© *Pakistan Journal of Economic Studies*
https://journals.iub.edu.pk/index.php/pjes
Vol. 5, No. 1, June 2022, Pages: 27-52

ISSN 2708-1486 (E)
ISSN 2708-1478 (P)

The Effect of Fiscal Decentralization on Sectoral Green Total Factor Productivity in Pakistan: An Empirical Evidence

Kinza Nadeem[1], Bushra Yasmin[2] and Iffat Irshad[3]

Abstract

The study endeavors to measure sectoral Green Total Factor Productivity (GTFP) and the role of fiscal decentralization and key environmental regulations in affecting GTFP, for the manufacturing sector of Pakistan over the time period 1975-2019. The growth accounting method is employed to measure sectoral GTFP to examine the sector's standing in attaining long-run environmental sustainability. Moreover, the role of fiscal decentralization and other lead determinants of GTFP is investigated by employing the Fully Modified OLS estimation technique. The study provides a highly volatile trend of sectoral green factor productivity and proved non-linearity in fiscal decentralization and sectoral GTFP relationship. The role of institutional quality also appears as positively significant for GTFP. Findings support a positive relationship between fiscal decentralization and GTFP however the link weakens and turns negative when excessive decentralization is adopted and hence, shows a trajectory of rising sectoral productivity but at decreasing rate with the pace of decentralization. National Environmental Protection Act 1997 and National Conservation Strategy 2005 have appeared significantly and positively contributing with an overwhelming effect on green factor productivity for the manufacturing sector and demands strengthening of environmental policies network along with its rigorous implementation. Moreover, a dedicated though cautious move towards fiscal decentralization is required to achieve environmental sustainability in Pakistan.

Key Words: Green Factor Productivity, Fiscal Decentralization, Environment, FMOLS

[1] Department of Economics, Fatima Jinnah Women University, Rawalpindi, Pakistan. Email: Kinza_nadeem@yahoo.com
[2] Department of Economics, Fatima Jinnah Women University, Rawalpindi, Pakistan. Email: bushra.yasmin@fjwu.edu.pk
[3] Department of Economics, Fatima Jinnah Women University, Rawalpindi, Pakistan. Email: iffat@fjwu.edu.pk

JEL Codes: Q5, H7, C5

1 Introduction

Decentralization is the transmission of political, administrative, fiscal and financial responsibility from the central government to the lower tiers of government i.e., at the provincial and local government levels.[4] The transfer of fiscal autonomy to the lower tier can take place substantially in a number of ways. Like administrative decentralization not only relocates the responsibility but also impart the power of resource utilization for supplying public services to the diverse levels of government. While, fiscal decentralization refers to the transfer of revenues and expenditures to provincial and local government. The political decentralization is basically a reflection of sub-national governments' structure though which is designed to engage the sub-national political parties in election process, to improve the legislation in a vow to promote and defend the public interest (Litvack and Seddon, 1999).

Hayek (1945), who put forth the idea of fiscal decentralization, argues that it helps in providing public goods effectively and local governments are expected to perform better in terms of service delivery due to close connections with masses and the accessibility of more information at the grass root level. In this regard, 'Theory of Federalism' provides solid theoretical background for a regulatory framework under which various functions are performed at diverse administrative levels.

On the other hand, total factor productivity (TFP), a ratio of factor inputs and output, introduced by Tinbergen (1942), was developed with the neoclassical growth theory framework and provides the basic link of aggregate production function with total factor productivity. As the economic growth cannot be explained thoroughly by the input growth only, the unexplained part of GDP growth, the residual, reflects technological progress and other factors and overall defines the concept of TFP. The idea of Green Total Factor Productivity (GTFP) emerges out of this concept and helped researchers not only to widen the TFP scope but also enhanced the methodology by adding ecological environment protection in its computation. According to Song et al. (2015),

[4] Rondinelli (1981)

green productivity account for the environmental protection while measuring technical progress. In order to tackle the challenges of growing environmental degradation worldwide, researchers have brought in the role of fiscal decentralization as one of the crucial determinants in green total factor productivity literature (Li et al., 2021).

Fiscal decentralization is expected to improve the efficiency in provision of public services since local governments are closer to the general public and know the local demands and priorities better. Fiscal decentralization accompanying decentralized environmental administration leads to efficient allocation of resources and is expected to reduce environmental pollution and hence may lead to improve green factor productivity as suggested by Song et al. (2018). Moreover, Tan and Zhang (2015) and Potoski (2001) argue that fiscal decentralization empowers the local governments in environmental governance funds and control over pollutant discharge. It can lead to reduce pollution and hence improve green factor productivity. From that context, carbon dioxide (CO2) is one of the leading greenhouse gas containing almost 58% of the total greenhouse gas emissions and has serious implications for environment (Shahzad et al., 2017). Specifically, in case of Pakistan, the advancement from agriculture-driven to industrial-based economy has resulted in rising greenhouse gases emission. Though the efforts to introduce legislation specifically for environmental protection were initiated in 1977, a due weightage was given to the environmental consideration in national planning in 1990s and a number of environmental regulations and protection laws have been laid out by the successive governments to handle the issue effectively. These efforts are expected to control pollution and improve environmental quality hence may result in higher green factor productivity.

Pakistan adopted National Conservation Strategy (NCS) in 1992 which is considered a major milestone in Pakistan environmental history. The main objectives of the strategy were to conserve natural resources and sustainable development with improved efficiency in resource utilization for environmental protection of the country. NCS basically proved a crucial step in transforming public attitude and practices and also in modifying

consumption pattern. While the environment protection agencies were the hallmark towards sustainability in Pakistan in late 80s and early 90s at federal and provincial level both.5 The role of civil society, private sector and academia also played significant role in devising and implementing the strategy. This was followed by Environmental Protection Act (1997) and National Conservation Policy (2005) under National Environmental Protection Plan. The protection act was envisioned to provide protection, conservation, rehabilitation and improvement of the environment by controlling pollution to achieve sustainable development.

The National Conservation Policy was approved in 2005 to restore the efforts in meeting the objectives of sustainable development by offering an overreaching framework to address the country's environmental issues. The said policies are incorporated in empirical modelling of fiscal decentralization and sectoral green total factor productivity nexus. Apart from these policies and acts, there are several initiatives and campaigns that have being adopted for the improvement of environmental quality in recent years. Clean and Green Pakistan, Ten Billion Tree Tsunami, Recharge Pakistan, Protected Areas Initiative and Electric Vehicle Policy are a few among them. Main aim of these initiatives is to reduce the pollution and improve environmental protection in the country not only by strengthening the institutions but also by engaging general public to serve the said purpose. There is growing concern regarding green development universally and among developing countries in particular (Kwakwa et al., 2018).

As argued by Zhang et al. (2011) carbon emissions tend to increase with the decentralization which is known as 'green dilemma'. On the contrary, Song et al. (2018) and Guo et al. (2020) concluded that fiscal decentralization is a stimulating factor in improving green factor productivity. Therefore, it becomes very pertinent to examine the impact of fiscal decentralization on green TFP along with measuring it itself. This study will contribute to the existing stock of literature not only by computing sectoral green TFP but also by highlighting the

[5] Accessed from https://www.commissiemer.nl/docs/os/sea/casestudies/16_pakistan_national_conservation_strategy.pdf

contribution of fiscal decentralization in controlling environmental degradation and improving green factor productivity in Pakistan.

Under the dual constraints of environmental pollution and keeping pace with economic development, the investigation of the effect of fiscal decentralization on sectoral GTFP, controlling the role of institutional quality and other lead variables of green factor productivity will provide valuable insights. Hence, this study has dual objectives. First is to compute the sectoral green total factor productivity (SGTFP) for the manufacturing sector of Pakistan for the period 1975-2019. Secondly, the study endeavors to determine the role of fiscal decentralization and environmental regulations in affecting SGTFP along with other leading factors including institutional quality, trade openness, industrial structure and energy consumption. The main hypothesis to be tested in this study is that fiscal decentralization positively affects green factor productivity but at decreasing rate at higher percentiles.

The remaining paper is organized as follows. Second section reviews the relevant literature. Third section provides the historical perspective of fiscal decentralization in Pakistan. Section 4 discusses the methodology, while the 5th section reports and discusses the empirical findings. The final section concludes the study by providing some policy implications.

2 Literature Review

Theoretical literature provides two main strands, one is the environmental federalism theory which believes that environmental management performs better under the decentralized government. Environmental centralization theory, on the other hand, offers opposite view and argues that the environment is better taken care of under the centralized government. Overall efficient environmental management leads to reduce the pollution and improves the GTFP. According to environmental federalism theory the costs and benefits of decentralized environmental policies are internalized by the local governments they add to the social welfare. As argued by Stigler (1957), local government is in close connection with the residents as compared to central government, so it better understands their preferences and demand for public goods. Additionally, a decentralized environmental administration allocates resources

more efficiently even when there are no 'Coase Negotiations'6 and when there is heterogeneity among consumers and products as the local government has better information and is more concerned with the local area's environmental issues than the central government (Ogawa and Wildasin, 2009). Comparatively, the environmental centralization theory believes that free riders' problem can be avoided with the help of environmental centralization which can improve the efficiency of environmental governance (Song et al., 2020).

Stewart (1977) believes that central government can make the environmental policies better since it can achieve economies of scale and can also avoid the 'Tragedy of the Commons', where the individuals prefer their own well-being over that of the society as a whole. Therefore, the allocation between central and local governments should be rational in order to deal with environmental issues effectively.

The contemporary empirical literature pertaining to GTFP can be classified into two main aspects. One related to the measurement of GTFP and the other focusing on its determinants. While the major focus of the empirical research on fiscal decentralization is on computing the degree of fiscal decentralization and measuring its impact on major socio-economic variables. For instance, Adam et al. (2014) investigated the effect of fiscal decentralization on the efficiency of public sector for 21 OECD countries for the time period 1970 to 2000. Another study by Sun et al. (2017) has also proved the existence of inverted-U relationship between fiscal decentralization and economic growth in 29 provinces of China. Iqbal et al. (2010) reported a significantly positive effect of fiscal decentralization on macroeconomic stability in Pakistan. Similarly, Mangnejo and Rahpoto (2019) have empirically proved significantly positive relationship between fiscal decentralization and economic growth.

However, a very few studies are available that explore the relationship between fiscal decentralization and green TFP. In this regard, pioneering empirical work on the relationship between fiscal decentralization and GTFP is done by Song et al. (2018) who estimated the GTFP for 11 provinces of China and then

[6] Coase negotiations result in economically optimal allocation irrespective of the initial distribution given the right conditions (c.f. Song et al., 2020)

analyzed the impact of fiscal decentralization and environmental regulations on GTFP. The results of the study shows that fiscal decentralization leads to increase GTFP growth but this effect starts declining as the degree of decentralization increases hence discouraging the excessive decentralization. The authors have particularly specified the range within which fiscal decentralization can help increasing the growth rate of GTFP. The study also estimated GTFP under the dual constraints of economic growth and pollution emissions. This analysis found support in favor of environmental regulations and China's decentralization system for promoting GTFP growth.

Further extending their work, in another study Song et al. (2020) have disaggregated fiscal decentralization into revenue and expenditure decentralization and estimated their effect on GTFP and have come up with the conclusion that expenditure decentralization and fiscal expenditure competition among various areas have contributed to increase GTFP. Revenue decentralization, on the other hand, have found to be discouraging GTFP. Additionally, fiscal expenditure competition has been found to be conducive for GTFP while fiscal revenue competition has hindered GTFP improvements. The study has further investigated the effects on efficiency improvements and concluded that expenditure decentralization is conducive to efficiency based on technical progress whereas revenue decentralization has slightly negative effect on efficiency improvements. Hence this study has advocated for optimizing fiscal decentralization and promoting economic development in China.

Although, there is scarcity of empirical literature directly relating fiscal decentralization with GTFP however, there are a few studies that have investigated the impact of fiscal decentralization on some environmental variables which might have effects on GTFP. For example, Guo et al. (2020) have investigated the effect of fiscal decentralization on environmental pollution in Chinese provinces. The study also examined the role of government environmental preferences. The findings of this research shows that although fiscal decentralization does not lead to improve local environmental pollution, but this negative effect can be moderated by the environmental preference of the government. The study advocates that government should

prioritize the environmental concerns so that fiscal decentralization can be utilized to benefit economy in a sustainable manner.

Similarly, Yang et al. (2021) estimated the effect of environmental regulations on carbon emissions in 30 provinces of China during 2002-2017. The study also examined the intervening role of fiscal decentralization in environmental regulations and carbon emissions nexus. The findings show positive role of environmental regulations in reducing carbon emissions. Moreover, the fiscal decentralization tends to reduce carbon emissions in the Eastern region and vice versa for the Western region, while having insignificant effect for the central region. As far as the moderating role of fiscal decentralization is concerned, the study did not offer significant role for the country but for the western region only. Similarly, Zhang et al. (2019) computed GTFP (along with its efficiency change and technical change) for 33 countries along Belt and Road from 1995 to 2012. The authors have estimated the impact of market misallocation on GTFP and come up with the findings that the main contributor of GTFP is the technical change in Asian countries while, in European countries it is the efficiency change. Moreover, the results have also shown that market misallocations significantly reduce GTFP in the selected sample. Findings based on counterfactual measures have also shown that if market misallocation are removed then GTFP can be increased by an average of 1.24%.

The review of existing literature on the issue concerned shows that there is scarcity of empirical literature on the relationship between fiscal decentralization and GTFP. Moreover, GTFP for Pakistan has also not been computed previously. In this regard, this study aims at contributing to the existing literature by filling this gap. The study also contributes by computing the optimal level of fiscal decentralization in Pakistan that ensures its potential benefits in terms of improving SGTFP. This completes the review, now we turn to the historical overview of the phenomenon in Pakistan.

3 Fiscal Decentralization and Green Total Factor Productivity in Pakistan: Historical Overview

There are three levels of government in Pakistan; Federal, Provincial and Local. The federal government collects revenues

and distributes them in order to extend vertical and horizontal fiscal space among federation and its constituencies. The National Finance Commission (NFC) Award was enacted in earlier years to control fiscal imbalance and to manage financial resources among provinces to meet their expenditures as per Constitution of Pakistan (1973). Theoretically, the resource transmission is of two main types; systematic (formula-based) and random (non-formula-based i.e., grants etc.). Under systematic transmission, revenues are shared through NFC at the federal and local levels. While transmission from provincial finance commission takes place to the local government. Another strand is transfers from federal to local and from local to local government as well (Jaffery and Sadaqat, 2006). Random transfers, however, include, administrators discretionary and parliamentarian funds, special or development grants etc.

The government of Pakistan made consistent move towards decentralization which were initiated by the Niemeyer Award in 1947 followed by the Raisman Award in 1952, the One Unit Scheme in 1961 and 1965, and National Finance Commission (NFC) award. Later, nine NFC awards come forth, however, only a few of them contributed towards significant improvements in the distribution mechanism of revenues between the federation and the provinces.[7] The other awards largely remained insufficient due to disagreement among the stakeholders.

Initially, the population was the sole criterion for resource distribution between provinces which was in favor of province Punjab and its share in divisible pool increased from 56 to 60%. Other provinces have had their concerns over the revenue sharing so this award did not result in efficient policy management as well. Hence the 7th NFC award, in combination with the 18th amendment, was inclusive of other indicators in addition to population. These indicators also incorporate revenue generation by the provinces, poverty, and inverse population density. Subsequently, the execution of the 7th NFC award tends to improve the underdeveloped regions of KPK and Baluchistan. The resource transfer resulted in increasing the provincial shares in revenues by 18% in 1990 from 1974 due to increase in the

[7] NFC awards of 1974, 1991, and 2010 are noteworthy in this regard.

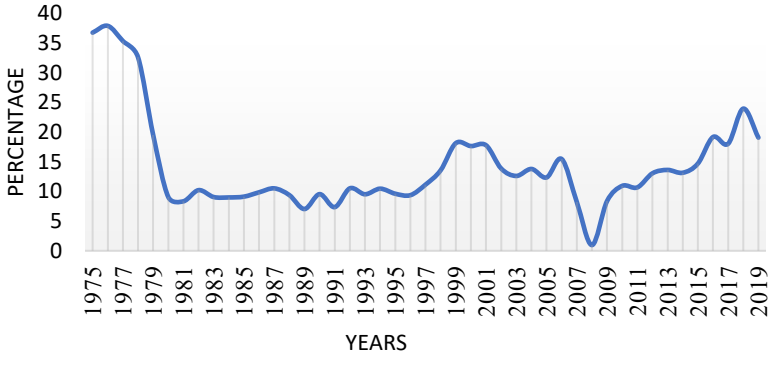
excise tax on cigarettes and sugar. This award was a major step towards fiscal decentralization which yielded more financial autonomy to the provinces.

There are however some concerns regarding the efficiency of the NFC award. Under the 18th amendment provinces' share has been fixed. It cannot be less than 57.5% of the overall divisible pool. This has made the award a little inflexible. It has created a burden on the federal government to meet the increased spending needs out of the remaining divisible pool. For improved efficiency in delivering services like debt servicing, defense, development and natural calamities (e.g., Covid-19) there is a need of joint efforts by the federal and provincial governments and a dynamic NFC formula is required (Ahmad et al., 2021). Moreover, there is a need to increase the provinces' capacity for revenues generation to reduce the dependence on the center. Additionally, in order to reap the actual benefits of fiscal decentralization and efficiency gains the center has to ease itself up by restraining from provincial matters like rural development, SSGs allocation, gender issues and social transfer programs etc. (Ahmad et al., 2007).

Figure 1 displays the trend of fiscal decentralization for the time period 1975-2019.

Figure:1

Fiscal Decentralization in Pakistan



Source: Handbook of Statistics (2020) and Various issues of Pakistan Economic Survey

The computation of fiscal decentralization is based on composite decentralization formula adopted from Martinez-Vazquez and Timofeev (2010) and is measured as: $CD = \frac{\text{RD}}{1-\text{ED}}$,

where RD stands for revenue decentralization and ED refers to expenditure decentralization.

The composite decentralization is wide ranged with a fluctuating trend of revenue and expenditures decentralization. The composite decentralization index shows a sharp drop in 1980 while from 1981 through 2006 it remained between 9% and 15%. In year 2018 it was at peak with 23 percent falling back 19 percent in the subsequent years.

4 Methodology

4.1 Theoretical Framework

The Harrod-Domar Growth Model (1939, 1946) marks the empirical investigation of economic theory enabling economic growth analysis more precise than before. Following the neoclassical growth theory of Solow (1956), the concept of Total Factor Productivity (TFP) was widely acknowledged. Solow growth model introduced the role of technology in the growth theory, based on 'Cobb-Douglas' production function under constant returns, and referred technology as the 'growth residual'. However, it can refer to any inherent factor related to output growth but invariable with respect to the changes in input. Researchers started exploring the exogenous sources of TFP growth after the recognition of Solow residual as TFP. Later, the concept was further modified by incorporating the role of technology as endogenous by Romer (1986) and Lucas (1988). They put forth the role of human capital and technology as stimulating factors for labor's and capital's efficiency. Neoclassical growth model argued that the long run growth depends on the productivity growth because the physical capital accumulation will become stable as it attains steady state (Kim, 2001).

The concept of green total factor productivity extends the meaning of TFP along with adding the other determinants including ecological environment. As high productivity offers continuous economic development, the environmental protection inclusion promises to make it sustainable in the framework. Hence, green productivity can play the role of a policy instrument for improving the overall productivity. The idea of green productivity was initiated in 1994 in the wake of Earth Summit held in 1992 which brought political leaders, scientists, media

personnel, government and non-governmental organizations from 179 countries on one platform to ponder on the challenges for environment thrusted by human socioeconomic activities. In this regard, Asian Productivity Organization (2002) presented green productivity as a way to address the challenges of sustainable growth practically.

4.2 Empirical model

The following functional form of the model is used to estimate the effect of fiscal decentralization on GTFP of manufacturing sector.

$$SGTFP_t = f(FD_t) \quad (4.2.1)$$

Where $SGTFP$ refers to Sectoral Green Total Factor Productivity and FD stands for Fiscal Decentralization. The following econometric model is formed on the basis of above functional form:

$$SGTFP_t = \alpha_0 + \alpha_1 FD_t + \alpha_2 FD_t^2 + \alpha_{3i} \sum_{i=1}^{3} D_i + \alpha_{4i} \sum_{i=1}^{4} X_{it} + \mu t \quad (4.2.2)$$

Where $SGTFP$ refers to Sectoral Green Total Factor Productivity, FD and FD^2 stand for Fiscal Decentralization and its square term, D shows three dummy variables for environmental policies and regulations while X stands for the other control variables including institutional quality (IQ), trade openness (TO), industrial structure (IS) and energy consumption (EC).

4.2.1 Calculation of Sectoral GTFP

The sectoral GTFP is computed by Growth Accounting Method (GAM), widely accepted as growth accounting framework (Jorgenson, 1963; Haskel et al., 2012; Oulton, 2012). This measures the country's capacity to produce output from a particular set of inputs while considering the negative repercussions for environment (Xia and Xu, 2020). It is expected to offer optimal efficiency with the least possible environmental pollution (Song et al., 2018).

The steps involved in calculating sectoral GTFP are as follows:

Labor income share: $$S_{L_t} = \frac{wages\ at\ year\ t}{GDP} \quad (1)$$

Average Labor Income Share: $$SA_{L_t} = \frac{1}{2}(S_{L_t} + S_{L_{t-1}}) \quad (2)$$

Where S_{L_t}refers to the share of labor in year t and $S_{L_{t-1}}$refers to the share of labor in previous year, successively.

Capital Income Share: $S_{C_t} = 1 - S_{L_t}$ (3)

Average Capital Income Share: $AS_{C_t} = \frac{1}{2}(S_{C_t} + S_{C_{t-1}})$ (4)

Where S_{C_t}refers to the capital share in year t and $S_{C_{t-1}}$refers to the share of capital in previous year, successively.

Economic Growth: $EG_t = [LnGDP_t\text{-}LnGDP_{t-1}]$ (5)

Where EG refers to economic growth, measured as the difference between current and previous GDP, taken as log. The calculation of capital stock growth is given as below:

$CG_t = (LnC_t - LnC_{t-1}) \, x \, 100$ (6)

Where LnC_tstands for log of capital stock at year t while LnC_{t-1} refers to capital stock in previous year, successively. Weighted average of Capital Stock is computed as below:

$CGA_t = \frac{1}{2} (S_{C_t} + S_{C_{t-1}}) (LnC_t - LnC_{t-1}) \, x \, 100$ (7)

Similarly, the calculation of labor growth is given as below:

Labor growth: $G_{L_t} = (LnL_t - LnL_{t-1}) \, x \, 100$ (8)

Weighted average of Labor growth: $GA_{L_t} = \frac{1}{2} (S_{L_t} + S_{L_{t-1}}) \, x \, (LnL_t + LnL_{t-1}) \, x \, 100$ (9)

The calculation of Carbon Emission (CO2) growth is given as below:

$G_{CO2_t} = (LnCO_{2_t} - LnCO_{2_{t-1}}) \, x \, 100$ (10)

The weighted average of CO2 Emission growth is calculated as:

$GA_{CO_{2_t}} = \frac{1}{2} (CO_2 IS_t + CO_2 IS_{t-1}) \, x \, (LnCO_{2_t} - LnCO_{2_{t-1}}) \, x \, 100$ (11)

Finally, the Sectoral Green Total Factor Productivity (SGTFP) is measured as below:

$S_{GTFP} = (EG_t - GA_{K_t} - GA_{L_t} - GA_{CO_{2_t}})$ (12)

Where, EG refers to Economic Growth, GA_{K_t} refers to capital stock growth, GA_{L_t}refers to labor growth and $GA_{CO_{2_t}}$refers to carbon emission growth, at time t.

4.2.2 Measurement and Justification of Variables

Literature used broadly two measures: revenue decentralization and expenditure decentralization as the measures

of fiscal decentralization. Martinez-Vazque and Timofeev (2010) suggested a composite indicator of fiscal decentralization combining the revenues and expenditures ratios and we have followed that approach to have a consolidated effect, given as.

$$FD_t = \frac{RD_t}{1 - ED_t}$$

Where, FD refers to the Fiscal Decentralization, RD stands for Revenue Decentralization which is measured as provincial government's revenues divided by total federal and provincial governments' revenues and shows the share of provincial revenues in total revenues. Similarly, ED reflects Expenditures Decentralization and is measured as the ratio of provincial government expenditures to total expenditures, excluding defense spending and debt interest payments.

Fiscal decentralization is expected to have significantly positive impact on sectoral GTFP as decentralization of revenues and expenditures at provincial level tends to improve the effectiveness of public services due to close connection with people and recognition of their priorities. Moreover, lower-tier government is expected to be in a position to manage public goods better and services according to the needs of local community. Song et al. (2018) provided a positive association between fiscal decentralization and the GTFP but the effect tends to decline at the higher quantiles.

The environmental regulations namely National Conservation Strategy (1992), NCS, Environmental Protection Act (1997), EPA, and National Conservation Policy (2005), NCP, are captured with the help of dummy variables. The dummy variable D1, is assigned value 1 for the years of introduction of NCS i.e., 1992 and onward, while 0 for the years before 1992. Similarly, for the EPA the dummy variable, D2, takes value 1 for the year 1997 and onward, while 0 for the years before 1997. And for the dummy variable D3, used for NCP, the assigned value is 1 for the year 2005 and onward, while 0 for the years earlier than 2005. The environmental protection policies and regulations are expected to yield relatively higher green factor productivity for the post regulation period as compared to the earlier time period. The 'Porter Hypothesis' states that environmental regulations can increase corporate costs in the short-run while improves corporate sector productivity in the long run due to technological

innovations. Elgin and Oztunali (2014) provided a direct inverse U-shaped relationship between environmental regulations and environmental degradation for a panel of 128 countries. While Rammer and Rexhauser (2014) came up with a weak relationship and indicated that Porter hypothesis does not hold in all industries.

Regarding other control variables, the variable of institutional quality is taken from data on Polity 4, Centre for Systematic Peace showing unified polity scale. It ranges from +10 for strongly democratic to -10 for strongly autocratic. The expected effect of institutional quality on GTFP is positive as supported by Bernauer et al. (2012) that democratic government offers high quality of institutional governance which have trickle down effects at the sub-government level as well. Primarily, due to accountability and the rights and freedom of information on the part of general public as an offshoot of better political institutions, the expected relationship is positive.

Trade openness is calculated as the sum of exports and imports as percentage of GDP. The expected effect can take either positive or negative effect depending on the country's nature of exportable and importable and attached regulations. The industrial structure is measured as industry value added taken as percentage of GDP and is expected to have negative effect as the industry is assumed to release more polluted substances and can reduce the green factor productivity. However, the positive effect may also be hypothesized keeping in view the share of manufacturing sector in country's total production which can offset the effect of pollution. Hou et al. (2020) concluded a negative impact of industrial structure on environment. Energy consumption is measured by fossil fuel energy consumption as percentage of total consumption. Energy consumption has been regarded a key determinant in environmental pollution (Ang, 2007) and is expected to affect sectoral GTFP negatively.

The data is extracted from Handbook of Statistics (2020), Yearbook of Labor Statistics, Penn World Table and World Development Indicators. The estimation is done in Eviews 9.

4.3 Estimation Technique

The empirical model is estimated by the Fully Modified Ordinary Least Square (FMOLS) estimation technique to get the long-run relationship between selected variables. The FMOLS technique, introduced by Philips and Hansen (1990), is used for

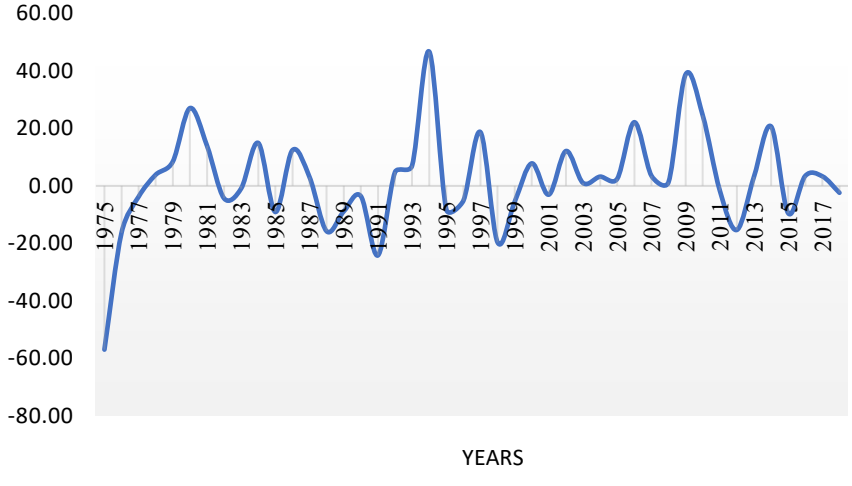
computing single co-integrating relationship which is co-integrated of order one. It produces reliable estimates for small sample and provides a valid check for endogeneity. Engle and Grange tau and z test of co-integration are used as the diagnostics tests for verifying the existence of co-integrating relationship among the variables.

5 Empirical Findings

The computed GTFP presented in Figure 2 shows a highly fluctuating trend for the given time period and has remained at margin line, the trend is gradually increasing and then decreasing showing non-linear trend. For few years the productivity growth has even remained in negative zone. According to Chaudhry (2009), average productivity of manufacturing sector increased by 2.4 percent per year from 1985 to 2005 where capital has remained major contributor. While the overall TFP has increased by 1.1 percent only in the given years where three quarter is attributed to the labor and capital. This can be attributed to environmental degradation that partially offset the spillover effects of total factor productivity.

Figure: 2

Sectoral Green Total Factor Productivity



Source: Author's own computation from GAM

Turning towards result of the empirical model, Table 1 presents the results of the unit root test applied for the stationarity check of the series.

Table: 1
ADF Unit Root Results

Variables	Level	1st Diff.	Decision
SGTFP	-2.061	-6.082	Integrated at order 1
FD	-2.785	-5.912	Integrated at order 1
FD^2	-2.847	-6.239	Integrated at order 1
IQ	-2.543	-6.218	Integrated at order 1
TO	-2.594	-6.478	Integrated at order 1
EC	-0.169	-8.057	Integrated at order 1
IS	-2.849	-7.307	Integrated at order 1

Note: The critical values are -4.180, -3.515 & -3.188 at 1%, 5%, and 10% level of significance, respectively.

The order of integration of all variables mentioned in Table 1 is one i.e., they are all I (1) at 1% level of significance, this allows to proceed with the application of Fully Modified OLS (FMOLS), results reported in Table 2. The fiscal decentralization and its square term, institutional quality and two dummies out of three for environmental regulations i.e., Environmental Protection Act, 1997 and National Conservation Policy, 2005 appeared as significant. The diagnostic tests validate the presence of long-run relationship among the variables. Normality test shows the residuals are normally distributed. The Wald test reports chi-square statistic for overall significance of the model. Tau-statistic and Z-statistic used to determine the long-run cointegrating relationship among the variables and rejects the null hypothesis of no co-integration.

We found a non-linear relationship between fiscal decentralization and sectoral GTFP from the level and squared term of fiscal decentralization. The impact of fiscal decentralization is positively significant while its square term carries negative sign which indicates the increase in green productivity of manufacturing sector at decreasing rate as a result of fiscal decentralization. This implies that a moderate level of fiscal decentralization is recommended while the excessive decentralization can discourage green productivity. The results are in line with the findings of Song et al. (2018) which proved that excessive decentralization tends to decrease the GTFP. It can result in some undesirable consequences, such as loss in economic efficiency, increased predatory intergovernmental

competitiveness, unbalancing the public revenues and expenditures and resulting in long-term deteriorated economic growth. Particularly, the unhealthy competition among various tiers of government brings in rent seeking and can deteriorates the green productivity. Hence, for the environmental sustainability of the country an adequate level of fiscal decentralization is probably the best option as also suggested by Hui and Martinez-Vazquez (2021). Yang (2016) also highlighted that an excessive devolution of resources may generate high risk of resource misallocation due to enlarging the local government size.

Table 2

FMOLS Estimates

Variables	**Coefficients**	**Standard Errors**
Dependent Variable: *Sectoral Green Total Factor Productivity*		
FD	4.602***	1.105
FD^2	-4.116***	0.970
IQ	0.031***	0.006
TO	-0.032*	0.018
EC	-0.001	0.011
IS	-0.020	0.037
D1	-0.106	0.412
D2	0.424**	0.165
D3	0.504***	0.103
Diagnostic Test Results		
R^2		0.878
Engle-Granger tau statistic		0.063
Engle-Granger z statistics		0.050
Normality test		0.265
Wald test (χ^2)		0.000

*Note: *, ** and *** represents significance at 10%, 5% and 1%, respectively. Standard errors are in parentheses.*
p-values are reported for diagnostic tests.

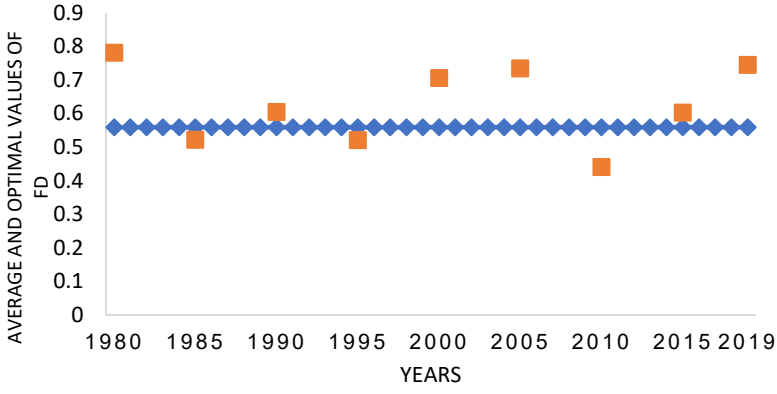
Moreover, the threshold of fiscal decentralization is also computed by the optimization principle applied on the estimated equation. The computed optimal value of fiscal decentralization yields 56 percent as optimal level of fiscal decentralization to gain its potential benefits to improve green total factor productivity of manufacturing sector. Figure 2 compares the optimal value with the five years average value of fiscal decentralization.[8] Looking at

[8] The optimal value of FD has been obtained by applying first order condition on equation 4.2.2.

the graph, it can be noticed that fiscal decentralization dropped sharply in the first 5 years of 80s, a time period of local governance system and inactive provincial government role.

Figure: 2

Optimal Level of Fiscal decentralization



Source: Author's own computations

The revenues and expenditures share of provincial government set to decline from 78 to 52 percent, which then gradually rise to 60 percent in 90s. Similarly, the average value of FD crossed the optimal value in subsequent years reaching to above 70 percent and later touched its lowest at 40 percent only. The average fiscal decentralization in Pakistan has remained around 55 percent which is a reasonable value from productivity point of view. Pakistan adopted the environmental regulation measures at faster pace as compared with other Asian countries and various measures have been taken up so far for effective implementation of the policies. The efforts to introduce legislation for environmental protection were started in 1977 while the environmental consideration became the part of national planning in 1992 and various environment regulations and protection laws emerged, hereafter. In this regard, the National Conservative Strategy (1992) proved a major milestone in that direction and contributed well to transforming public attitude and practice towards climate change. Later, the Environmental Protection Act (1997) and National Conservation Policy (2005) provided an overreaching framework and proved major steps to provide protection, conservation and rehabilitation accompanied by policy restoration for sustainable development.

Two dummies that we used for environmental regulation i.e., D2 (Environmental Protection Act, 1997) and D3 (National Conservation Policy, 2005) appeared as statistically significantly positive which shows that the green sectoral factor productivity has remained relatively high in the post-Act period of 1997 and post-policy period of 2005. The magnitude of conservation policy variable is relatively large than protection act while the conservation strategy has not significantly affected the green productivity for the given time period. The result validates 'Porter Hypothesis' and implies a long-run stimulating role of environmental regulations for better green factor productivity.

The variable institutional quality is statistically positively significant at 1% level of significance. The size of the coefficient shows that 1 unit increase in institutional quality tends to increase sectoral GTFP by 0.03 percent. The high level of institutional quality is attached with democracy and offers an improvement in environmental quality by enabling freedom of information and political rights especially when fiscal decentralization is controlled. This overall raises the public awareness about the optimal use of natural resources. The result is in line with Bernauer et al. (2012).

Trade opennes is statistically significant with a negative cofficient. As the sign was expected to be going in either direction, the justification for negative effect lies in the fact that trade opening can worsen the enviroment by increasing importable with high level of carbon emissions. In order to attract foreign investment country softens the terms and conditions and indirectly invite more polluted items in home. The term is referred as 'Pollution Heaven Hypothesis' for developing countries (Baek et al., 2009; Shahbaz et al., 2014; and Atici, 2012). Industrial structure and energy consumption appeared as insignificant in our model.

6 Conclusions

The objective of this study was to compute sectoral green factor productivity and to evaluate the impact of fiscal decentralization on green factor productivity. A non-linear model for fiscal decentralization was estimated for the manufacturing sector of Pakistan for the time period from 1975 to 2019. The model was estimated by applying Fully Modified Least Square

(FMOLS). The role of various environmental regulations affecting GTFP in the form of act and policies were also investigated along with other controlled variables.

According to empirical findings, fiscal decentralization appears to have positively significant effect on sectoral GTFP in Pakistan. While the non-linearity holds with a negative effect of square term of fiscal decentralization on GTFP. This indicates the degrading role of decentralization at higher percentiles. The environmental protection act and conservation policies have appeared significant in improving green productivity of manufacturing sector in Pakistan. The role of institutional quality also imparts positively significant effect on GTFP.

Keeping in view the findings, it is suggested to advocate moderate fiscal decentralization and rigorous and steady implementation of environment protection policies in Pakistan. The improvement in institutional quality and resource diversion for environmental preservation at sub-national level can promise a sustainable future, by improving green factor productivity in the manufacturing sector of Pakistan.

References

Adam, A., Delis, M. D. and Kammas, P. (2014). Fiscal decentralization and Public Sector Efficiency: Evidence from OECD Countries. *Economics of Governance*, *15*(1), 7-49.

Ahmad, I., Mustafa, U., & Khalid, M. (2007). National Finance Commission Awards in Pakistan: A Historical Perspective. *Pakistan Institute of Development Economics*. (PIDE Working Paper Series 33).

Ahmad, I., Iqbal N., and Khalid, M. (2021). Fiscal Federalism in Pakistan: Need for a Revisit. *Pakistan Institute of Development Economics*. (PIDE Policy Viewpoint no. 33:2021).

Ang, J. B. (2007). CO2 Emissions, Energy Consumption, and Output in France. *Energy Policy*, *35*(10): 4772-4778.

Atici, C. (2012). Carbon Emissions, Trade Liberalization, and the Japan–ASEAN Interaction: A Group-Wise Examination. *Journal of the Japanese and International Economies*, *26*(1), 167-178.

Awan, U., Kraslawski, A., Huiskonen, J. and Suleman, N. (2020). Exploring the Locus of Social Sustainability Implementation: A South Asian Perspective on Planning for Sustainable Development. In *Universities and Sustainable Communities: Meeting the Goals of the Agenda 2030* (pp. 89-105). Springer, Cham.

Baek, Jungho. and Koo, Won W. (2009). A Dynamic Approach to the FDI-Environment Nexus: The Case of China and India, *East Asian Economic Review, Korea Institute for International Economic Policy*, 13(2), 87-106.

Bashier, A. A. A. and Wahban, A. N. (2013). The Determinants of Employment in Jordan: A Time Series Analysis. *International Review of Management and Business Research, 2*(4), 927-936.

Bernauer, T., Böhmelt, T. and Koubi, V. (2012). Environmental Changes and Violent Conflict. *Environmental Research Letters*, 7(1), 015601 (8pp).

Chaudhry, A. A. (2009). Total Factor Productivity Growth in Pakistan: An Analysis of Agricultural and Manufacturing Sector, *The Lahore Journal of Economics*, *14*, 1-16.

Cheema, A.R. (2015). Pakistan: High-Rise Buildings Worsened Heatwave, *Nature, 524*(7563), 35-35.

Chen, C., Lan, Q., Gao, M. and Sun, Y. (2018). Green Total Factor Productivity Growth and Its Determinants in China's Industrial Economy. *Sustainability*, *10*(4), 1052-1076.

Corrado, C., Haskel, J., Jona-Lasinio, C. and Iommi, M. (2012). Intangible Capital and Growth in Advanced Economies: Measurement Methods and Comparative Results (No. 6733). IZA (Discussion Papers No 6733).

Domar, E. D. (1946). Capital Expansion, Rate of Growth, and Employment. *Econometrica*, 14(2), 137–147.

Elgin, C. and Oztunali, O. (2014). Institutions, Informal Economy, and Economic Development. *Emerging Markets Finance and Trade,50*(4): 145-162.

Elsadig, M.A. (2012). Green TFP Intensity Impact on Sustainable East Asian Productivity Growth. Economic Analysis & Policy, 42(1), 67-78.

Guo, S., Wen, L., Wu, Y., Yue, X. and Fan, G. (2020). Fiscal Decentralization and Local Environmental Pollution in

China. *International Journal of Environmental Research and Public Health*, *17*(22), 8661-86678.

Harrod, R. F. (1939). An Essay in Dynamic Theory. *The Economic Journal*, *49*(193), 14–33.

Hayek, F. A. (1945). The Use of Knowledge in Society. *The American Economic Review*, *35*(4), 519-530.

Hou, B., Wang, B., Du, M. and Zhang, N. (2020). Does the SO2 Emissions Trading Scheme Encourage Green Total Factor Productivity? An Empirical Assessment on China's Cities. *Environmental Science and Pollution Research*, *27*(6), 6375-6388.

Hui, J., and Martinez-Vazquez, J. (2021). Sustainable Development and the Optimal Level of Fiscal Expenditure Decentralization. *International Center for Public Policy*, Andrew Young School of Policy Studies, Georgia State University. (Working Paper 21-03)

Jaffery, N. B., and Sadaqat, M. (2006). NFC awards: Commentary and Agenda. *Pakistan Economic and Social Review*, *44*(2), 209-234.

Jorgenson, D. W. (1963). Capital Theory and Investment Behavior. *The American Economic Review*, *53*(2), 247-259.

Kim, S. (2001). International Transmission of US Monetary Policy Shocks: Evidence from VAR's. *Journal of Monetary Economics*, *48*(2), 339-372.

Krugman, P. (1994). Defining and Measuring Productivity. *The Age of Diminishing Expectations*.

Kuai, P., Yang, S., Tao, A., and Khan, Z. D. (2019). Environmental Effects of Chinese-style Fiscal Decentralization and the Sustainability Implications. *Journal of Cleaner Production*, *239*, 118089-118102.

Kwakwa, P. and Alhassan, H. and Aboagye, S. (2018). Environmental Kuznets Curve Hypothesis in a Financial Development and Natural Resource Extraction Context: Evidence from Tunisia. *Quantitative Finance and Economics*, *2*, 981-1000.

Li, X., Yu, Z., Salman, A., Ali, Q., Hafeez, M., & Aslam, M. S. (2021). The Role of Financial Development Indicators in Sustainable Development-Environmental Degradation

Nexus. *Environmental Science and Pollution Research*, *28*, 33707- 33718.

Litvack, J. I., and Seddon, J. (Eds.). (1999). *Decentralization Briefing Notes*. Washington, DC: World Bank Institute.

Lucas Jr, R. E. (1988). On the Mechanics of Economic Development. *Journal of Monetary Economics*, *22*(1): 3-42.

Maddison, A. (1991). *Dynamic of Capital Accumulation and Economic Growth*, Oxford University Press, Oxford.

Mangnejo, G. M., and Rahpoto, M. S. (2019). A Study of Linkages between Fiscal Decentralization and Macroeconomic Performance in Pakistan (2000-2015). *Global Regional Review*, *4*(4), 219-228.

Martinez-Vazquez, J. & A. Timofeev (2010). Decentralization Measures Revisited. Public Finance and Management *10*(1), 213–244.

Musgrave, R. A. (1959). *The Theory of Public Finance; A Study in Public Economy.* McGraw-Hill, New York.

Oates, W. E. (1972). Fiscal Federalism. Journal of Economic Issues, *6*(4), 225–227.

Oates, W. E. (2005). Toward a Second-Generation Theory of Fiscal Federalism. *International Tax and Public Finance*, *12*(4), 349-373.

Ogawa, H., and Wildasin, D. E. (2009). Think Locally, Act Locally: Spillovers, Spillbacks, and Efficient Decentralized Policymaking. *American Economic Review*, *99*(4),1206-17.

Oulton, N. (2012). How to Measure Living Standards and Productivity. *Review of Income and Wealth*, *58*(3), 424-456.

Perez-Sebastian F, Raveh O. (2016). The Natural Resource Curse and Fiscal Decentralization. *American Journal of Agricultural Economics*, *98*(1): 212–230.

Potoski, M. (2001). Clean air federalism: Do States Race to the Bottom? *Public Administration Review*, *61*(3), 335-343.

Qian, Y., and Weingast, B. R. (1997). Federalism as a Commitment to Reserving Market Incentives. *Journal of Economic perspectives*, *11*(4), 83-92.

Rexhäuser, S., and Rammer, C. (2014). Environmental Innovations and Firm Profitability: Unmasking the Porter

Hypothesis. *Environmental and Resource Economics*, *57*(1): 145-167.

Roll, E. (1938). A History of Economic Thought, 4th ed. Revised and Enlarged, London: Faber and Faber, 1973.

Romer, P. M. (1986). Increasing Returns and Long-Run Growth. *Journal of Political Economy*, *94*(5): 1002-1037.

Rondinelli, D. A. (1981). Government Decentralization in Comparative Perspective: Theory and Practice in Developing Countries. *International Review of Administrative Sciences*, *47*(2): 133-145.

Rubinfeld, D. L. (1987). The Economics of the Local Public Sector. *Handbook of Public Economics*, *2*, 571-645.

Shahbaz, M., Nasreen, S., Ling, C. H., and Sbia, R. (2014). Causality between Trade Openness and Energy Consumption: What Causes What in High, Middle and Low Income Countries? *Energy Policy*, *70*, 126-143.

Shahzad, S.J.H., Kumar, R.R., Zakaria, M. and Hurr, M. (2017). Carbon Emission, Energy Consumption, Trade Openness and Financial Development in Pakistan: A Revisit, *Renewable and Sustainable Energy Reviews*, *70*, 185-192.

Solow, R.M. (1956). A Contribution to the Theory of Economic Growth, *Quarterly Journal of Economics*, *70*(1): 65-94.

Song, M., Du, J., and Tan, K. H. (2018). Impact of Fiscal Decentralization on Green Total Factor Productivity. *International Journal of Production Economics*, *205*, 359-367.

Song, M., Tao, J., & Wang, S. (2015). FDI, technology spillovers and green innovation in China: analysis based on Data Envelopment Analysis. *Annals of Operations Research*, *228*(1), 47-64.

Stewart, J. D. (1977). The Green Paper on Local Government Finance-a viewpoint. *Local Government Studies*, *3*(4), 9-15.

Stigler, G. (1957). The Tenable Range of Functions of Local Government‖ in US Congress Joint Economic Committee.(ed.) Federal Expenditure Policy for Economic Growth and Stability (Government Printing Office: Washington, DC).

Sun, Z., Chang, C. P., and Hao, Y. (2017). Fiscal Decentralization and China's Provincial Economic Growth: A Panel Data

Analysis for China's Tax Sharing System. *Quality & Quantity, 51*(5): 2267-2289.

Tan, Z., & Zhang, Y. (2015). An empirical research on the relation between fiscal decentralization and environmental pollution. *China Popul Resour Environ*, *25*(4), 110-117.

Tinbergen, J. (1942). On the Theory of Long-term Economic Development. *World Economic Archives*, 511-549.

Woller, G. M., and Phillips, K. (1998). Fiscal decentralization and IDC Economic Growth: An Empirical Investigation. *The Journal of Development Studies*, *34*(4), 139-148.

Xia, F., & Xu, J. (2020). Green Total Factor Productivity: A Re-Examination of Quality of Growth for Provinces in China. *China Economic Review*, 62, 101454-101484.

Xie, F., Zhang, B., and Wang, N. (2021). Non-linear Relationship between Energy Consumption Transition and Green Total Factor Productivity: A Perspective on Different Technology Paths. *Sustainable Production and Consumption*, *28*, 91-104.

Yang, Y., Yang, X., and Tang, D. (2021). Environmental Regulations, Chinese-style Fiscal Decentralization, and Carbon Emissions: From the Perspective of Moderating Effect. *Stochastic Environmental Research and Risk Assessment*, 35, 1985-1998.

Yang, Z. (2016). Tax Reform, Fiscal Decentralization, and Regional Economic Growth: New Evidence from China. *Economic Modelling*, 59, 520-528.

Yuan, J. I. N. (2012). A Review of the Development and Application of Solow's Economic Growth Model [J]. *Modem Business*, *17*, 28-29.

Zhang, K., Wang, J., & Cui, X. (2011). Fiscal decentralization and environmental pollution: from the perspective of carbon emission. *China Ind. Econ*, *10*, 65-75.

Zhang, K., Zhang, Z. Y., and Liang, Q. M. (2017). An Empirical Analysis of the Green Paradox in China: From the Perspective of Fiscal Decentralization. *Energy Policy*, *103*, 203-211.

Zhang, Q., Yan, F., Li, K., and Ai, H. (2019). Impact of Market Misallocations on green TFP: Evidence from Countries along the Belt and Road. *Environmental Science and Pollution Research*, *26*(34), 35034-35048