with the successful transfer of design information from product design to manufacturing.

3.4 Financial self-reliance

A much less covered topic in western academic research is how Toyota have been more or less financially self-reliant over a long period of time, and have, according to Akio Toyoda, mostly grown organically "*by selling one car after the other"* [30]. In fact, [36] claims that the company has been debt-free since 1977, which suggests Toyota financed its global expansion that started with the first factories in the US with internal funds. Along with Kaizen, the target cost system is arguably the method that delivers the economic flexibility of Toyota. This process starts as early as the product planning phase and ends in the tail end of the model life-cycle, with the purpose of systematically reducing cost throughout the life-cycle of the product. The cost reduction is achieved by applying technology and smartness throughout the value chain, not through so-called strategic cost-management associated with more traditional business models [37] (i.e., outsourcing component manufacturing to lowest bidder). Instead of shifting the VA wealth creation to shareholders or similar, Toyota have always kept a large reserve of cash and cash equivalents to fund its big bets. Exemplified with its expansion into, first, the American market, then the luxury market (with Lexus), and now on connectivity with Woven City and the future power systems of cars (triple bet on hydrogen, hybrid and full electric)

4 Research Design

The research follows an exploratory inductive case study research design to develop propositions from complex social phenomena [38]. To generate valuable insight, we compared our findings from the literature review with three case studies selected due to their success in lean implementation (above industry average growth, profitability and returns) as well as industry recognition of their "leanness", i.e., two of the companies have won national lean prizes, and the third has been widely studied and written about in the extant lean literature. We conducted interviews with executives from the three different companies in three different countries (in Scandinavia, and the U.S.), and combined the interview data with publicly available financial data to explore the potential of an economic theory of lean. Based on our findings we suggest one economic proposition for each differentiator that should be explored in further research.

5 Findings and Discussion

The lean journey starting points for the three companies in question were similar. The CEO had either learned about TPS or lean before starting the journey or was trained internally by the company in question (e.g., Executive A spent one year training his senior team before making any changes to the company, Executive B was trained on the ground by his CEO who himself had worked directly with Japanese Sensei). As such they all tick the first success criteria presented by [14] *"the commitment of top management"*. However, our findings suggest that all three went one step further and changed the way they lead the company based on what they had learned.

Furthermore, all three companies experienced unprecedented growth (from 200% - 500%) and profitability (from loss to 15% EBIDTA) over a short period of time, suggesting that developing lean capabilities within the company allowed them to realize the potential of the business in a way that traditional western management capabilities would not. In Table 1 we summarize our findings, comparing the case companies' business model to the four differentiating factors of the lean business model.

Table 1. Comparison of the case companies' business practice with the lean business model.

Case Company	Quality through TPS+Kaizen?	Learning curve on flexibility	Re-invested in people development	Achieved financial self-reliance
Case A	Yes	Yes	Yes	Partially
Case B	Yes	Yes	Yes	No data
Case C	Yes	Yes	Yes	Yes

From our interviews and the operational data we collected from the companies we found that *quality through TPS + Kaizen* was key in order to achieve and sustain the economic performance. One interviewee reported that the gains from kaizen activities had allowed the company to postpone investments for almost 8 years, and when the investment had to be made, the learning from kaizen activities meant that they made different choices to what they would have made if these activities had not been carried out. The two others reported both cost reduction and quality increase benefits from kaizen activities. All three companies experienced increased sales and revenue due to improvements in quality, lead-time and cost. This leads us to our first proposition*: TPS + Kaizen leads to increased sales due to better quality, lower capital expenditure through just-in-time and lower operational expenses through Jidoka.*

Leveraging the flexibility learning curve to better serve customers was also reported as key for all three companies. Two of them had expanded their product portfolio 10-fold while at the same time keeping quality high and cost low. The third leverage their flexibility capability to serve their professional customer as a one stop shop for both equipment and consumables. All three companies had throughout their lean journey

emphasized flexibility in the form of SMED-training, quick die change and other activities that gave the companies greater agility. Bear in mind that it is not necessarily about the broadest possible product range, but one that covers the market space with good product-market fit in the market the business is in. Thus, our second proposition is: *Increased flexibility allows a company to offer a broader range of products and should increase turn-over, without the capital investment usually associated with broadening the product-range*.

Reinvesting productivity gains into the development of engineers and operators emerged as a success factor for all three case companies, which led to better decisions on how to improve both manufacturing processes and product design. Even after re-investing in people development, the three case companies like Toyota had surplus wealth creation. Toyota as we discussed earlier used this to free itself from debt and largely financed its own international expansion. Even though all three case companies to some extent used their new-found financial strength for investments, we found that only one company used this self-reliance to continue its growth, something that suggests this point might be considered an outcome of the lean business model adoption and not a pre-requisite practice *per se*. Regardless, developing people is key to the lean business model and, as such, our third proposition is: *by developing the technical competence of people, precision increases and costs decrease, and the capability for innovation also increases.*

The case companies took different choices with the freed resources and cash derived from the productivity gains. One company used it to fund acquisitions and set up aggressive improvement targets for these newly acquired companies and as such managed to sustain growth over a period of 10 years. Another company used the productivity gains to in-source activities as space and people were freed. The third company paid most of their gains towards the parent company until it was eventually sold in 2015. Even so, based on our literature review and findings, our fourth proposition is: *financial self-reliance makes the organization less sensitive to financial cycles, and allows it to fund stable growth through big bets on the future.*

6 Conclusions and suggestions for further research

In its nature, theory building is fraught with difficulties. However, based on our continued research into lean production in general and more specifically Toyota Motor Corporation in particular, we argue that reducing lean to production efficiency or the adoption of shop-floor best practices will only hinder, not help, our understanding of a phenomena that seems to outlive the traditional management fad cycle normal associated with such buzzwords. Lean and TPS are systems, and as such one must research them in their entirety, rather than simply taking one's fancy from a buffet of component parts. In the age of sustainable manufacturing this becomes even more important, as sustainability will not be achieved through adoption of digital (or indeed analogue) best practices but by engaging everyone, everywhere in kaizen, and then re-investing the gains in the development of the people that can create and manufacture ever more sustainable products. According to [24], *"Lean is the people centric business model of our time"*,

and we suggest more effort should be put into researching and understanding its enduring appeal; not as a set of best practice bundles for efficient manufacturing but as a complete business model that better serves customers by continuously developing people.

Based on our review we were able to define four differentiating characteristics of Toyota's superior business model which we then evaluated using three case studies from Europe and the U.S. From the resulting findings, we developed and proposed four propositions towards an economic theory of lean, which needs to be explored in further research, that can help better explain the potential of lean thinking and practice outside of operations management.

Acknowledgements
The authors acknowledge the support of the Norwegian research council for the research project Circulær.

References

1. Krafcik, J.F.: Triumph of the lean production system. Sloan Management Review. 30, 41 (1988)
2. Shafer, S.M., Smith, H.J., Linder, J.C.: The power of business models. Business Horizons. 48, 199–207 (2005).
3. Hopp, W.J., Spearman, M.S.: The lenses of lean: Visioning the science and practice of efficiency. Journal of Operations Management. 1–17 (2020).
4. Ballé, M., Jones, D.T., Chaize, J., Fiume, O.: The Lean Strategy: using lean to create competitive advantage, unleash innovation, and deliver sustainable growth. McGraw Hill Professional, New York (2017)
5. Liker, J.K.: Toyota way: 14 management principles from the world's greatest manufacturer. McGraw Hill Education (2004)
6. Fujimoto, T.: The evolution of a manufacturing system at Toyota. Oxford University Press, Oxford (1999)
7. Takeuchi, H., Osono, E., Shimizu, N.: The contradictions that drive Toyota's success. Harvard Business Review. 86, 1–19 (2008).
8. Spear, S., Bowen, H.K.: Toyota DNA. Harvard Business Review. 77, 96–106 (1999)
9. Fullerton, R.R., McWatters, C.S., Fawson, C.: An examination of the relationships between JIT and financial performance. Journal of Operations Management. 21, 383–404 (2003).
10. Bendig, D., Strese, S., Brettel, M.: The link between operational leanness and credit ratings. Journal of Operations Management. 52, 46–55 (2017).
11. Netland, T.H., Powell, D.: The Routledge Companion to Lean Management. Routledge, New York (2017)
12. Netland, T.H., Aspelund, A.: Company-specific production systems and competitive advantage: A resource-based view on the Volvo production system. International Journal of Operations and Production Management. 33, 1511–1531 (2013).
13. Shah, R., Ward, P.T.: Lean manufacturing: context, practice bundles, and

performance. Journal of Operations Management. 21, 129–149 (2003).
14. Netland, T.H.: Critical success factors for implementing lean production: The effect of contingencies. International Journal of Production Research. 54, 2433–2448 (2016).
15. Jadhav, J.R., Mantha, S.S., Rane, S.B.: Exploring barriers in lean implementation. International Journal of Lean Six Sigma. 5, 122–148 (2014).
16. Lucey, J., Bateman, N., Hines, P.: Why major lean transitions have not been sustained. Management Services. 49, 9–13 (2005)
17. Hines, P., Taylor, D., Walsh, A.: The Lean journey: have we got it wrong? Total Quality Management and Business Excellence. 31, 389–406 (2020).
18. Pettersen, J.: Defining Lean Production : Some conceptual and practical issues. The TQM Journal. 21, 127–142 (2009)
19. Hines, P., Holwe, M., Rich, N.: Learning to evolve: A review of contemporary lean thinking. International Journal of Operations and Production Management. 24, 994–1011 (2004).
20. Netland, T., Ferdows, K.: What to expect from a corporate lean program. MIT Sloan Management Review. 55, 83–89 (2014)
21. Karlsson, C., Hlström, P.: Assessing changes towards lean production. International Journal of Operations and Production Management. 16, 24–41 (1996).
22. Imai, M.: Gemba Kaizen. McGraw Hill Professional, New York (2012)
23. Bessin, O.: Learn Lean from the source. Toyota Material Handling Europe. 0–15 (2020)
24. Ballé, M., Chartier, N., Coignet, P., Olivencia, S., Powell, D.J., Reke, E.: The Lean Sensei. Go, See, Challenge. The Lean Enterprise Institute Inc, Boston, MA (2019)
25. Monden, Y., Hamada, K.: Target Costing and Kaizen Costing in Japanese Automobile Companies. Jouirnal of Management Accounting Research. 3, 16–34 (1991).
26. Shiozawa, Y.: Product Variety for Effective Demand Creation. In: Fujimoto, T. and Fumihiko, I. (eds.) Industrial Competitiveness and Design Evolution. pp. 97–123. Springer Japan, Tokyo (2018)
27. Adler, P.S., Goldoftas, B., Levine, D.I.: Flexibility Versus Efficiency? A Case Study of Modelt Changeovers in the Toyota Production System. Organizational Science. 10, 43–68 (1999)
28. Smalley, A.: Set Up Reduction In Toyota, http://artoflean.com/index.php/2010/02/15/set-up-reduction-in-toyota/
29. Bertel, S.: Inside Toyota's Takaoka #2 Line: The Most Flexible Line In The World, (2019)
30. Profiroiu, M., Kaneko, H., Vlad, C., Dutescu, A., Ishida, H.: Toyota Motor Corporation ' s Culture Strategy. Review of International Comparative Management. 21, 458–489 (2020).
31. Morgan, J.M., Liker, J.K.: Designing the Future. McGraw Hill Professional, New York (2019)
32. Spear, S.J.: Learning to Lead at Toyota. Harvard Business Review. 82, 78-86+151 (2004)
33. Liker, J.K., Mayer, D.P.: Toyota Talent. McGraw Hill Education, New York (2007)
34. Shook, J.: How to Change a Culture : Lessons From NUMMI Backstory : Why NUMMI Began , and How It Fared. MIT Sloan Management Review. 51, 63–68

(2010)
35. Heller, D.A., Fujimoto, T.: 6 Monozukuri Management. In: Nakano, T. (ed.) Japanese Management in Evolution: New Directions, Breaks, and Emerging Practices. pp. 107–126. Routledge, New York (2018)
36. Nayebpour, M.R., Saito, A.: Toyota Vs . Nissan – a Contrast in Culture , Corporate Governance , Operational Strategy , and Financial Performance. Desicion Science Institute. 567–578 (2007)
37. Monden, Y.: Cost Reduction Systems: Target Costing and Kaizen Costing. Productivity Press, Portland, Oregon (1995)
38. Eisenhardt, K.M.: Building Theories from Case Study Research. Academy of Management Review. 14, 532–550 (1989).