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PRODUCTIVITY GROWTH AND BUSINESS MODEL INNOVATION

Wit Wannakrairoj
(University of Cambridge)

Chander Velu
(University of Cambridge)

Organizational factors have been identified as a possible explanation for total factor productivity and hence the Solow paradox. We posit that business model innovation is a major organizational factor. However, there has not been any systematic study on how business model innovation affects productivity growth rates. We introduce a novel approach of measuring business model innovation using change in the net asset turnover ratio. The study shows that business model innovation contributes significantly to productivity growth across firms in the UK between 2003 and 2017. The study provides empirical support that business model innovation could partially explain the Solow productivity paradox.

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Wit Wannakrairoj[1], Chander Velu[2]

Highlights

- Organizational factors have been identified as a possible explanation of total factor productivity.
- We posit that business model innovation is a major organizational factor.
- We introduce a novel approach of measuring business model innovation using change in the net asset turnover ratio.
- We show that business model innovation contributes to productivity growth.

Keywords: Business Model Innovation, Productivity Paradox, Firm Productivity and Production Function
JEL Classification: D22, D24, M21, O33, O47

Abstract

Organizational factors have been identified as a possible explanation for total factor productivity and hence the Solow paradox. We posit that business model innovation is a major organizational factor. However, there has not been any systematic study on how business model innovation affects productivity growth rates. We introduce a novel approach of measuring business model innovation using change in the net asset turnover ratio. The study shows that business model innovation contributes significantly to productivity growth across firms in the UK between 2003 and 2017. The study provides empirical support that business model innovation could partially explain the Solow productivity paradox.

[1] Institute for Manufacturing, Department of Engineering, University of Cambridge, UK;
Chulalongkorn Business School, Chulalongkorn University, Thailand
[2] Institute for Manufacturing, Department of Engineering, University of Cambridge, UK
* Correspondence to: Institute for Manufacturing, Department of Engineering, 17 Charles Babbage Rd, Cambridge, CB3 0FS, UK
E-mail addresses: ww313@cam.ac.uk (W. Wannakrairoj), cv236@cam.ac.uk (C. Velu)
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Introduction

Total Factor Productivity (TFP) has been attributed to the portion of output not explained by the amount of inputs used in production, which is a means of capturing how efficiently and intensely the inputs were utilized (Comin, 2010). TFP is a key element to explain the Solow productivity paradox (Solow, 1987). TFP could be explained by many factors including technical innovations, organizational and institutional changes, omitted variables, and measurement error (Cette et al., 2018, Hulten, 2001).

Studies on the adoption of new technologies have particularly emphasized the importance of organizational factors as complementary innovations that are often underemphasized in examining the impact on productivity (Brynjolfsson and Hitt, 2003). The extant literature has highlighted management innovation as a form of organizational factor that contributes to productivity improvements (Bloom and Van Reenen, 2007; Alexopoulos and Tombe, 2012; Bloom, Sadun, and Reenen, 2016). Management innovation is defined as the invention and implementation of a management practice, process, structure or technique that is new to the state of the art and is intended to further organizational goals (Birkinshaw, Hamel, and Mol, 2008). We distinguish management innovation to another form of organizational factor which is business model innovation. A business model summarizes the architecture and logic of a business and defines the organization's value proposition and its approach to value creation and value capture (Velu, 2015). In doing so, the business model acts as the means to translate the benefits of technologies to customer value via markets.[3] Business model innovation articulates the changes to the means of value creation and value capture. Business model innovation might often involve management innovation. However, management innovation can be implemented in an existing business model to improve performance. Business model innovation has been shown to affect productivity within a single firm (Brea Solis et al., 2015). However, studies have not shown the impact of business model innovation on productivity across firms partly due to the lack of systematic ways of measuring the former.

We introduce a novel approach of measuring business model innovation using change in the net asset turnover ratio (NATO) which is operationalized as sales over the average net operating assets.[4] We posit that a major change in the NATO ratio would only be possible if there is a fundamental change in the

[3] New technologies often act a catalyst for business model innovation (Klöckner, Kurpjuweit, Velu and Wagner, 2020). For example, the advent of 3D printing might enable distributed manufacturing whereby production takes place closer to the location of the customer. This might result in changes to the production processes and hence, the business model of the original equipment provider in not needing to hold spare-parts for the customers' equipment.

[4] The NATO ratio is a measure of asset utilization and efficiency, which generally comes from efficient use of property, plant, and equipment; inventory processes; and other forms of working capital management (Soliman, 2008).

business model of the firm. We show that changes in TFP can be explained by business model innovation measured as changes in NATO by using a dataset of UK firms. We show the robustness of our results by addressing endogeneity issues by using instrumental variables and alternative specifications of the production function.

This research makes two contributions to knowledge in the field of business model innovation and productivity. First, the study proposes a novel approach to measuring business model innovation. Second, the study shows that business model innovation might be an important factor in explaining TFP which has wide managerial and policy implications.

Measuring Business Model Innovation

We illustrate that NATO is a good proxy to measure differences in business models using the online retail and traditional bricks-and-mortar bookstores. We chose this example because there are three firms with different business models for the 10-year period 2001 to 2011.[5] The firms were Amazon.com which is an online retail store; and Borders Group and Barnes & Noble Inc[6] which were primarily non-online retail stores. During the period of the case illustration, Amazon's business model was based on its e-commerce platform which operates 24/7 without physical stores. It also carries its own inventory within its network of warehouses or delivers directly from its suppliers. Such a business model enables Amazon to hold relatively low inventory compared to traditional bricks-and-mortar stores. We highlight two distinguishing features of NATO for Amazon, Borders Group and Barnes and Noble Inc as shown in Figure 1. First, Amazon's NATO is significantly different compared to Borders Group and Barnes & Noble Inc which have large physical store footprints.[7] Second, innovations of the business models of these three firms during the period result in changes in NATO.[8] However, such changes in NATO still maintain the difference in NATO of Amazon compared to Borders Group and Barnes & Noble Inc. The illustration provides support for our proposition that changes in NATO is a good proxy to measure business model innovation.

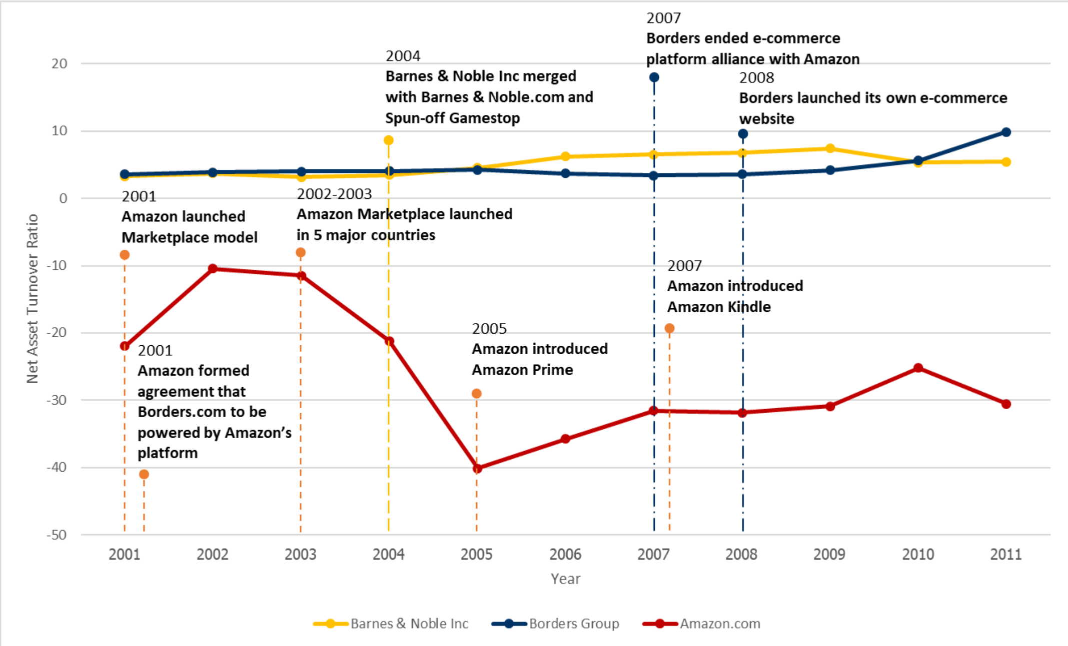
[5] Borders Group filed for Chapter 11 protection in 2011.

[6] The annual reports show that Barnes & Noble Inc and Borders Group had average online sales of less than 10% and 5% of total sales respectively during the period of the case illustration.

[7] Amazon has long credit terms from suppliers when compared to the cash receipt from buyers resulting in a large sum of cash and payables on its balance sheet with approximately one to one ratio. For this reason, Amazon's NATO is negative. In contrast, Borders Group and Barnes & Noble Inc have a very different business model than Amazon and have payables around 10 times the amount of cash they are holding.

[8] For example, the Borders Group's NATO increased from 4x to 6x after the introduction of its online store in 2008. Similarly, Barnes & Noble Inc simplified its corporate structure to be more focused on their core book business by merging its operations with Barnes & Noble.com and spinning-off GameStop Corp, its gaming merchandise retailer in 2004 resulting in a rise in NATO from an average of 3.5x to 6x. Amazon's NATO captures changes in its business such as when the firm launched Amazon Marketplace which enable third-part sellers on the Amazon platform and partnered with Borders to provide its online offering in 2001. Amazon also launched Marketplace in 5 major countries between 2002-2003, introduced Amazon Prime which is a membership-based loyalty program in 2005, and released Amazon Kindle, its first e-reader in 2007 resulting in changes to the NATO from an average of -10x to -20x during 2001-2004 to -30x to -40x during 2005-2011 respectively.

Figure 1: Net Asset Turnover Ratio: Book Retail



Source: Capital IQ, Annual Report, and authors' calculation

Empirical Model

This study presents an empirical model to estimate the TFP by using the Cobb-Douglas production function. Equation (1) can be linearized into natural log form to Equation (2).

$$Y = AL^{a}K^{ß} \quad (1)$$

$$\ln Y = \ln A + \alpha \ln L + ß \ln K \quad (2)$$

where *A* represents Total Factor Productivity (TFP), *Y* represents output (revenue), *L* represents labor (number of employee), and *K* represents capital at firm-level (total asset).

The change in TFP (ln *A*) is then modeled by a change in business model (ln *BMI*) which is proxied by a change in NATO ratio and unobserved technological and efficiency factors (*A'*).

$$\ln A = \mu \ln BMI + A' \quad (3)$$

Then Eq. (2) and Eq. (3) are combined into an extended Cobb-Douglas function which includes the proposed business model innovation variable.

$$\ln Y = \mu \ln BMI + \alpha \ln L + ß \ln K + A' \qquad (4)$$

Hence Eq. (5) for empirical estimation can be written as

$$\ln Y_{it} = \mu \ln BMI_{it} + \alpha \ln L_{it} + ß \ln K_{it} + A'_{it} + u_{it} \qquad (5)$$

Where u is an error term, subscript i denotes firm and t denotes year.

Methods and Data

The analysis is based on panel linear regression econometric analysis (Least Squares) framework. We control for cross-section fixed effects and period fixed effects. The model satisfied all diagnostic tests for fixed/random effects through the Hausman test, autocorrelation, multicollinearity and normality.

We use an Instrumental Variable (IV) approach to address endogeneity issues arising from limitations of the proxy variable to measure business model innovation. Two-stage least squares (2SLS) is implemented using instrumental variable (IV) estimation through a set of IVs including Euclidean Return on Equity (ROE) distance, the percentage change in Selling, General and Administrative expense (SG&A), and 1-year lagged NATO ratio.[9]

We obtain firm-level data from BvD FAME, which consist of an unbalanced panel data of 15,844 UK companies from 19 industries between the years 2000-2017.[10] We implemented data transformation to enable the use of logarithms where non-negative and non-zero number are required. Change in NATO is

[9] Euclidean ROE Distance: The Euclidean ROE distance measures the position of a firm's ROE relative to the industry average ROE and hence is a proxy for the intensity of competition between firms (Baum & Mezias, 1992). The smaller the Euclidean ROE distance the higher the intensity of competition which implies that the more likely firms will innovate their business models (Goettler & Gordon, 2011).

Change in SG&A Expense: SG&A measures the stock of organizational capital via spending on items such as advertising, distribution system and employee training (Peters & Taylor, 2017). Therefore, the change in SG&A measures the change in organizational capital via changes in the values, beliefs and culture that are required for business model innovation (Hock et al., 2016).

Lagged Explanatory Variable: We use 1-year lagged value of the explanatory variables as instruments in 2SLS to address the problems posed by the regressor potentially being correlated with the residual and addresses potential biases from reverse and simultaneous causality (Reed, 2015). Lagged values are less likely to be influenced by current shocks and captures changes in productivity from a firm's decision to innovate their business model.

[10] Firms without data on revenue, with negative revenue, with ROE and total asset equal zero, with ROE above 200% and less than -200%, without profit margin, and without employee numbers are all excluded.

taken as an absolute number to capture changes in business models. Similarly, percentage change in SG&A is also calculated as an absolute number.

Table 1 shows average firm revenue and absolute change in NATO between 2003-2017 summarized in five-year time periods and across the 19 industries in the sample. As shown in the last row of Table 1, the overall firm level aggregate data displays an increase in average absolute change in NATO and average revenues across the three five-year period. Although Table 1 provides an overall description of the data, the correlation and trend between these increases cannot be interpret directly as they constitute averages across firms, industries and time periods. Moreover, they do not account for other factors that could influence the relationship between productivity and business model innovation. We next use regression analysis as outlined earlier in order to better understand such underlying relationships.

Table 1: Average Revenue and Absolute Change in NATO

		2003-2007		2008-2012		2013-2017		2003-2017	
	Obs.	Avg. Revenue (£ '000)	Avg. Change in NATO	Avg. Revenue (£ '000)	Avg. Change in NATO	Avg. Revenue (£ '000)	Avg. Change in NATO	Avg. Revenue (£ '000)	Avg. Change in NATO
Agriculture	141	38,883	0.25	67,942	0.30	80,127	0.22	65,460	0.26
Accommodation	476	42,210	0.51	48,974	0.44	52,011	0.30	46,787	0.38
Mining	163	3,681,477	0.55	4,033,393	7.45	3,299,850	0.48	3,348,108	2.63
Transportation	678	90,348	0.46	118,900	1.03	152,429	0.49	118,518	0.67
Construction	865	88,336	1.10	92,661	1.30	114,176	1.63	95,823	1.28
Wholesale and Retail	2583	130,652	0.39	180,737	0.46	180,435	0.62	161,028	0.42
Water Supply	85	55,629	1.02	70,616	0.38	74,567	0.29	63,224	0.40
Electricity	55	1,209,827	0.45	1,386,326	2.08	1,402,568	0.48	1,280,129	1.06
Manufacturing	3396	107,809	0.64	128,046	0.40	140,496	0.88	125,204	0.69
Information and Communication	1138	70,279	0.77	80,582	0.78	100,058	0.82	83,321	0.85
Financial and Insurance	1198	193,651	2.07	203,033	2.40	188,487	1.21	185,883	2.11
Real Estate	312	30,913	1.15	31,159	1.03	40,830	0.98	33,812	0.96
Professional	1350	150,128	1.15	168,551	1.12	174,452	2.21	152,711	1.66
Admin and Support	1548	70,204	1.15	75,202	1.04	97,181	0.84	80,979	0.91
Public Admin and Defence	60	63,733	0.92	51,949	1.02	76,977	0.68	55,572	0.97
Education	157	13,736	2.90	15,556	0.97	17,327	1.02	15,244	1.12
Health	475	23,028	0.95	35,530	0.88	48,274	0.73	38,416	0.91
Art	387	115,061	3.47	39,500	0.98	53,626	4.73	59,916	2.30
Other Services	777	31,657	1.24	28,036	1.16	32,529	0.82	27,728	0.99
Overall	15844	140,641	0.92	162,549	0.95	165,689	1.05	150,573	0.98

Results and Discussion

Table 2 shows that business model innovation through the change in NATO ratio is statistically significant with coefficients of 0.003 and 0.004 (models 2 and 3) when both cross-section and period fixed effects are implemented and also with the cross-section fixed effects respectively. Table 3 shows the results using 2SLS with the three IV variables of Euclidean ROE distance, a percentage change in SG&A and 1-year lagged NATO ratio respectively.

Table 2: OLS Results

	Model		
Variable	1	2	3
Ln (K)	0.607*** (0.001)	0.444*** (0.001)	0.397*** (0.002)
Ln (L)	0.359*** (0.001)	0.485*** (0.002)	0.496*** (0.002)
Ln (BMI)	0.019*** (0.001)	0.003*** (0.000)	0.004*** (0.000)
Fixed Effect - Cross Sectional	No	Yes	Yes
Fixed Effect - Period	No	No	Yes
Adjusted R^2	0.810	0.972	0.972
Cross-sections	15844	15844	15844
Unbalanced Observation	175391	175391	175391

Standard Errors are in parentheses
*** 1% significant

The results in Table 3 show that the business model innovation variable is statistically significant when all combination of IVs are included. The coefficient for business model innovation variables ranges from 0.027 to 0.193 (models 1-6) when a single IV is included to around 0.055 (model 7) when all the IVs are included. These results show that a doubling in the NATO ratio of a firm due to changes in business model innovation results in approximately 2.7-19.3% increase in the firm's productivity (model 1-7). Furthermore, as expected the coefficients of labor and capital have a statistically significant effect on productivity.

Table 3: 2SLS Results

	Model						
Variable	1	2	3	4	5	6	7
Ln (K)	0.414*** (0.002)	0.402*** (0.002)	0.399*** (0.002)	0.406*** (0.002)	0.402*** (0.002)	0.400*** (0.002)	0.402*** (0.002)
Ln (L)	0.515*** (0.003)	0.501*** (0.002)	0.498*** (0.002)	0.506*** (0.002)	0.501*** (0.002)	0.499*** (0.002)	0.501*** (0.002)
Ln (BMI)	0.193*** (0.015)	0.056*** (0.008)	0.027*** (0.005)	0.100*** (0.007)	0.055*** (0.005)	0.035*** (0.004)	0.055*** (0.004)
Fixed Effect - Cross Sectional	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effect - Period	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2SLS IV- Ln (Euclidean ROE)	Yes	-	-	Yes	Yes	-	Yes
2SLS IV - Ln (Change Net Asset Turnover) (-1)	-	Yes	-	Yes	-	Yes	Yes
2SLS IV - Ln (Change in SG&A)	-	-	Yes	-	Yes	Yes	Yes
Adjusted R^2	0.954	0.971	0.972	0.968	0.971	0.972	0.971
First Stage R^2	0.238	0.240	0.244	0.242	0.246	0.248	0.249
First Stage IV - Significant Level for each IV	***	***	***	***, ***	***, ***	***, ***	***,***, ***

Cross-sections	15844	15844	15844	15844	15844	15844	15844
Unbalanced Observation	175391	175391	175391	175391	175391	175391	175391

Standard Errors are in parentheses
*** 1% significant

For robustness, we tested the model using OLS pooled method and 2-Stage Least Squares using revenue per employee as the dependent variable and the results are similar to that in Tables 2 and 3 respectively.

While Cobb-Douglas is one of the most common parametric production functions, other approaches to measure productivity can also be used. In order to test the robustness of our results, we also incorporate a more general approach to measure TFP using index numbers. We adopt the index numbers approach found in Van Beisebroeck (2007) to calculate the change in TFP and re-estimated the regression based on model (7) in Table 3. This index number approach is similar to Solow (1957) whereby TFP growth is calculated by

$$\ln A_{it} - \ln A_{it-1} = \ln (Y_{it} / Y_{it-1}) - ((S_{it} + S_{it-1}) / 2) \ln (L_{it} / L_{it-1}) - (1 - (S_{it} + S_{it-1}) / 2) \ln (K_{it} / K_{it-1}) \quad (6)$$

where A_{it} represents TFP which differs across firms *i* and time periods *t*, *Y* represents output (revenue), *L* represents labor (number of employee), *K* represents capital at firm-level (total asset), and *S* represents the wage share or the fraction of wage in revenue.

We found that the results using the TFP from index number method are consistent with our main findings showing that business model innovation is statistically significant at the 1% level with a coefficient of 0.010.

Conclusion

The contribution of this paper is to propose a novel approach to measure business model innovation and study its relationship to productivity. This research emphasizes the importance of business model innovation in order for firms and policy makers to reap the full benefits of productivity growth.

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