The Impact of Fintech adoption on the regional innovation efficiency: Empirical evidence from Jordan

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Abstract:

With the growing trend of fintech in the previous years, it has become the central point of attention for many researchers. The objective of this study is to examine the effect of fintech on the innovation efficiency by using the data on governorates level of Jordan. The two stage DEA method is used to assess innovation efficiency. Spatial Durbin Model is used for the empirical analysis. It is found that fintech has a positive effect on overall efficiency and launching efficiency but have a very little impact on the research and development efficiency.it is also observed that in launching phase, fintech has a spatial spillover effect.

Keywords: Fintech, regional innovation efficiency, spillover, spatial effect**,** Jordan, DEA, technological innovation.

1. INTRODUCTION:

In past, technological innovation used to be a competitive advantage, but as time goes on, it becomes a necessity for survival in any industry. Wessel et al., (2021) the responsibilities of technologies grow, they are inevitably going through significant changes that will impact sales, services for both internal and external clients, and even digital business strategies. Technological innovations are becoming the part of financial sector just like they are in any other industry. The advancement of financial technology has had a profound impact on financial services. Fintech is defined as "the digital transformation" of the financial sector (Mcauley, 2014). It is the fusion of technology and financial services. It is described as a sector of the economy where financial services are altered through the application of technology. Fintech is the advanced version of shadow finance (Goldman Sachs, 2015). Technological innovation in the financial sector is the main factor of fintech (UK Government Office for Science, 2015). In the 20 biggest economies of the world, almost one-third of people who are digitally active are using fintech services (Ernst and Young, (2014). Since the development of new and advanced applications, all the fields of finance (payment, saving, loans, management of risk, and financial advice) have become part of fintech. Technology has replaced the traditional functions of financial sectors with remittances through mobile, robot advisors, and remittances through Fintech.

Like other countries, Jordan is also focusing on the progress of fintech. Fintech startups are increasing day by day. The government of Jorden is also working on the innovation of financial technology. The government in Jordan launched the REACH2025 Vision in 2016, to digitalize the sectors, companies, and individuals till 2025. The digitalization vision (REACH 2025) is important for transforming and enabling individuals, sectors, and companies in Jordan the adoption of digital concepts and build a strong base for operating businesses (Adaileh and Alshawawreh, 2021).

In 2022, Cairo Amman bank constructed a new digital bank called neobank LINC. Many banks have started the partnership with fintech companies like Arab bank started two partnerships i.e., AB iHub and AB accelerator.

The central Bank of Jordan has developed a regulatory fintech sand box, which will provide all kind s of innovative financial services from money transfer to providing security and efficiency. Notably, the establishment of the Jordan Payments and Clearing Company (JoPaCC) by the CBJ played a significant role in the growth of Jordan's fintech ecosystem. It assists in the creation of digital payment systems and makes investments in technological innovations. The Government of Jordan is continuously working to grow their fintech industry. And there is huge investment in fintech and innovation sector.

Currently, the improvement of regional innovation efficiency is gaining much importance in the field of research. As innovation plays a very important role in the regional development. The innovation efficiency is considered as the most important factor in measurement of regional innovation capacity. Berman et al., (2020) stated that innovation is a process that transformed the inputs like R&D staff, R&D funds into the outputs like patent, new technologies and product etc.

It is found that it is not necessary that region with more of the R&D investment achieve perfect R&D outputs.

With the huge advancement of financial technology in the recent decades, many innovations have developed and transformed the financial services in Jordan. In Jordanian market, number of fintech companies are growing rapidly (Sami et al., 2015). Even the central Bank is also focusing on the fintech innovation in local market. One of the notable things about fintech is that, other than traditional financial institutions, many leading industries and firms are becoming participants of fintech industry and with their network effect, they are transforming the financial system immensely.

Together with that fintech also help the innovative financial firms, in order to bridge the gap between technological innovation and small and medium-sized enterprises' (SMEs) financing needs, thereby adding to innovation effectiveness (Erić, et al., 2011; Intarakumnerd & Goto. (2016). However, the efficiencies generated by fintech-based financial services may lead to a drain on the economic resources of surrounding regions, potentially resulting in "market stealing" phenomenon. And created a problem, explained by the following statement:

The growth of fintech in Jordanian market increases the concern about its potential to affect local economies and deplete nearby area's financial resources.

Cumming and Schwienbacher, (2018) stated that Fintech startups don't always abide by all financial regulations. Certain models of fintech circumvent the limitations of the conventional regulatory system of financial control by using asset securitization (ABS), (Hornuf and Schwienbacher, 2017), thus amplifying the fintech drain on nearby areas. As a result, the following research question has arisen:

Q1: Does adoption of fintech affect the regional innovation efficiency?

In our study this we have divided innovation efficiency into two phases. The first phase is called as the research and development efficiency (R&D phase), it is, how efficiently and quickly a company develops the technology, and after the development of the technology then comes the second phase i.e., how efficiently company introduce and sell their technologies into the market to earn profits. This phase is called market launching phase. These two phases together make the overall innovation efficacy of the regions.

Jordan currently lacks a regional innovation policy and it is very important to know that how the fintech effect the regional innovation efficiency in Jordan to develop the region-specific policy for development of every governorate. So, in this paper our goal is to provide a detail analysis of fintech's impact on the innovation efficiency of different governorates of Jordan and the spatial

spillover effect in the nearby governorates to develop the better policy for the country. In sum, our aim is to:

Study the impact of fintech on regional innovation efficiency and the spillover effect on the nearby governorate

Our research adds in the body of knowledge on fintech and regional development research. It is found in many studies that the fintech has a direct promotion effect on financial firms and regional innovation development (Fuster et al., 2019; Haddad and Hornuf, 2018). According to certain studies, fintech that is supported by recently founded nonfinancial businesses, has been linked to the industry harm (Chen et al., 2019; Geddes and Schmidt, 2020). Our study therefore also added to the literature, by presenting the context of the innovation process, discussing spatial spillover, and examining the varied impact of fintech. The findings of this paper provide help for the regional government and policy makers to develop policy regarding fintech, so that it positively affects all the governorates and in term help in the economic development. Further research can be done by using different sectors of economy as fintech in entering into almost all the sectors.

The paper has the following structure. In Section 2 we present the detailed review of literature. Section 3 defines the data and variables and proposed methodology. Section 4 explains analytical results and managerial understandings based on f analysis. Finally, Section 5 contains research conclusions and future directions and recommendation.

REVIEW OF PREVIOUS RESEARCH

Financial sector has been greatly influenced by the technology but the fintech not only influenced the financial sector but cover far more than the financial sector. New fintech firms are creating challenges for the traditional financial firms. Like many shadow banks has grown and flourished because of a difference in regulations and technology in fintech (Buchak et al., 2018). Most of the researchers has studied the influence of fintech only on the financial industry.

Fuster et al. (2019) discovered that, rather than raising the default rate, fintech increased the processing speed of loan applications by about 20%. Fintech-enabled loan lenders can also reduce financing constraints for businesses, better handle demand shocks, and gather market intelligence.

Hornuf et al., (2020) demonstrated that a large number of established organizations have integrated fintech start-ups and/or their goods and services into their own business models, acknowledging the superiority of these companies.

Fang et al., (2021) found that machine learning or big data make it easy for the firms to access finances and reduces risk. Young firms use fintech, which is a technological change in financial industry, to challenge the already existing firms. Researches has studied the impact of fintech that extend beyond the financial sector. Like Zhang et al., (2020) studied the impact on urbanization, Puthusserry et al., (2021) studied the impact of fintech on internationalization and Berman et al., (2021) studied the relation between fintech and innovation and niche technologies. The results of these studies had contributed to the body of knowledge of innovation process and technology spatial spillover.

There are number of studies on the effect of fintech on the different stages of innovation. Kortum et al., (2000) found that Value-added services from venture capital, like market relations and management experience, can help new product listings and the development of improved management teams. Hall & Lerner (2010) stated that venture capitals also face problems in providing funds to the new and small innovation business, which causes limitations in innovation.

Huggins (2003) performed an index study in UK regions. He studied four variables, regional economic growth, innovation activities, development of competition and finally the total number of knowledge-based firms for the period of 1993 to 1999. A strong correlation was found among the variables.

Chuan et al., (2021) used a stochastic meta frontier approach, to calculate the relevant efficiency scores for Chinese banks with varying ownership structures. The findings demonstrate that state-owned commercial banks use subpar technology and have the lowest cost efficiency. When evaluating the impact of fintech development, it is important to note that fintech innovations not only increase banks' cost effectiveness but also improve the technology they employ.

Martin (2004) found that there is a significant effect of different expenditure on national income (per capita), on a regional level. He used barro type convergence approach for the period of 1980 to 2001. The independent variables he used were R&D expenditures, physical capital, high technology sector's share.

In Taiwan, China, Korea, Singapore and Hong-Kong, Innovation capacity is positively affected by many variables (Hu and Mathews, 2005). They studied the variables over the period of 30 years i.e., 1970 to 2000. They have found that innovation has a negative relation with intellectual property rights, the more the intellectual property rights are, the less the innovation while innovation increases with other variables like trade openness, research expenditure, academic publications.

There are large number of studies on the technology spatial spillover. Samila & Sorenson (2011) studied that a spatial spillover of finance occurs when the venture capital's accumulation effect increases the development of regional entrepreneurship and formation of new firms. On the basis of these studies, our paper focuses on the spillover of fintech (both direct and indirect) and its impact on innovation. The effect on the specific governorate is called direct effect whereas the effect on the neighboring governorate is called as indirect effect.

Dong & Yu (2023) studied the effect of financial technology on the innovation of firm. They found that by increasing symmetry of information and financial constrain, fintech increases the innovation of firms. The concluded that the private firms in central region and high technology have more effect of fintech.

Stein (2002) stated that in traditional financial system the regulatory requirements are very tough compared to the new financial model created by fintech that supports some firms for the advancement of innovation efficiency. But this makes the innovation uncertain which causes problems for the firms to attain financing. Technological enterprises use crowdfunding because of their features like openness, small amount and mass.

Fintech also have an indirect effect on innovation, in which a concept of new economic geography is considered. There are two spillovers of fintech, one is technology and information and the other is competition and market crowding out effect and they may be positive as well as negative.

Almeida & Kogut (1999) stated that the increase in the technology space spillover increases the positive effect. For example, there is a transfer of technology among the regions when there is the movement of resources, raw material, labor, R&D essentials or by more direct technology license transfer, which results in the regional innovation system.

Liao (2023) studied the effect of fintech on the Taiwan bank efficiency by using parametric and non-parametric analysis. He found that fintech promotes bank's efficiency.

From the perspective of new economic geography, the efficiency advantage that fintech has demonstrated in financial services may, on the one hand, absorb the neighboring economies'

resources. The benefit of industrial accumulation and the formation of the "core-periphery" structure can result from this flow of research and development factors from other regions.

Bai & Li (2009) studied the regional innovation efficiency in China and examined the impact of local government on regional efficiency. They collected the panel data from 1998 to 2008. They found a low regional efficiency in China. Regional innovation efficiency has a negative relation with the R&D expenditure of local government. It is concluded that there is no important part of regional government of China in increasing the innovation efficiency of the region. They had also concluded that there are other aspects that also have a negative relation with innovation efficiency. Those aspects are research institutions and different financial institution in regional innovation system. And it can be said that internet construction requires a huge level of improvement in order to be perfect. China has to work on innovation environment improvement and system network construction in every region, to achieve better and perfect innovation.

2.3 Hypothesis Development:

It is studied in the literature that fintech has an impact on innovation efficiency in a specific governorate. But it is seen in some studies that it has a potential to negatively affect the efficiency of nearby governorates/ region. Based on the above analysis we have developed the following hypothesis.

H1: FinTech affects the regional innovation efficiency in Jordan and have a spatial spillover effect in nearby governorates

3. METHODOLOGY:

In this paper, we have analyzed the effect of Fintech (financial technologies) on regional innovation efficiency, this makes it causal research. To study this impact, we have selected 7 years' time period i.e., 2016 to 2022, and applied the Spatial Durbin model. The spatial matrix of 12 governorates was calculated.

3.1 Data and Variables:

3.1.1 Dependent variable: Innovation efficiency

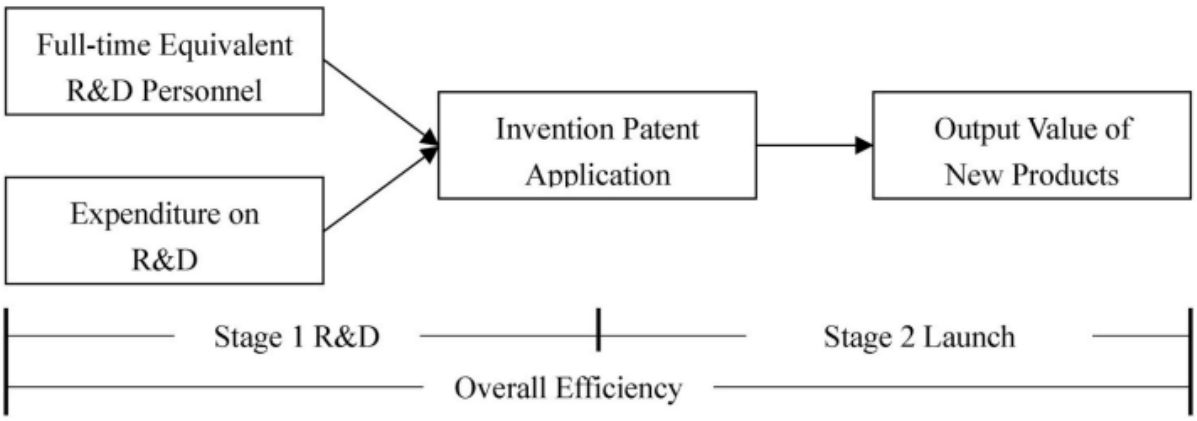
The dependent variable of our study is Innovation Efficiency. On the basis of previous literature, we have used a method of efficiency measure called data envelopment analysis (Charnes, Cooper & Rhodes, 1978) and divided our dependent variable i.e., innovation efficiency into two phases The first phase is called as the research and development efficiency (R&D phase), it is, how efficiently a company develops the technology, and after the development of the technology then comes the second phase i.e., how efficiently company introduce and sell their technologies into the market to earn profits. This phase is called market launching phase.

This method has many advantages over others, first there is no assumption of parameter distribution, second it includes the whole innovation process, as the first phase shows how the company invests its capitals and expertise in order to develop technologies and patent, the second phase shows that the company uses those patents for improvement and further new technology development. From a measurement point of view, we can say that experts and expenditures on R&D are the inputs of 1st phase, we have used the full time research and development's staff and Expenses on research and development as the proxies for that. And the output of this phase is the

total number of accepted invention patent applications. Among all the three types of patents, the invention patents are highly standard and represents innovation perfectly, so we have selected invention patent for our analysis. We used other patents in our robustness test.

According to DEA method the output of 1st phase is used as an input of 2nd phase, so here inventions patents are the input of the second phase and its output is transformation technologies and for this we have used output value of new products as proxy.

Fig 1. Innovation Stages



We have selected industrial firms listed on Amman stock exchange with the sales revenue above 20 million. The DEA method measure the efficiency of the firms (DMUs) in the same time period, as in multiple periods, changes in production frontiers makes the results biased. We selected the window analysis to solve this issue (Charnes, 1994). In this method, we divided the data into many windows and then by taking average of the windows, the final efficiency values if DMUs in a certain period, is calculated. In DEA window analysis, first of all window width (*d*) is calculated, *d* = 3 or *d* = 4 is considered as the best for better reliability and stability of results, we have selected 3 as our window width.

3.1.2 Independent variable: Fintech (Financial Technology)

The previous researches showed that there are two methods to measure fintech. One method is used on unstructured data and is called data mining method. In these methods fintech sentiment index is constructed. Examples of this methods are machine learning and in news text analysis. In second method, the transection and operation data of fintech firms are used for the construction of structured indicator system. Feng, et.al. (2019) used this method to develop the inclusive finance index.

We have chosen second method used by Feng, et.al. (2019), because it is more reliable, as the first method is based on the news and reports which are not consistent, so it is not possible to clearly and accurately represent the development of fintech on the basis of this method considering the growing stage of fintech in Jordan, most of the patents are in the process of application.

3.1.3 Control variables.

The control variables that are included in our study are as follow

- Regional economic development (GDP per capita)
- Fiscal research expenditures
- Infrastructure Regional internet (Broadband Subscribers port of internet)

3.2 Model:

The model we have designed for our analysis is as follow

$$y_{it} = \beta_0 + \beta_1 Fintech_{it} + \beta_2 \mathbf{W} \cdot Fintech_{it} + \beta_3 \mathbf{W} \cdot y_{it} + \boldsymbol{\beta}_4 \mathbf{Control_{it}} + \varepsilon_{it}$$

Where,

y_{it} = Innovation Efficiency
Fintech it = financial technology index
W = spatial weight matrix
W. fintech it = interaction of financial technology with spatial matrix
W. y_{it} = Spatial lag term of Innovation efficiency
Control it = control variable
ε_{it} = residual

We have followed the Leasage and Pace (2012) methodology to estimate the effect of fintech and divided that effect into three categories i.e., overall, direct and indirect. They stated that the exact spatial spillover cannot be estimated by β2 coefficient. In addition, considering other spatial correlation forms of innovation efficiency We have used SAR (spatial autoregressive model) which have spatial lag term. Spatial error model is used to estimate the direct impact in robustness test

4. Results and Discussion

4.1 Descriptive statistics.

The descriptive stats of our analysis are given in Table 1. These results are in accordance with the condition of Jordan's development at the governorate level. In 2016 the output level of new product in some governorates was very little, which lead to a very small level of overall and launch efficiency.

Table 1: Descriptive Statistics

Variables	Mean	Std. error	Min. Value	Max. Value
Overall	0.127	0.050	0.001	0.258
R&D	0.437	0.189	0.152	1.000
Launch	0.282	0.156	0.001	1.000
Fintech	210.2	69.8	62.6	346.8
Reg. Eco. Dev.	5.448	2.442	2.045	16.99
Fisc. Expenditure	0.012	0.016	0.001	0.102
Broad-band	0.088	0.068	0.002	0.354

4.2 Base Regression

Table 2 shows the results of base regression. The effect of un-observed variables is controlled by incorporating the fixed effect and robustness standard error. It is found from table 2 that there is a positive relation between fintech and overall and launch efficiency which means fintech positively impacted the innovation efficiency but the interaction of fintech and spatial matrix's coefficient is negative. It can be stated that in a specific governorate fintech has positive effect on innovation efficiency and launch efficiency but negatively effect these two in the nearby governorates. There is no effect of fintech on R&D efficiency. Lesage and Pace (2012) found the similar results, as it is

difficult for venture capitalist to provide funds to the small and new firms, so the positive effect of fintech over innovation is only in the second phase i.e., launching phase in specific governorate but it impedes the innovation efficiency of neighboring governorate.

Table 2: Base regression

	(1) Overall efficiency	(2) Research and development efficiency	(3) Launch efficiency
Fintech	**0.00101****	**-0.00168**	**0.00281****
	(0.000416)	**(0.00142)**	**(0.00109)**
W.fintech	**-0.000815***	**0.00212**	**-0.00242****
	(0.000408)	**(0.00136)**	**(0.00120)**
Reg. Eco. Dev.	**-0.00699****	**-0.0306****	**0.000241**
	(0.00298)	**(0.0128)**	**(0.0101)**
Fisc. Expenditure	**0.885****	**2.304**	**0.241**
	(0.416)	**(1.437)**	**(1.165)**
Broad-band	**-0.0610**	**0.182**	**-0.0910**
	(0.106)	**(0.349)**	**(0.288)**
fintech_direct	***0.000998*****	***-0.00169***	***0.00284*****
fintech_indirect	***-0.000684****	***0.00201***	***-0.00229******
Fintech_total	***0.000344******	***0.000298****	***0.000476******
R^2	**0.1862**	**0.0822**	**0.1005**
Log likelihood	**475.26**	**215.00**	**259.80**

***** p< 0.01 , ** p < 0.05, * p < 0.1**

4.3 Robustness Test:

Following test are performed for the confirmation of the result's robustness.

- Time trend
- Other model specification
- Fintech's lag term
- Control spatial correlation of economic development

4.3.1 Time trend:

With the passage of time, there are many changes in technology and innovation. Time plays a very important role as it effects both the fintech and innovation efficiency. So, to incorporate this effect the time trend term has been used with space fixed effect as an alternative method, in order to avoid the non-convergence of likelihood in estimation. And it is found in Table 3 that there is no significant change in the coefficients. As the time trend have different no linear effects, we have further added the quadratic term of time trend. The results are given in the Table 4 and are similar to the baseline estimation.

Table 3: Robustness test (I): Adding time trend (linear)

	(1) Overall efficiency	(2) Research and development efficiency	(3) Launch efficiency

Fintech	**0.000714***	**-0.00241***	**0.00241****
	(0.000421)	**(0.00142)**	**(0.00120)**
W.fintech	**-0.00129*****	**0.000784**	**-0.00319*****
	(0.000422)	**(0.00145)**	**(0.00118)**
Reg. Eco. Dev.	**-0.00946*****	**-0.0342*****	**-0.00265**
	(0.00372)	**(0.0126)**	**(0.0101)**
Fisc. Expenditure	**1.062*****	**2.448***	**0.510**
	(0.418)	**(1.431)**	**(1.150)**
Broad-band	**-0.168**	**-0.127**	**-0.268**
	(0.108)	**(0.365)**	**(0.302)**
Trend	**0.0268*****	**0.0648*****	**0.0447****
	(0.00711)	**(0.0231)**	**(0.0197)**
R^2	**0.1862**	**0.0822**	**0.1005**
Log likelihood	**482.22**	**217.21**	**261.45**

***** p< 0.01, ** p < 0.05, * p < 0.1**

Table 4: Robustness test (I): Adding time trend (Quadratic polynomial)

	(1) Overall efficiency	(2) Research and development efficiency	(3) Launch efficiency
Fintech	**0.00100*****	**-0.00191**	**0.00288****
	(0.00100)	**(0.00141)**	**(0.00112)**
W.fintech	**- 0.000709***	**0.00162**	**-0.00245****
	(0.000378)	**(0.00141)**	**(0.00114)**
Reg. Eco. Dev.	**-0.0105*****	**-0.0318*****	**-0.00389**
	(0.00325)	**(0.0126)**	**(0.00979)**
Fisc. Expenditure	**1.003*****	**2.451***	**0.4322**
	(0.365)	**(1.376)**	**(1.118)**
Broad-band	**-0.344*****	**-0.391**	**-0.423**
	(0.0971)	**(0.371)**	**(0.287)**
Trend	**-0.0410*****	**-0.0410**	**-0.0461**
	(0.0106)	**(0.0364)**	**(0.0308)**
Trend 2	**0.00564*****	**0.00786*****	**0.00683*****
	(0.000711)	**(0.00236)**	**(0.00159)**
R^2	**0.1862**	**0.0822**	**0.1005**
Log likelihood	**482.22**	**217.21**	**261.45**

***** p< 0.01, ** p < 0.05, * p < 0.1**

4.3.2 Other Model Specification:

Here we used Spatial Durbin Model and its various forms like SAR which consider spatial lag term and SEM that incorporated the spatial correlation of residuals.

SAR Model:

$$y_{it} = \beta_0 + \beta_1 Fintech_{it} + \beta_2 \mathbf{W} \cdot y_{it} + \boldsymbol{\beta}_3 \mathbf{Control_{it}} + \varepsilon_{it}$$

SEM Model

$$y_{it} = \beta_0 + \beta_1 Fintech_{it} + \boldsymbol{\beta}_2 \mathbf{Control_{it}} + \varepsilon_{it}$$
$$\varepsilon_{it} = \lambda \mathbf{W} \cdot \varepsilon + u, u \sim N(0, \sigma^2 I_n)$$

It is shown in Table 5 (SAR analysis) and Table 6 (SEM analysis) that the overall efficiency and launch efficiency are slightly consistent with the base line estimation and in addition to that fintech has a positive impact on R&D efficiency. The results don't show the complete pattern of fintech, as the spatial interaction term of fintech was not included in the analysis.

Table 5: Robustness test (II): SAR

	(1) Overall efficiency	(2) Research and development efficiency	(3) Launch efficiency
Fintech	0.000192***	0.000369*	0.000373**
	(5.92e-05)	(0.000191)	(0.000160)
Reg. Eco. Dev.	-0.00509	-0.0378***	0.00815
	(0.00350)	(0.0120)	(0.00956)
Fisc. Expenditure	0.959**	2.189	0.366
	(0.430)	(1.449)	(1.168)
Broad-band	-0.110	0.314	-0.236
	(0.108)	(0.352)	(0.288)
R^2	0.1744	0.0751	0.0810
Log likelihood	471.22	211.80	256.95
Λ	0.346***	-0.109	0.113

*** p< 0.01, ** p < 0.05, * p < 0.1

Table 6: Robustness test (II): SEM

	(1) Overall efficiency	(2) Research and development efficiency	(3) Launch efficiency
Fintech	0.000264***	0.000349*	0.000410**
	(6.78e-05)	(0.000179)	(0.000159)
Reg. Eco. Dev.	-0.00501	-0.0369***	0.00898
	(0.00336)	(0.0119)	(0.00950)
Fisc. Expenditure	0.939**	2.086	0.311
	(0.409)	(1.469)	(1.154)
Broad-band	-0.166	0.312	-0.308
	(0.114)	(0.348)	(0.305)
R^2	0.1640	0.0730	0.0809
Log likelihood	470.24	211.86	256.78
Λ	0.356***	-0.0916	0.136

*** p< 0.01, ** p < 0.05, * p < 0.1

4.3.3 Lag term of Fintech:

The fintech's lag term is included in the analysis because the application of invention patent always lagged behind the R&D phase. Together with that spatial interaction is also analyzed. For controlling the other variables, fintech index remained in the regression and we found the same results as the base estimation, shown in Table 7.

Table 7: Lag term of fintech

	(1) Overall efficiency	(2) Research and development efficiency	(3) Launch efficiency
Fintech	0.000690*** (0.000160)	0.000469 (0.000536)	0.00155*** (0.000448)
L.fintech	0.00150*** (0.000510)	0.000690 (0.00178)	0.00247* (0.00139)
W*L.fintech	-0.00160*** (0.000489)	– 0.000410 (0.00174)	– 0.00280** (0.00139)
Reg. Eco. Dev.	–0.0101*** (0.00350)	– 0.0360*** (0.0124)	– 0.00395 (0.01000)
Fisc. Expenditure	1.360*** (0.439)	3.630** (1.528)	0.810 (1.236)
Broad-band	– 0.280** (0.112)	– 0.208 (0.390)	– 0.658** (0.310)
R^2	0.4014	0.1048	0.2149
Log likelihood	424.37	198.20	236.68

4.3.4 Control Spatial Correlation of Economic Development

It is found in base estimation that in a specific governorate fintech has positive effect on innovation efficiency and launch efficiency but negatively affect these two in the nearby governorates, and the reason is regional economic development, because when there is growth of financial technology it absorbs resources from the adjacent governorates. For controlling the spatial correlation of regional economy development, we added the spatial interaction term of GDP (per capita) and the results are shown in table 8 and the new model is as follow

$$y_{it} = \beta_0 + \beta_1 Fintech_{it} + \beta_2 \mathbf{W} \cdot Fintech_{it} + \beta_3 \mathbf{W} \cdot GDPpercapita_{it} + \beta_4 \mathbf{W} \cdot y_{it} + \boldsymbol{\beta}_5 \mathbf{Control_{it}} + \varepsilon_{it}$$

Table 8: Control Spatial Correlation of Economic Development

	(1) Overall efficiency	(2) Research and development efficiency	(3) Launch efficiency
Fintech	0.00148*** (0.000519)	– 0.00118 (0.00175)	0.00289** (0.00149)
W*fintech	–0.00130** (0.000519)	0.00170 (0.00179)	– 0.00250* (0.00150)

Reg. Eco. Dev.	**− 0.00520** **(0.00368)**	**− 0.0290**** **(0.0129)**	**0.00271** **(0.0108)**
W* Reg. Eco. Dev	**− 0.00640** **(0.00528)**	**− 0.0288** **(0.0190)**	**− 0.000789** **(0.0149)**
Fisc. Expenditure	**0.970**** **(0.421)**	**2.380** **(1.450)**	**0.319** **(1.172)**
Broad-band	**− 0.0459** **(0.110)**	**0.380** **(0.379)**	**− 0.0629** **(0.309)**
R^2	**0.1777**	**0.0860**	**0.0939**
Log likelihood	**469.05**	**209.18**	**256.37**

4.4 Impact of Different Patent Types:

In our base DEA analysis, we have only used the invention patent as the input but to compare the results, we have now used the invention patent, utility patent and design patent as the input and the results are given in the Table 9. It is found that overall efficiency has the similar results as of base regression, but research and development efficiency and Launch efficiency don't have. The direct and indirect effect are positive and prominent in R&D phase but both of these effects are not significant in the second stage i.e., launching phase. The same results are found in utility and design patents models in R&D stage i.e., the fintech has positively impacted the R&D efficiency, but have the negative indirect effect.

Table 9: Impact on different patent types

	(1) Overall efficiency	(2) Research and development efficiency	(3) Launch efficiency
Fintech	**0.00440***** **(0.00125)**	**0.00409**** **(0.00176)**	**0.00271** **(0.00191)**
W.fintech	**−0.00390***** **(0.00119)**	**− 0.00369**** **(0.00179)**	**− 0.00189** **(0.00178)**
Reg. Eco. Dev.	**−0.0170**** **(0.00820)**	**− 0.0350***** **(0.0131)**	**0.009220** **(0.0120)**
Fisc. Expenditure	**2.570***** **(0.980)**	**3.729**** **(1.468)**	**0.580** **(1.489)**
Broad-band	**− 0.210** **(0.249)**	**− 0.330** **(0.368)**	**− 0.368** **(0.380)**
fintech_direct	**0.00419*****	**0.00390****	**0.00269**
fintech_indirect	**0.00419*****	**− 0.00310***	**− 0.00189**
Fintech_total	**0.000719*****	**0.000821****	**0.000740*****
R^2	**0.1650**	**0.0645**	**0.1650**
Log likelihood	**202.56**	**200.19**	**202.56**

Table 10: Comparison of different patent types

	Overall		R&D Phase		Launch Phase	
	Direct	Indirect	Direct	Indirect	Direct	Indirect
Invention	Positive	Negative	Nil	Nil	Positive	Negative
3 types	Positive	Negative	Positive	Negative	Nil	Nil

5. Conclusion and Recommendations

In this paper we have studied the effect of fintech financial technology on the Jordan's regional innovation efficiency and also the spatial spillover effect of fintech. We selected the time period from 2016 to 2022. Like Chen &yang (2019), it is found in our analysis that, in launching phase the regional innovation efficiency increase, with the increase of fintech. Our results also showed that though fintech in one governorate increases the efficiency in that governorate but also creates the crowding effect in the neighboring governorates, that results in the very little or no innovation efficiency in neighboring governorates. Yang & Wang (2022) found the similar results

The findings suggest that fintech does not have a major impact on R&D efficiency (Yand & Wang, 2022), which presents opportunities for fintech companies. Fintech companies can engage in more R&D since they are technology companies and start-ups that challenge already existing financial intermediary businesses. Furthermore, the findings indicate a detrimental effect on neighboring regions, suggesting that fintech could take resources and market share from these areas.

Theoretically, the use of fintech might promote information spillover and improve regional innovation synergy. Deepening the spatial spillover effect of fintech requires maximizing its positive economic impact. Secondly, the fintech's mixed effects are most noticeable during the product launch phase, when technological advancements are turned into new products that are placed on the market. However, the impact on research and development is not as great. Fintech is still in its early stages of development, but in the long run, there is more room in technology for it and big tech companies to engage in R&D and promote technical advancement. Fintech's early-stage involvement in innovation offers businesses different opportunities.

The empirical findings imply that when more businesses use fintech, they might compete for homogenous resources at the R&D stage, such as finance and specialists. Future study and more identification techniques are needed to ascertain whether there is a nonlinear relationship and other mechanisms.

Implications for policy makers:

In the developing digital economy, the intricacy of fintech's effects on the actual economy has significant regional consequences for industrial policy. Fintech, in the first place, encourages innovation efficiency and has the ability to exacerbate regional differences in innovation levels. Policymakers need to take into account the coexistence of industrial agglomeration and competitiveness effects in business practices, as well as the significance of industry-level tradeoffs between the adoption of new technologies and regional development. We recommend that decision-makers consider the possible negative impact to regional growth.

At present, Jordan has no regional innovation policy. Every governorate can get benefits from the formation and implementation of region-specific policies of innovation, in order to perform accurate innovation activities that could lead to the economic development in each governorate.

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