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**RESEARCH ARTICLE**

# Drivers of export upgrading: Evidence from panel data for upper-middle and high income groups, low and lower-middle income groups

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**Abstract:** The objective of this study is to contribute with empirical evidence to the understanding of the determinants of export upgrading measured through two alternative indicators (export complexity level and degree of export diversification) using a cross-country panel dataset over the 1999-2013 period. For this purpose, a panel cointegration framework and two homogeneous subpanels have been considered based on the income level of the sample countries (upper-middle and high income groups, low and lower-middle income groups). Based on the Dynamic OLS (DOLS) and Fully Modified OLS (FMOLS) technique, the results indicate that export upgrading of countries is enhanced by GDP per capita, knowledge creation ( this variable is differentiated into internal knowledge(*i.e* human capital and research & development) and external knowledge (*i.e* Foreign Direct Investment and imports) and Institutional quality. The effects of these determinants vary between low, lower-middle income, upper-middle and high income country.

**Keywords:** export upgrading, determinants of export upgrading, panel cointegration, Dynamic OLS (DOLS), Fully Modified OLS (FMOLS)

## 1 Introduction

In the last several decades, the nature of international trade has been dramatic changes. One of the most important changes is the increasing interconnectedness of production processes across many countries, with each country specializing in particular stages of a good's production sequence. This phenomenon has been called 'slicing up the value chain' or 'fragmentation'. It defined as the splitting of a production process into two or more steps that can be undertaken in different locations but that lead to the same final product [1–3]. It allows countries to specialize in tasks in which they have comparative advantage (Whittaker, *et al.* 2010; Baldwin, 2011) and participate in the global supply chain. However, it is recognized that not all countries benefit from it. Not all countries are a like in terms of their integration into the global economy.

Actually, several developing countries have undertaken structural reforms that were aimed to improve economic performance through upgrading in the global value chain or moving up the value chain. This concept is defined by Pavlinek and Zenka (2011) [4], Kaplinksy (2004) [5], Humphrey and Schmitz (2002) [6], Porter (2000) [7] as the process by which economic actors nations engaging in the production of higher value-added products, employing more efficient production strategies, and increasing the skill content of activities by firms.

In recent years, small previous literature has emerged, arguing that the key factor of moving up the value chain is the export upgrading strategies. It defined by Gereffi (2005) [8] as the process by which economic actors nations, firms and workers move from low-value to relatively high-value activities in global production networks. It refers to the capacity of a firm to innovate to increase the value added of its products and processes [6, 7, 9]. The literature suggests that export upgrading can have important effects on productivity and economic growth. Countries with more "sophisticated" export bundles appear to grow faster [10, 11]. Indeed, specializing in some products will bring higher growth than specializing in others' [12]. Similar evidence is provided by Jarreau and Poncet (2012) [13] for Chinese provinces; they find that regions specializing in more sophisticated goods subsequently grow faster.

Several studies have examined the determinants of export upgrading. Therefore, it is important to analyze and understanding the main drivers of export upgrading. The literature is not

abundant in this regard. In fact, there are few studies exploring the factors that are important for understanding changes in export upgrading [15].

The objective of this study is to contribute with empirical evidence to the understanding of the factors that explain export upgrading for 55 countries over the period 1999-2013, using a panel cointegration framework based on DOLS and FMOLS technique.

This paper makes three key contributions to the debate. The first contribution is to provide new empirical evidence within a panel cointegration framework to examine the determinants of export upgrading that takes into account the order of integration of the variables; we apply the panel stationarity test developed by Im-Pesaran-Shin (2003). To estimate what are the major determinants that can contribute to export upgrading, we employed the Dynamic OLS (DOLS) and we used Fully Modified OLS (FMOLS) in order to check the robustness of results. The second contribution is splitting the sample into two different groups of countries: upper-middle and high income groups, low and lower-middle income groups) depending on the relative ranking of their income per capita. The third contribution refers to the use of two distinctive measures of export upgrading in order to check the robustness of results with respect to a variation in measurement. The first measure is the "economic complexity index" (ECI), developed by Hidalgo and Hausmann (2009). This index measures the degree of diversification and complexity of a country's export basket. A higher value of this index is associated with more sophisticated manufacturing capabilities of the country's production structure (Sweet and Maggio, 2015). The second measure is the Cadot *et al.* (2011) export diversification index (EDI); where a higher value of the index indicates lower diversification thus it could also be referred to as a measure of export specialization [16].

The remainder of the paper is organized as follows. Section 2 proposes a theoretical framework to analyze the determinants of export upgrading. Section 3 presents data, descriptive statistics, and the empirical methodology. Section 4 discusses the results and Section 5 concludes.

# 2   Literature review

What factors determining export upgrading is the key question of development economy. Several studies has been the focus of empirical investigations for many groups of countries and time periods which authors have researched to examine the factors that can influence export upgrading. In this line of thought, Amighin and Sanfilipp (2014) [17] has applied the Generalized Method of Moments (GMM) for the period between 2003 and 2010 to explain what are the determinant of African exports upgrading measured both as export diversification and increasing export unit values. According to these authors, several factors appear to have contributed positively to export diversification including the level of development of a country, as represented by per capita GDP, exchange rate, imported goods geographical remoteness, inward FDI. But others do matter for export upgrading including the share of domestic investment to GDP, natural resources, inflation rate and term of trade.

In his paper, Sandu and Ciocanel (2014) [18] examined the impact of R & D on technical upgrading. In their study, they used a panel data for 27 EU countries, during 2006-2010 and employed a linear regression estimation. According to these authors, there is a positive correlation between total R & D expenditure volume and the level of high-tech exports and the influence of private R & D expenditure on high-tech exports is stronger than public R & D expenditure.

In order to identify the different determinants of export upgrading among countries of different income levels, Zhu and Fu (2013) [15] used 171 countries classified into different groups of countries: low, medium, and high income country over the 1992–2006 period. The results suggest that the export sophistication of countries is enhanced by different factors and its effect vary between each country group. According to Zhu and Fu (2013) [15]. Institutional quality, capital–labor ratio, human capital and R & D, FDI and imports are an important determinant of export upgrading in the high income country group. In middle income country, capital–labor ratio, institutional quality, FDI and imports facilitate the export upgrading of countries. However, in the low income country group, natural resources and education have a significant positive effect on export sophistication. But, capital intensity do not appear to enhance export upgrading for this group.

Empirical evidence on the main factors of export upgrading is provided by several authors. For example, Alvarez and Bravo-Orteg (2012) [14] analyzed what are the main factors driving export upgrading. In their paper, the authors used a larger dataset for 79 countries around the world covering the period 1962-2000. Using the generalized method of moments (GMM) estimator. They found that trade openness induces higher specialization. Financial development

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does not seem to help countries to diversify their exports. In contrast, exchange rates, human capital accumulation and term of trade have positive effects and contribute positively to diversify exports.

Sharma (2003) [19] explored the factors that are important for understanding changes in export performance in India for the period 1970-1998. Simultaneous equation estimation results revealed that several factors appear to have contributed to this phenomenon. For example, export supply and the real depreciation of the rupee affect positively India's export performance. But foreign investment appears to have statistically no significant impact on export performance although its coefficient has a positive sign.

In a more recent paper, Karagöz (2016) [20] investigated the determinants of Turkey's export performance in a time series setting using the data set covering the period of 1980-2014. Results of the analysis reveal that turkey's export performance has been positively affected by the depreciation of domestic currency. Foreign direct investment and external income level turned out insignificant.

Yi, Wang and Kafouros (2013) [21] examined the determinants of export upgrading. The authors used 30 manufacturing sectors throughout all 31 china's provinces for the period of 2005-2007. Employing a baseline model and the generalized method of moments (GMM), they showed that innovative capabilities are positively associated with export performance. Institutional variables, foreign ownership and marketization have a positive effect on a firm's export performance. In contrast, government relationship and business groups are significant but produce a negative effect on export performance. So, the results explored the joint effect of innovative capabilities and institutional factors on export performance.

Using the generalized method of moments (GMM) for a sample of developing countries covering 2001-2005, Fu and Gong (2010) [22] explored the role of indigenous and foreign innovation efforts on technological upgrading. The empirical evidence suggests that foreign technology transfer may facilitate technology development. R & D activities at the industry level are found to be the major driver of technology upgrading of indigenous firms that push out the technology frontier. While foreign investment appears to contribute to static industry capabilities. While, R & D activities of foreign-invested firms have exerted a significant negative effect on the technical change of local firms over the sample period.

Makhlouf, Kellard and Vinogradov (2015) [16], emphasized the importance of trade openness for export diversification. They applied ordinary least squares method for a sample of 116 countries over 35 years (1970 to 2005). The result indicated that openness can be positively associated with export diversification. Using ordinary least squares and a sample of 68 manufacturing firm from 1998 to 2009, Qiu, Ortolano and Wang (2013) argued that technology acquisition, domestic R & D and government policies have a significant impact on technology upgrading.

In other study, Felipe, Kumar, Abdon and Bacate (2012) applied the method of reflections and used a sample for 124 countries from 2001-2007. They demonstrated that export shares of products of different complexity (in the country's total exports) vary with income per capita: the major exporters of the more complex products are the high-income countries, while the major exporters of the less complex products are the low-income countries.

With a sample of 96 Nigerian manufacturing firm for the year 2005, Adeoti (2012) utilized a logit regression framework and demonstrated that technology investment and firm size have a strong positive relationship with export potential. In other study, Noureen and Mahmood (2014) applied the fully modified ordinary least squares co-integration for a sample of ASEAN and SAARC member countries for the time period 1986 to 2012. They argued that foreign direct investment, domestic investment, competitiveness, financial sector development and institutional strength are significantly and positively related to export diversification in both the regions.

In a series of recent papers, the link between a country's FDI flows and its ability to upgrade its export structure has long been analyzed by the international trade literature [19,23–25]. The idea that, FDI has an important role in promoting export upgrading is emphasized by a large amount of research. This assumption is explored by Kemeny (2010). In a multi-country study, the author employed the generalized method of moments (GMM) to examine the relationship between inward foreign direct investment and technological upgrading for a panel dataset covering 142 countries (splitting the sample into different groups of countries: low and lower-middle, medium, and high income countries) over the period 1972-2001. The result found that FDI is positively associated with technological upgrading. However, It impact depends on an economy's level of development and social capability. For lower-income countries, upper-middle- and high-income the effect of FDI on technological upgrading is considerably stronger among those endowed with higher levels of social capability. In low- and lower- middle-income countries, industrial upgrading is affected by other factors for example well- educated workforce, infrastructure, greater trust, and effective economic, social and political institutions.

# 3 Model specification and data

## 3.1 Model

In this study, we examine the major determinants that can affect export upgrading and know does the importance of these determinants vary among countries. We applied the Dynamic ordinary least squares co-integration (DOLS) and fully modified ordinary least squares co-integration (FMOLS) for robustness check purposes.

Specifically, we consider the following linear heterogeneous panel regression models:

$$EXPU_{it} = \alpha_0 + \gamma_i + \theta_i + \beta_1(Y_{it}) + \beta_2(HC_{it}) + \beta_3(FDI_{it}) + \beta_4(RD_{it}) + \beta_5(M_{it}) + \beta_6(I_{it}) + \varepsilon_{it} \quad (1)$$

Where = 1, . . . , denotes a country index and = 1, . . . , denotes the time period. *EXPU* is the export upgrading indicator, measured by the Cadot *et al.* (2011) export diversification index (EDI) and the economic complexity index (ECI) developed by Hidalgo and Hausmann (2009). *Y* is the level of a country's economic growth, measured by the natural logarithm of the real GDP per capita in constant 2005 US dollars. Control variables including, in line with Zhu and Lu (2013) are classified on knowledge creation via Research and development expenditure % of GDP (RD) and human capital measured by the share of population enrolled in secondary schooling (HC) and knowledge transfer via FDI (the Foreign direct investment inflows over GDP (FDI) and the imports of goods and services to GDP). The variable I is institutional quality, proxied by the "rule of law index" is a country-specific intercept, is a time dummy, and is the composite error term.

## 3.2 Data sources and descriptive statistics

We use data for a panel of 55 countries over the period 1999-2013 (When we use export diversification index as the export upgrading indicator, the sample period is limited to 1984-2010, since export diversification data from IMF is not available for the more recent period.). Countries are split into two sub-panels based on the World Bank's income classification: upper-middle and high income groups (39), low and lower-middle income groups (16) (See Table 1 for a full list of the countries included in the sample). Data on per capita GDP, Research and development expenditure % of GDP, the imports of goods and services to GDP, school enrolment, and foreign direct investment inflows as a percentage of GDP come from the World Bank's World Development Indicators database. The economic complexity index is from the MIT's Observatory of Economic Complexity. The export specialization index comes from the International Monetary Fund online database (Aavailable at https://www.imf.org/external/np/res/dfidimf/diversification.htm) and rule of law index is from Descriptive statistics and correlation matrixes between variables are summarized in Tables A3 and A4.

## 3.3 Econometric methodology

The main objective of this paper is to investigate factors that explain export upgrading by applying panel cointegration. The testing procedure involves the following steps: we examine the existence of unit root using the first generation panel unit root test Im-Pesaran-Shin (IPS, 2003). Second we used the panel cointegration test proposed by Pedroni (1999). Once it is established that the panel is subject to a significant long cointegration relationship we employed Dynamic Ordinary Least Squares co-integration (DOLS) and fully modified ordinary least squares co-integration (FMOLS) for robustness check purposes.

# 4 Empirical results

## 4.1 Panel unit root tests

In order to verify that all of the variables are integrated to the same order, we should employ the first generation panel unit root tests of Im-Pesaran-Shin which is denoted IPS (2003). The null hypothesis is that the series contains a unit root. The IPS statistic is based on average of individual Cross-Sectional ADF (CADF) statistics and can be written as follow:

Table 2 mentions the result of unit root tests. It shows that the null hypothesis of the unit roots for the panel is rejected. These results strongly indicate that the variables are non- stationary in the intercept form and stationary when we include time trend at the 1% significance level for high and low-income sub-panels as well as for the whole panel block. Therefore, this implies that all variables are integrated of order one, *i.e.* I (1).

**Table 1**   Summary statistics

|  | Mean | Std Dev | Min | Max | -1 | -2 | -3 | -4 | -5 | -6 | -7 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| All countries |  |  |  |  |  |  |  |  |  |  |  |
| LGDP | 0.6161 | 0 .8283 | -1.694 | 23.888 | 10.000 |  |  |  |  |  |  |
| ECI | 93.839 | 10.970 | 69.549 | 111.432 | 0.9887 | 10.000 |  |  |  |  |  |
| FDI | 44.887 | 69.047 | -92.012 | 880.963 | 0.1221 | 0.1522 | 10.000 |  |  |  |  |
| M | 381.281 | 180.635 | 83.972 | 100.597 | 0.1135 | 0.0019 | 0.3991 | 10.000 |  |  |  |
| HC | 94.335 | 233.077 | 134.844 | 165.581 | 0.2609 | 0.5554 | 0.1214 | 0.0612 | 10.000 |  |  |
| RD | 12.297 | 10.858 | 0.0307 | 44.074 | 0.7204 | 7304 | 0.0253 | -0.1008 | 0.3920 | 10.000 |  |
| I | 0 .6879 | 0.9266 | -17.425 | 20.026 | 0.6077 | 0.8749 | 0.1531 | 0.1173 | 0.5399 | 0.0450 | 10.000 |
| Upper-middle and high –income groups |  |  |  |  |  |  |  |  |  |  |  |
| LGDP | 0.0358 | 15.007 | -93.316 | 248.651 | 10.000 |  |  |  |  |  |  |
| ECI | 0.0025 | 0.0037 | -0.0099 | 0.0168 | 0.0699 | 10.000 |  |  |  |  |  |
| FDI | 11.586 | 22.877 | -31.566 | 543.822 | -0.0037 | -0.0439 | 10.000 |  |  |  |  |
| M | 0.0159 | 0.0887 | -0.2953 | 0.3251 | 0.0565 | 0.2224 | -0.0160 | 10.000 |  |  |  |
| HC | 0.0103 | 0.6200 | -0.8398 | 0.5437 | 0.0437 | 0.0064 | -0.0163 | 0.0251 | 10.000 |  |  |
| RD | 0.0321 | 0.2238 | 0.9562 | 23.596 | -0.0288 | -0.0961 | 0.0014 | 0.0041 | -0.0557 | 10.000 |  |
| I | 0.6800 | 19.558 | -68.881 | 44.999 | 0.0012 | 0.0768 | -0.0044 | -0.0438 | 0.1164 | -0.0917 | 10.000 |
| Low and lower-middle –income groups |  |  |  |  |  |  |  |  |  |  |  |
| LGDP | 0.6066 | 0.4802 | -18.460 | 0.3542 | 1.000 |  |  |  |  |  |  |
| ECI | 66.862 | 0.6916 | 54.639 | 78.236 | 0.5627 | 10.000 |  |  |  |  |  |
| FDI | 40.820 | 60.740 | -24.988 | 45.289 | -0.3104 | -0.1258 | 10.000 |  |  |  |  |
| M | 362.062 | 131.920 | 130.542 | 84.006 | -0.1069 | 0.1167 | 0.5158 | 10.000 |  |  |  |
| HC | 518.652 | 273.030 | 51.648 | 99.338 | 0.4361 | 0.7044 | -0.0342 | 0.2701 | 10.000 |  |  |
| RD | 0.2691 | 0.2142 | -0.1166 | 0.8410 | 0.3203 | 0.0235 | -0.0306 | 0.2415 | 0.0297 | 10.000 |  |
| I | 0.6164 | 42.353 | -11.749 | 171.482 | -0.4178 | -0.3770 | -0.0826 | -0.1047 | -0.1047 | -0.1460 | 10.000 |

**Table 2**   Im-Pesaran-Shin IPS (2003) panel unit root test results

|  | Intercept only | | Intercept and trend | |
|---|---|---|---|---|
|  | Statistic | p-value | Statistic | p-value |
| All countries |  |  |  |  |
| ECI | -5.594*** | 0.0000 | -5.594*** | 0.0000 |
| EDI | -10.790*** | 0.0000 | -11.499*** | 0.0000 |
| LPIB | 2.526 | 0.9940 | 0.71769*** | 0.0570 |
| FDI | -7.050*** | 0.0000 | -8.874*** | 0.0000 |
| M | -2.960*** | 0.0015 | -7.007**** | 0.0000 |
| HC | 1.749 | 0.5994 | -0.835*** | 0.2010 |
| RD | 1.618 | 0.9117 | -4.434*** | 0.0000 |
| I | -2.419*** | 0.0078 | -5.375*** | 0.0000 |
|  |  |  |  |  |
| High income countries |  |  |  |  |
| ECI | -11.837*** | 0.0000 | -12.503*** | 0.0000 |
| EDI | -1.944*** | 0.0025 | -6.0060*** | 0.0025 |
| LPIB | -7.470*** | 0.0000 | -8.8430*** | 0.0000 |
| FDI | -10.396*** | 0.0000 | -10.572*** | 0.0000 |
| M | -11.666*** | 0.0000 | -11.861*** | 0.0000 |
| HC | -7.1240*** | 0.0000 | -7.337*** | 0.0000 |
| RD | -10.563*** | 0.0000 | -11.288*** | 0.0000 |
| I | -11.793*** | 0.0000 | -11.923*** | 0.0000 |
|  |  |  |  |  |
| Low income countries |  |  |  |  |
| ECI | -3.103*** | 0.0010 | -4.742*** | 0.0000 |
| EDI | -0.5446 | 0.2930 | -2.402*** | 0.0081 |
| LPIB | 90.3600 | 1.0000 | -1.667* | 0.0440 |
| FDI | -1.9120** | 0.0270 | -2.643*** | 0.0041 |
| M | 0.8400 | 0.7990 | -2.760*** | 0.0029 |
| HC | -0.2540 | 0.3991 | -2.414*** | 0.0007 |
| RD | -3.2790*** | 0.0005 | -4.841*** | 0.0000 |
| I | 1.7420 | 0.959 | -3.182*** | 0.0070 |

Note: The null hypothesis is that the variables are not cointegrated; ** $p < 0.05$

## 4.2  Panel cointegration test

We apply the panel cointegration tests proposed by Pedroni (1999). The null hypothesis of this test is no cointegration. Table 3 describes the results of Pedroni's cointegration test. It indicates that for full sample and subgroups of countries most statistics are statistically significant (Panel pp-stat, Paneladf-stat, Group pp-stat and Group adfstat). It shows that the null hypothesis of no cointegration can be rejected at the 5% significance level. Therefore, they accept the alternative hypothesis of presence of cointegration.

**Table 3**  Pedronipanel cointegration test results

|  | All countries | | High and high-middle income group | | Low and low-middle income group | |
| --- | --- | --- | --- | --- | --- | --- |
|  | Test stat | prob | Test stat | prob | Test stat | prob |
| Export complexity | | | | | | |
| Panel v-stat | -5.7606 | 1.000 | -5.0443 | 1.0000 | -2.9212 | 0.9983 |
| Panel rho-stat | 7.5215 | 1.000 | 5.6883 | 1.0000 | 2.1769 | 0.9853 |
| Panel pp-stat | -10.6032*** | 0.000 | -5.5863*** | 0.0000 | -7.2262*** | 0.0000 |
| Paneladf-stat | -2.9530*** | 0.0018 | -5.4940*** | 0.0000 | -1.5954* | 0.0556 |
| Group rho-sta | 10.1121 | 1.000 | 7.9395 | 1.0000 | 4.4582 | 1.0000 |
| Group pp-stat | -16.8653*** | 0.000 | 8.3814*** | 0.0000 | -11.2037*** | 0.0000 |
| Group adf stat | -1.4273* | 0.0767 | -3.4500*** | 0.0000 | -3.0212*** | 0.0013 |
|  | | | | | | |
| Export diversification | | | | | | |
| Panel v-stat | -7.3360 | 1.000 | -4.7159 | 1.0000 | -3.1473 | 0.9992 |
| Panel rho-stat | 6.5740 | 1.000 | 6.8691 | 1.0000 | 4.1702 | 1.0000 |
| Panel pp-stat | -12.9353*** | 0.000 | -11.8363*** | 0.0000 | -10.5282*** | 0.0000 |
| Panel adf-stat | -2.1138** | 0.017 | -5.1856*** | 0.0000 | -5.0517*** | 0.0000 |
| Group rho-sta | 9.7161 | 1.000 | 9.3256 | 1.0000 | 6.0653 | 1.0000 |
| Group pp-stat | -17.4917*** | 0.000 | -18.8696*** | 0.0000 | -14.2542*** | 0.0000 |
| Group adf stat | -1.7351** | 0.0414 | -6.4665*** | 0.0000 | -4.8610**** | 0.0000 |

Note: The null hypothesis is that the variables are not cointegrated; ** $p < 0.05$

## 4.3  Panel cointegration regressions

Several estimation methods have been proposed in the literature to estimate what factors can contribute to industrial upgrading, like the Generalized Method of Moments (GMM), linear regression estimation, ordinary least squares. We used panel cointegration framework. Specifically, we employed the Dynamic ordinary least squares co-integration (DOLS) and fully modified ordinary least squares co-integration (FMOLS) estimators us an appropriate econometric method that can test the major determinants of export upgrading.

Our results are reported under two sub-sections: (a) results for the whole dataset and (b) results when the dataset is split into income level sub-groups. The income level sub- groups were created in order to investigate whether relationships are particularly strong or weak for countries with different levels of income. We ran separate regressions excluding and including variable institutional quality (model 1 and model 2). We also carried out further robustness checks in which we examined whether the general results are robust when the method of measuring key variables is changed.

**(1) Empirical analysis of all countries**

Empirical results are represented in Table 4 using two indicators of export upgrading, ECI and EDI, respectively. The main results using export complexity are reported in Panel A of Table 4. The DOLS results (model 1) indicate that GDP per capita has a positive and significant effect on export complexity at the 5% level. Our results confirm that there is a positive relation between the dgree of complexity and the level of development of a country, as represented by the significant positive coefficient of per capita GDP. This result is consistent with some recent empirical studies [14] (Tadesse and Shukralla, 2013) and confirms that countries at an early stage of development have larger opportunities to diversify.

Similarly, we find a positive and significant impact of research and developpement on export complexity but humain capital has no significant effect. According to this result human capital accumulation tends to reduce export complexity. Also we find that importing from other developing countries has a positive and significant impact on export complexity. This implies that trade impact positively export upgra ding measuring by export complexity. The share of domestic investment to GDP has a negative and significant impact on export diversification, which can be interpreted as a signal of efficient allocation of resources within the economy.

The estimated coefficients of institutional quality as proxied by the rule of law are negative and statistically significant.

The panel DOLS results for model 2 suggested that expect for FDI, all other variable exerted a significant positive effect on industrial upgrading. The estimated results using the FMOLS method are broadly consistent with the estimates from the panel DOLS with the exception that the coefficients of variables FDI and I become positive and insignificant. As regards the impact of our variables of interest on export upgrading, we find GDP per capita has the strongest impact on export complexity using DOLS and FMOLS methods.

Panel B of Table 4 reports the estimations for export diversification index as a second proxy for export upgrading, The result are broadly similar to the ones presented using export complexity index but we find that GDP per capita has a statistically insignificant positive effect on export specialization. Regarding the control variables, we find a positive relation between the degree of diversification and Knowledge creation activities, as represented by the significant positive coefficient of research and developpement but humain capital has negative and statistically significant effect. FDI and imports also demonstrate a significant negative effect on the export complexity index. Institutional quality also shows a significant negative effect on export complexity.

When we excluding quality institution (model 2), we find that the level of development of a country continue to contribute positively on the degree of diversification as represented by the significant positivecoefficient of per capita GDP (FMOLS).

**Table 4**  DOLS and FMOLS estimate sresults

| | Panel A: ECI as an export upgrading indicator | | | | Panel B: EDI as an export upgrading indicator | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | DOLS | | FMOLS | | DOLS | | FMOLS | |
| | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 |
| LGDP | 0.3107** | 0.2370*** | 0.1245*** | -0.1422 | 0.1236 | -0.3383 | -0.2693 | 0.5481*** |
| | (0.035) | (0.006) | (0.003) | (0.172) | (0.2674) | (0.617) | (0.418) | (0.000) |
| FDI | -0.0081** | -0.0102*** | 0.0048 | 0.0155*** | -0.0035 | -0.0362 | -0.0164 | -0.0026 |
| | (0.012) | (0.000) | (0.3364) | (0.0017) | (0.1474) | (0.017) | (0.027) | (0.497) |
| CH | -0.0008 | 0.0009 | -0.0066** | 0.2865*** | -0.0031* | 0.0016 | 0.0010 | -0.0058 |
| | (0.655) | (0.386) | (0.0327) | (0.007) | (0.0594) | (0.877) | (0.836) | (0.967) |
| RD | 0.4685*** | 0.4453*** | 0.3373*** | 0.3512*** | 0.0397 | 0.0214 | 0.1180 | -0.0525 |
| | (0.000) | (0.000) | (0.001) | (0.0038)*** | (0.6546) | (0.968) | (0.653) | (0.692) |
| M | 0.0113*** | 0.0090*** | -0.0012 | -0.0054*** | -0.0040*** | 0.0179 | 0.0094 | -0.0037* |
| | (0.000) | (0.000) | (0.3854) | (0.0032) | (0.0876) | (0.298) | (0.175) | (0.0637) |
| I | -0 .0863 | | 0.0172 | | -0.2570*** | | -0.4367* | |
| | (0.4747) | | (0.6968) | | (0.000) | | (0.069) | |

Note: ***, ** and * denote significance levels at the 1%, 5%, and 10%, respectivel

### (2) Empirical analysis of sub-groups by income level

In order to identify the different impacts of determinants on export upgrading among countries of different income levels, we classify all sample countries into two sub-samples: a high and middle income group (HM: including the upper-middle and high income groups) and a low and middle income group (LM: including low and lower-middle income groups). Details of the country classification and a list of countries in each category are given in Table 5.

Table 6 reports the estimated results for these country groups. For the HM income country group, the estimated coefficient of GDP per capita is positive and statistically significant. This finding, which is consistent with those Felipe, Kumar, Abdon and Bacate (2012) implies that countries that export shares of products of different complexity (in the country's total exports) vary with income per capita: the major exporters of the more complex products are the high-income countries. This variable has a positive but insignificant coefficient in LM countries. This imply that for these countries the GDP per capitat is not a significant determinant of their export upgrading. Human capital appears to play a positive role in upgrading the export complexiy in the LM income group. However, the effect of R & D is not statistically significant in these countries. On the contrary, R & D plays a statistically significant role in the upgrading of export sophistication in high income countries but higher education has a negative and significant effect on industrial upgrading in these countries. This result may be surprising in light of the importance attached to human capital for the level of export complexity. This evidence is in ligne with those of Zhu and Fu (2013) [15], who find that higher education does not show any significant effect on export sophistication level. The estimated coefficient of FDI is negative and statistically significant in both the LM and the HM countries. The result suggesting that for this countries, FDI exerted a significant negative effect on industrial upgrading. However,

**Table 5**  Sample countries and groups by income

| Low income economies | Lower middle Income economies | Upper Middle income economies | High income economies |
|---|---|---|---|
| Congo, Dem, Rep | Bolivia | Algeria | Australia |
| Madagascar | Cameroon | Bulgaria | Austria |
| Mozambique | Egypt | China | Belgium |
| Tanzania | Ecuador | Colombia | Canada |
| Uganda | Guatemala | Costa Rica | Chile |
| | Mangolia | Malaysia | Finland |
| | Marroco | Mauritus | France |
| | Pakistan | Mexico | Greece |
| | Paraguay | Panama | Irland |
| | Peru | Romania | Israel |
| | Philippines | South Africa | Italy |
| | Sri Lanka | Thailand | Japon |
| | Zambia | Tunisia | Netherlunds |
| | | Turkey | New Zealand |
| | | | Norway |
| | | | Poland |
| | | | Spain |
| | | | Sweden |
| | | | Trinidad and Tobag |
| | | | United States |
| | | | Uruguay |

Imports have a robust and statistically significant effect in the HM countries yet not in the LM country group. This suggests that imports are important drivers of export upgrading in high income countries. The result indicates a negative relationship between institutional quality and export upgrading in both HM and LM countries. This result is interesting and contrary to the normal expectation, it shows that countries with higher scores for "rule of law" and "political stability" appear to have achieved lower levels of export upgrading If we excluding quality institutional (model 2), the results can be summaries as flow. GDP per capital continue to contribute positively to export upgrading both for HM and LM countries croup. It is the key determinant of industrial upgrading. Knowledge creation activities such as human capital and R & D investment show a consistent and robust positive impact on export upgrading for LM and HM. Specially, Humain capital has a positive and significant impact on industrial upgrading for HM countries. In contrast international knowledge such as FDI and imports exerted a negative and significant effect on industrial upgrading for low income countries.

If we consider the export diversification index as a proxy for export upgrading, the results in Panel B of Table 6 show that for the high-income panels are broadly similar to the ones presented using export complexity index and point to a positive and significant relationship between economic growth and export upgrading. This finding suggests for the HM, export diversification significantly depends on its GDP per capita. This finding suggests a positive relation between the degree of diversification and the level of development of a country, as represented by the significant positive coefficient of per capita GDP. This result is consistent with some recent empirical studies [14]. The DOLS results show that, unlike the HM, GDP per capita has a negative effect on export diversification. The coefficient estimate implies that a 1% increase in GDP per capita reduces export diversification by around 0.610. Most of the explanatory variables have a positive signs. Knowledge creation activities such as human capital and R & D seem to favour export upgrading in HM and LM. As regards variables related to external knowledge such as FDI and imports also demonstrate a positive effect on the export diversification index in high income countries. Finally, we do not find any significant effect of institutional quality proxied by the rule of law index on export diversification in high income countries. However, this variable has a negative and significant effect in low income countries suggesting that countries with lower scores for "rule of law" and "political stability" can't achieve higher levels of export diversification .Excluding This variable (model 2) the results, showing similar determinants of export diversification as those observed in model 1. An interesting exception is the import coefficient, which affect negatively and significantly export diversification. For the low- income-countries panel, an interesting result is represented by the impact of the per capita GDP which suggests that this variable has a negative impact on export diversification. This result implies that GDP per capita does not seem to help low income countries to diversify their exports.

**Table 6**  DOLS estimates results upper-middle and high income groups, low and lower-middle income groups

| | Panel A: ECI as an export upgrading indicator | | | | Panel B: EDI as an export upgrading indicator | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | High and high-middle income group | | Low and low-middle income group | | High and high-middle income group | | Low and low-middle income group | |
| | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 |
| LGDP | 0.6651*** (0.000) | 11.558 (0.721) | 0.1265 (0.708) | 0.3050 (0.370) | 0.0535** (0.030) | 0.7727** (0.028) | -0.6109 (0.335) | -0.7478*** (0.360) |
| FDI | -0.0119*** (0.000) | -0.0104*** (0.000) | -0.0162 (0.056) | -0.118 (0.160) | 0.0080 (0.155) | 0.0115 (0.047) | 0.0553*** (0.004) | -0.0073 (0.768) |
| CH | -0.0065*** (0.000) | 9.8110*** (0.000) | 0.0076 (0.284) | 0.0029 (0.670) | 0.0027 (0.484) | 0.0019 (0.702) | 0.0047* (0.080) | 0.0041 (0.783) |
| RD | 0.3938*** (0.000) | 0.2302 (0.627) | 0.5426 (0.162) | 0.7945 (0.041)** | 0.1257 (0.538) | 0.1571 (0.550) | 0.3257 (0.631) | -0.6725 (0.439) |
| M | 0.0126*** (0.000) | 2.8579** (0.017) | -0.0105 (0.066) | -0.0112*** (0.049) | 0.0010 (0.573) | -0.0005 (0.298) | 0.0483*** (0.000) | 0.0617*** (0.000) |
| I | -0.2330** (0.021) | | -0.0359 (0.035) | | 0.0866 (0.681) | | -1.1085*** (0.003) | |

Note: ***, ** and * denote significance levels at the 1%, 5%, and 10%, respectivel

## 4.4   Robustness checks

To check the robustness of our results we estimate our model using fully modified ordinary least square (FMOLS). Table 7 reports estimations the Results of fully modified ordinary least square (FMOLS) method. These results present some similarities with those obtained with DOLS method. Both for complexity and diversification, GDP per capita shows a significantly positive coefficient for high and low income countries. The impact of inward FDI, import and humain capital continue to have a positive impact, and the accumulation of human capital is more favourable to diversification. This conclusion implies that countries with higher education can take advantage to develop new export. There appears to be an inverse relationship between institutional quality and export upgrading. In the case of the high-income countries panel, institutional quality to affect both export complexity and diversification upgrading negatively but for low income countries, it has a positive but not significant effect on export upgrading measuring by export complexity and export diversification.

**Table 7**  FMOLS estimates results upper-middle and high income groups, low and lower-middle income groups

| | Panel A: ECI as an export upgrading indicator | | | | Panel B: EDI as an export upgrading indicator | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | High and high-middle income group | | Low and low-middle income group | | High and high-middle income group | | Low and low-middle income group | |
| | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 |
| LGDP | 0.1980*** (0.0041) | 34.858*** (0.000) | 0.3884** (0.017) | 0.3820** (0.019) | 0.6597*** (0.000) | 0.2713*** (0.000) | -0.4414 (0.1251) | 0.4850 (0.1010) |
| FDI | 0.0001 (0.504) | 0.036 (0.549) | -0.012*** (0.003) | -0.0029 (0.416) | 0.0074 (0.1064) | -0.1801*** (0.000) | -0.0150 (0.1229) | -0.0147 (0.140) |
| CH | 0.0029*** (0.0014) | 0.7521*** (0.000) | -0.0022 (0.530) | -0.0029*** (0.002) | -0.0027 (0.352) | -0.0310 (0.398) | -0.0214*** (0.000) | 0.0201*** (0.001) |
| RD | -0.1343** (0.013) | -0.2399*** (0.000) | 0.5234*** (0.008) | 0.5324*** (0.007) | 0.0665 (0.993) | -0.1658*** (0.000) | -0.0186 (0.944) | -0.1197 (0.662) |
| M | 0.0003 (0843) | 0.6870*** (0.000) | 0.0037 (0.136) | 0.0041 (0.118) | -0.0061 (0.0138) | -0.0454*** (0.0014) | 0.0001 (0.9660) | -0.0001 (0.976) |
| I | -0.0336 (0.563) | | 0.1372 (0.210) | | -0.0255 (0.681) | | -0.3832** (0.0206) | |

Note: ***, ** and * denote significance levels at the 1%, 5%, and 10%, respectivel

# 5   Conclusions

Using a large dataset of countries during the period between 1999-2013, this study analyses the role of several potential determinants of export upgrading. We explore the role of several factors, and we use two alternative indicators of export upgrading. (Export complexity level and degree of export diversification.)

In order to identify the different impacts of determinants on export sophistication among countries of different income levels, we used 55 countries splitting into two sub-samples: a high

and middle income group (including the upper-middle and high income groups) and a low and middle income group (including low and lower-middle income groups). For this purpose, a panel cointegration framework has been employed using DOLS and FMOLS methods.

The results of panel unit root tests suggest that all the variables are integrated to the same order I (1). Besides, the cointegration tests yield evidence of a long-run relationship between and export upgrading (proxied by export complexity index or by export diversification index) and economic growth, FDI, human capital, research and developpement, imports and quality institution.

Our results indicate that GDP per capita has a positive and significant effect on export upgrading for the full-sample and high-income panels, while this effect is negative and significant for low-income countries. Also, we conclude that economic growth continues to affect export complexity the major exporters of the more complex products are the high- income countries., with a larger magnitude than that found in the full-sample model. More precisely, the long-run coefficient of the export complexity index in high-income-countries panel (0.665) is found to be approximately two times larger than the full-sample panel coefficient (0.337). This may suggest a stronger long-run relationship between export complexity and growth in high income countries than in middle- and low-income countries.

We look at the effect of institutional quality, we find that contrary the normal perspective on the role of institutional quality, this variable do matter for export upgrading in high income countries. However, its effect differs in countries with different income levels. Interestingly, low income countries with lower scores in "rule of law" and "political stability" have achieved a higher level of export upgrading.

As regards the internal knowledge creation (human capital and R & D) serve as important sources of indigenous knowledge creation, contributing directly to the export upgrading of countries. The effect of humain capital is significant in the low income country group while the effect of R & D is significant for high income countries. However external knowledge transfer (FDI) and imports were found to have positive impacts on the export upgrading of countries. The effect of FDI is positive but not significant across different country groups. The effect of imports is more robust and significant for low income countries. Our main results suggest the importance of external knowledge in the improvement of the export upgrading of countries.

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RESEARCH ARTICLE

# Managerial capabilities and firms' sustainable performance: Evidence from Chinese manufacturing small and medium-sized enterprises

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**Abstract:** This research seeks to address small and medium-sized enterprises (SMEs)' performance problems by linking dynamic managerial capabilities to firm performance. In today's dynamic market environment, it is vitally important for managers/owners of SMEs to possess dynamic capabilities. This study limited its focus to three managerial capabilities namely networking, sensing, and innovation with the moderating role of market dynamism. The data collection process and analysis provided findings that revealed that Chinese SME owners effectively employ managerial capabilities in managing their firms. The hypotheses tests resulted in significant positive relationship between the main variables and performance. The moderating variable, however, had a significant effect only on moderating the relationship between sensing capabilities and performance. The findings from this study suggest that SMEs need to improve their knowledge and application of managerial capabilities in transforming their business performance thereby contributing to the national economy. This study contributes to the dynamic capabilities' literature by adding to the existing research on the subject. It also provides an understanding of how dynamic capabilities are deployed to build up a solid and sustainable firm performance that resists the waves of market upheavals and it is expected to greatly benefit theory, policy and practice.

**Keywords:** dynamic capabilities, firm performance, small and medium enterprises, PLS-SEM

## 1 Introduction

Small and medium-sized enterprises (SMEs) have been the focus of research of academicians, practitioners and policy makers in recent decades. Studies have confirmed that these firms constitute the back bone of an economy. The contribution they make, particularly, towards employment is unparalleled. Moreover, SMEs are known for their support to the economy in terms of GDP output. Governments, in general, provide various forms of assistance to SMEs as these institutions are vitally important to the well-being of the overall economy. SMEs are well-known to be entrepreneurial in nature and a hub for innovation. In most of the developed and developing world SMEs constitute the vast majority of firms. The OECD has estimated that SMEs comprise more than 90% of all enterprises and they account for about 60% of private sector employment throughout the world [1]. According to these studies, it is more so with respect to developing countries. Nevertheless, it is equally argued that such firms encounter several hurdles that keep them from performing well in their particular sector or industry.

Many studies report that majority of SMEs fail in early years of their operation [2]. Such studies have come with a number of possible causes of SME failure. Despite the numerousness of the potential causes, they can be divided into internal and external [3]. According to the study, managerial competence and skills, best practices, and qualified labor constitute the main internal factors that impact a business concern's performance to a large extent. On the other hand, how a firm performs in its industry and the economy at large is also determined by factors external to the business, such as availability of adequate financing, government policy, level of crime and corruption, etc. This study seeks to gain understanding of how managerial capabilities affect the performance of an SME. Firm performance, being wide and huge subject, is difficult to assess as it is unlikely to have a limited number of determinants. Nonetheless, limiting the scope of study is imperative for researchers to have a focused approach. Consequently, this study, from a strategic management viewpoint, makes an attempt to identify key determinants and find out the magnitude of their effect on (sustainable) SME firm performance.

This study specifically focuses on assessing the factors that impact a firm's performance in a dynamic business environment. Dynamic managerial capabilities greatly determine a firm's success rate in environments of rapid change [4, 5]. According to these authors sensing, seizing and reconfiguring valuable resources are key in ensuring prolonged sustainability of a business. The managerial capabilities this study focuses on include: networking, innovation and sensing. Careful and informed choice is made in selecting these particular capabilities. Studies affirm that networking and innovation are two of the most widely identified antecedents to SME performance [6]. Dynamic capabilities literature [7] also attests to the fact that sensing capability is "more significant than ever to SMEs" (p. 3). This is due to the fact that in today's highly competitive and globalized market environment any market prediction is very difficult. The role of the moderating variable is also highly important as it has been underscored by several researchers. Extant research suggests that moderating variables such as market and technology dynamics are interesting subjects of investigation [8].

# 2  Literature review and hypotheses development

The research model for this study draws on the dynamic capabilities view. According to Teece, Pisano and Shuen [5] dynamic capabilities are defined as the "firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" (p. 516). Thus, as Leonard-Barton (1992) stated, dynamic capabilities portray the capacity an organization possesses to draw from its past experiences and decision-making processes to bring about novel and innovative forms of competitive advantage [5]. From a managerial viewpoint, Adner and Helfat [9] define dynamic managerial capabilities as "the capabilities with which managers build, integrate, and reconfigure organizational resources and competences" (p. 1012). It can therefore be concluded that dynamic managerial capabilities are key to firm performance though such an argument has to be empirically tested. Later on, Helfat *et al.* [10] defined a dynamic capability as "the capacity of an organization to purposefully create, extend, or modify its resource base" (p. 1). This statement underscores the importance of dynamic capabilities to firms to excel into a higher dimension to realize better outcomes as a result of improved practices. Further, this might transcend to particularly signify the importance of these capabilities to firms operating in economies which are highly global.

As Teece *et al.* [5] state, the crux of dynamic capabilities approach lies in its focus on the capacity to renew competencies and to strategically manage internal and external organizational skills, routines, and resources as the key instruments in changing business environments. According to Teece *et al.*, dynamic capabilities consist of examining existing internal and external firm-specific competences to meet the requirements of changing environments. Here, we can see the relevance of the dynamic capabilities approach especially to firms operating in dynamic business environments. Teece *et al.* [5] further assert that dynamic capabilities mainly focus on two aspects. First, the capacity to respond rapidly and in a timely fashion towards the changing environment. Second, the capability of management to effectively adapt, integrate, and reconfigure internal and external organizational processes to suite the rapidly changing business environment.

Nevertheless, studies [11] have found that there is lack of theoretical and empirical studies on how firms make use of their dynamic capabilities to foster organizational performance. There is also a need to examine dynamic capabilities in an integrated framework. This is in assertion with the fact that the proposed panel of dynamic capabilities, namely networking, sensing, and innovation have not been assessed in such an integrated manner. The unique aspect of this study is more pronounced when we consider the moderating role of market dynamism. Therefore, this research proposes to empirically test a model incorporating dynamic capabilities and their impact on firm performance including the moderating role of market dynamism.

## 2.1  Networking capability and firm performance

Networking greatly depends on mutual trust and interaction among the parties involved thereby allowing them to gain strategic resources without losing their core proprietary assets to their partners [12]. For a firm to gain advantages from networking, it ought to build capabilities that enable the firm to form indispensable relationship with various partners [13]. Therefore, the authors claim, firms' ability to form and maintain exchange of strategic resources that benefits them coupled with the ability to spot prospective partners in possession of such complementary resources contributes to the need to establish such key relationships. In line with this, it can be safely argued that firms need to be equipped with networking capability in order to maintain trust that allows smooth flow of key resources between partners with the aim of achieving increased

performance [13]. Based on study by Huang, Lai, and Lo [14] business networks can help lower transaction costs, as well as enhance and complement the strategic resources an organization needs. Therefore, developing and maintaining business networks for start-ups is essential and critical in terms of their long-term development. What is more, well-established firms also need to possess such capabilities to have a sustained competitive advantage and performance.

Several studies have found a positive, and significant, relationship between networking capability and firm performance. Terziovski [15] asserts that there is a significant positive relationship between network practices and business excellence. Watson [16] maintains that firms can gain the benefit of maximizing their chances of success while significantly reducing the risk of failure by making use of networks. Zacca, Dayan and Ahrens [17] based on a study of SMEs in the UAE, suggest that networking capabilities and knowledge creation lead to enhanced performance of small enterprises. Thus, it is hypothesized that:

*H1a: Networking capabilities positively influence SMEs' sustainable performance.*

## 2.2    Sensing capability and firm performance

In environments where technological and market conditions are constantly shifting, firms need to possess capabilities that allow them to scan, search, and explore opportunities across those technologies and markets. These capabilities were defined as sensing capabilities by Teece [18]. The importance of sensing capabilities lies in the fact that they have both internal (firm-level) and external aspects which in turn allow for controlling internal and inter-organizational information in order to assess the turbulent environment in which the firm operates [7]. Besides, the authors assert, sensing capabilities allow for integrating and analyses of information and knowledge to enable decision makers to make timely and effective decisions. As Wang and Ahmed [11] state, information and knowledge are valuable and unique capabilities which may not be easily substitutable and hence constitute the core elements of dynamic capability.

Sensing capability is of significant importance to firms, particularly in today's globally competitive, dynamic environments, given the fact that it allows firms to transform potential benefits of resources into realized outcomes [19]. Further, sensing capability enables firms to broaden their scope and to explore local and distant markets and technologies. In environments of rapid technological change and high velocity market, the possession of distinctive sensing capability can aid firms in transforming the potential benefits of resources into realized outcomes [20]. Moreover, the capability has a positive effect on achieving more innovative products at a faster speed than the market. According to Tseng and Lee [21], a firm's sensing capability has a positive correlation with the performance of SMEs that have applied knowledge management.

External technology ideas and discoveries might be easily overlooked simply because the firm may lack the necessary capability to tap into them. Zhou, Zhou, Feng and Jiang [22] suggested that stronger sensing capability of a firm has the capacity to provide enhanced technological innovation in the firm. A firm's sensing capability enables it to extract value from the social network and transform it into new product outcomes. Given its ability to increase firm's capacity to transform its assets into benefits through innovation and networking makes sensing capability a highly sought-after capability. Though several studies [19, 22] have found a significant positive relationship between sensing capability and firm performance, others [20] found the relationship to be insignificant. Following these findings, the following hypothesis is proposed:

*H1b: Sensing capabilities are positively related to SMEs' sustainable performance.*

## 2.3    Innovation capability and firm performance

Innovation capability, according to Terziovski [23], provides the potential for effective innovation. However, it is not a simple or single-factored concept, as it involves many aspects of management, leadership and technical aspects as well as strategic resource allocation, market knowledge, organizational incentives, etc. Lawson and Samson [24] define innovation capability as "the ability to continuously transform knowledge ideas into new products, processes and systems for the benefit of the firm and its stakeholders" (p. 384). The importance of innovation capability comes into play particularly when the environment is highly dynamic. When the market and technology in the environment in which the firm operates are in constant shift, the firm should be able to outmatch it by modifying and transforming into products, processes, and systems.

According to Calantone, Tamer, and Yushan [25], innovativeness plays a key role in determining a firm's performance. In line with this, several other studies [26, 27] agree with the idea that innovation is vitally important for firm's success. Scholars [26] attest to this claiming there is a positive relationship between a firm's innovativeness and its economic performance measured in terms of higher levels of productivity and economic upscale. Positive correlation has been

found between organizational innovativeness and firm performance [28]. Pertaining SMEs, Keskin [27] came up with the finding that a firm's innovativeness improves its performance. In earlier literature, Armbruster, Bikfalvi, Kinkel, and Lay [29] have exhibited that organizational innovation acts as a basis for optimal use of technical product and process innovations, thereby, combined, acting as bases of competitive advantage. The authors further assert that organizational innovation has an effect on firm performance as regards productivity, quality, flexibility, and lead-times. Therefore, it is hypothesized that:

*H1c: Innovation capabilities have a direct relationship with SMEs' sustainable performance.*

## 2.4  The moderating role of market dynamism

In the words of Hung and Chou [30] market dynamism (turbulence) is explained by how customer demand and preference vary rendering a concern's current market knowledge obsolete. Yang and Gan [31] clarify that the same concept results from variability in technology, price, product availability, and support services. Market dynamism may pose a certain degree of risk to firms as it makes it more difficult for managers/owners in managing their firms while having to figure out the future accurately. This is because when the external environment is highly dynamic, the ensuing uncertainty is likely to harm the business in its pursuit of meeting the ever-changing customer needs which require market demand predictions, and adjustment of strategic direction that corresponds to the turbulent environment [32]. Furthermore, in such highly turbulent environments, the situation might render the firm ineffective and inefficient to adapt to the circumstance, albeit customer integration can aid the firm to access information such as product price, market needs, and customer expectation from downstream organization [33]. This can be contrasted with the situation in which the firm faces stable market environment being subjected to less ambiguous circumstances can help the company visualize the whole situation of the market [31].

Further, Zhu, Dong, Gu, and Dou [34] maintain that in environments where the levels of dynamism are high firms are liable to making crucial decisions depending on incomplete and outdated information. This is mainly because of, the authors clarify, unclear information on market opportunities, increasing levels of uncertainty and risk, customers' inability to articulate their needs and uncertainty in timing and amount of capital investment. Sound cooperative relationship, that is the value of networking, among the parties involved are highly likely to be undermined in markets known for their rapid and dramatic changes because of high level of stress these situations may trigger [34]. Such market situations may cause firms to experience challenges in their operations although they may be able to gain some advantages through networking.

Zhu *et al.* [34] clarify that it may be challenging for firms in unstable markets despite the fact that managers' personal network with their business partners brings such advantages as information sharing, mutual trust, and reciprocity. Rapid changes in market elements such as customer demand, advances in scientific technology, and competitor structure usually are followed by information lag, technology obsolescence, and outdated prior scanning research work. Firms therefore must broaden their knowledge base by engaging in wider external searches and tapping into sources of new information to be able to adapt to the changing environment and seize potential market opportunities. Hansen (1999) state that in stable market conditions where each actor knows what the other members of the group know, business ties may generate information redundancy and be out-of-date [34]. Therefore, it is hypothesized that (see Figure 1):

*H2a: Networking capabilities will be highly related to SMEs' sustainable performance when the organization's market environment is perceived as dynamic; conversely networking capabilities will be minimally related to SMEs' sustainable performance when the organization's market environment is perceived as stable.*

*H2b: Sensing capabilities will be highly related to SMEs' sustainable performance when the market environment is perceived as dynamic; conversely sensing capabilities will be minimally related to SMEs' sustainable performance when the organization's market environment is perceived as stable.*

*H2c: Innovation capabilities will be highly related to SMEs' sustainable performance when the organization's environment is perceived as dynamic; Innovation capabilities will be minimally related to SMEs' sustainable performance when the organization's environment is perceived as stable.*
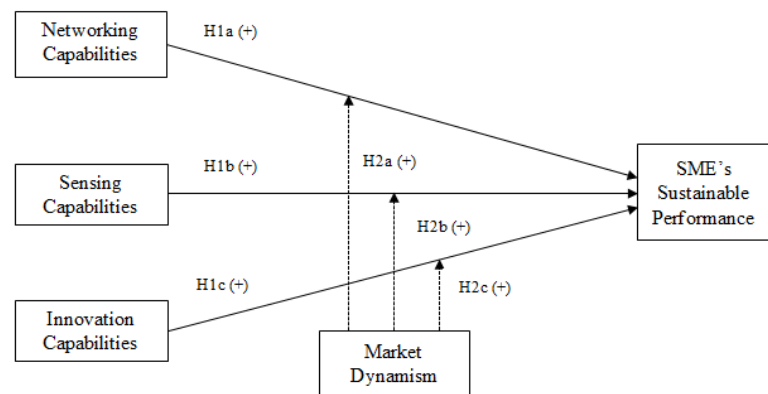
**Figure 1**    Conceptual framework and hypotheses

# 3    Methodology

## 3.1    Measurement

The constructs' measures were adopted from existing studies. In the following measurement details, unless specified otherwise, all the variables were measured using 5-point, Likert-type scales ranging from 1 = 'strongly disagree' to 5 = 'strongly agree'. Networking Capability (NC) was measured using seven items adapted from a study by Chen, Zou and Wang [35]. The items include analyzing what you would like to achieve with your collaborators, relying on close individual relationships to secure personnel and financial resources, deciding in advance which possible partners to talk to about building relationships, appointing managers/employees who are responsible for the relationships with our collaborators, discuss with collaborators regularly on how to support each other to achieve success, dealing flexibly with our collaborators, and solving problems constructively with our collaborators. Sensing Capability (SC) was measured using four items adapted from a study by Pavlou and El Sawy [36]. These include frequently scanning the environment to identify new business opportunities, periodically reviewing the likely effect of changes in your business environment on customers, reviewing your product development efforts to ensure they are in line with what the customers want, and devoting a lot of time implementing ideas for new products and improving our existing products.

Further, Innovation Capability (IC) was measured using six items adapted from a study by Calantone *et al.* [25]. The items include frequently trying out new ideas, seeking out new ways to do things, if the business is creative in its methods of operation, being the first to market with new products and services, if innovation is considered too risky and resisted in the company, and if your new product introduction has increased over the last 5 years. Six items measuring Market Dynamism were taken from the study by Shi and Wu [37]. The items include identifying if the company faces continuous changes in production techniques and processes, customers' needs, new products, competitor strategies and actions, customer intelligence, and competitor intelligence. Finally, six items measuring firm performance (FP) were adapted from Arend [38]. These include growth in sales; market share; quality of products, services or programs; development of new products, services or programs; satisfaction of customers or clients; increase in competitive position; return on assets; and ability to attract and retain essential employees.

## 3.2    Sample and data collection

China, being an active player in the global economy, was chosen as the empirical setting for the study. Zhou and Li [39] state that China provides a rich context to test the effect of knowledge-based and dynamic capabilities. This is because of the complex and dynamic nature of the transitional Chinese market. Zhou *et al.* [22] underscore that Chinese firms must build up their dynamic capabilities in order to sustain superior performance over time in the changing business environment. The authors further note that China is an ideal ground for testing a firm's dynamic capability empirically due to its rapidly changing and competitive business and technological environment. The data used in this study were collected from SMEs located in Suzhou Industrial Zone, Jiangsu Province, China between July - October, 2020. A total of 700 structured questionnaires were distributed to SMEs owners/managers. Out of the 700

questionnaires, 329 were filled and returned with 300 questionnaires complete and valid for data analysis.

# 4  Results

The main characteristics of the managers in the sample in terms of educational background, work experience and position in which they work are provided in Table 1 below. Most of SMEs' owners/managers were male (72%) with undergraduate degree (69%). Majority of research respondents have work experience ranging between 11-20 years (58%). Around 50% of SMEs have been in existence for 11-20 years followed by 28% with ages more than 20 years. With regard to firm size, 17.7% of SMEs can be considered as micro enterprises with number of employees 1-50, 42.3% are considered as small enterprises with number of employees ranging between 51-150, and 30% are considered as medium enterprises with number of employees ranging between 151-600. Finally, it is evident that Chinese SMEs are involved in different business activities especially Textile & Apparel (21%), Electrical & Electronics (18%), and food and beverage (14%).

**Table 1**  Descriptive analysis of respondents' profile

|  | Demographic | Frequency ($n$=300) | Percent |
|---|---|---|---|
| Gender | Male | 216 | 72 |
|  | Female | 84 | 28 |
| Education | Bachelor degree | 207 | 69 |
|  | Master degree | 60 | 20 |
|  | Doctoral degree | 21 | 7 |
|  | Other | 12 | 4 |
| Work experience | $\leq$ 5 years | 27 | 9 |
|  | 6 – 10 | 63 | 21 |
|  | 11 – 20 | 174 | 58 |
|  | $\geq$ 20 years | 36 | 12 |
| Firm Age | $\leq$ 5 years | 18 | 6 |
|  | 6 – 10 | 51 | 17 |
|  | 11 – 20 | 147 | 49 |
|  | $\geq$ 20 years | 84 | 28 |
| Firm Size (No. of Employees) | $\leq$ 50 | 53 | 17.7 |
|  | 51 – 150 | 127 | 42.3 |
|  | 151 – 300 | 87 | 29 |
|  | 301 -600 | 33 | 11 |
| Industry | Food & beverage | 42 | 14 |
|  | Automotive | 21 | 7 |
|  | Electrical & electronics | 54 | 18 |
|  | Textile & apparel | 63 | 21 |
|  | Furniture | 39 | 13 |
|  | Metal & metal products | 27 | 9 |
|  | Wood & wood products | 36 | 12 |
|  | Chemicals | 18 | 6 |

## 4.1  Data analysis

The Structural Equation Model (SEM) provides the opportunity to measure unobservable variables with indicators. This is an important point for the dynamic capabilities theory as there exist variables which need indicators to be described. This represents a large advantage for scientific work [40]. PLS-SEM as a multivariate statistical technique allows to analyze multiple variables and multiple equations simultaneously. The estimation procedure of PLS is an ordinary least squares regression-based method rather than minimizing the error terms of the endogenous constructs to estimate the path relationships in the model [41].

The results of the data analysis are presented as follows. In order to ensure the measurement validity and reliability of the research model, criteria on internal consistency, indicator reliability, discriminant and convergent validity have been evaluated for the constructs. Pertaining internal consistency, as illustrated in Table 2, all of the composite reliability values and Cronbach's $\alpha$ values were >0.8 [42]. Good indicator reliability has been achieved as the entire outer

loading of construct indicator has a value above 0.7 [42] for all the independent variable items. However, the dependent variable (i.e., firm performance) had two items namely return on assets an ability to attract and retain essential employees with outer loading values of 0.639 and 0.592 respectively. Thus, all independent variables and moderating variables have good indicator reliability and the two items were removed from the dependent variables and used for further data analysis. With regard to convergent validity, all Average Variance Extracted (AVE) scores were >0.6 (see Table 3). Since all values reached the minimum threshold value 0.50 of AVE [42], the correct convergent validity for the measurement model of the present study was demonstrated. Moreover, the square root of the AVE of each construct was higher than its highest correlation with any other construct in the model establishing discriminant validity [43] as presented in Table 4.

**Table 2**   Internal consistency measures

| Variables | Cronbach's Alpha | Composite Reliability |
|---|---|---|
| SME's Performance | 0.927 | 0.938 |
| Networking Capabilities | 0.883 | 0.892 |
| Sensing Capabilities | 0.916 | 0.924 |
| Innovation Capabilities | 0.891 | 0.895 |
| Market Dynamism | 0.876 | 0.883 |

**Table 3**   AVE value

| Variables | AVE |
|---|---|
| SME's Performance | 0.713 |
| Networking Capabilities | 0.684 |
| Sensing Capabilities | 0.728 |
| Innovation Capabilities | 0.687 |
| Market Dynamism | 0.735 |

**Table 4**   Fornell-Lecker criterion

| | FP | NC | SC | IC | MD |
|---|---|---|---|---|---|
| FP | 0.861 | | | | |
| NC | 0.791 | 0.846 | | | |
| SC | 0.729 | 0.813 | 0.879 | | |
| IC | 0.771 | 0.817 | 0.699 | 0.862 | |
| MD | 0.764 | 0.810 | 0.772 | 0.806 | 0.811 |

Note: FP = Firm Performance, NC = Networking Capabilities, SC = Sensing Capabilities, IC = Innovation Capabilities, MD = Market Dynamism

**Table 5**   Path coefficient and hypothesis testing

| Path | Path Coefficient | SE | t-value | Sig* | Status |
|---|---|---|---|---|---|
| NC→FP | 0.249 | 0.068 | 2.060 | 0.003 | Accepted |
| SC→FP | 0.476 | 0.047 | 4.659 | 0.000 | Accepted |
| IC→FP | 0.349 | 0.064 | 2.345 | 0.007 | Accepted |
| NC*MD→FP | 0.292 | 0.065 | 1.386 | 0.063 | Declined |
| SC*MD→FP | 0.268 | 0.054 | 1.662 | 0.047 | Accepted |
| IC*MD→FP | 0.124 | 0.062 | 0.722 | 0.316 | Declined |

Note: FP = Firm Performance, NC = Networking Capabilities, SC = Sensing Capabilities, IC = Innovation Capabilities, MD = Market Dynamism, SE = Standardized Estimate

According to Hair *et al.* [42], when the empirically measured statistical t-value is greater than the critical value, the coefficient is considered significant at a specific confidence level. For the present study, t-value of 0.95 is used at a significance level of 0.05. Hair *et al.* [42] further clarified that the nonparametric statistical test called bootstrapping is carried out by PLS-SEM in order to measure the importance of the calculated route coefficients. They also reported that the coefficient values are between -1 and +1. Thus, the values of the path coefficients close to +1 suggested a strong relationship, while the values of the coefficient close to -1 revealed a weak relationship. The values of t-values, p-values and path coefficients calculated between variables in the present study are shown in Table 5 in the next section. The acceptance or rejection of the hypothesis was focused on the evaluation of the direction. Thus, based on the results of the present study, all study hypotheses were approved at a significance level of 0.05.

## 4.2    Hypotheses testing

The research proposed six hypotheses to determine the direct and moderated relationship between the proposed variables. For H1a, the result revealed that path coefficient between networking capabilities and SME performance was 0.249. In assessing the significance level, the t-value was 2.060 which is higher than critical value of 1.96 and the p-value of 0.003 which is lower than the threshold value of 0.05 as suggested by Hair, Hollingsworth, Randolph, and Chong [44]. Guided by these results, H1a is accepted and the present study determined a significant relationship between networking capabilities and SME performance. Similarly, for H1b, the result revealed that path coefficient between sensing capabilities and SME performance was 0.476. For the measuring significance of this relationship, the t-value was 4.659 which is greater than critical value of 1.96. Similarly, the p-value of 0.000 was also found to be significant and less than the threshold value of 0.05 [44]. These statistics presented sufficient empirical evidence that the hypothesis H1b is accepted and the present study determined a significant relationship between sensing capabilities and SME performance.

H1c was also accepted as the result revealed that path coefficient between innovation capabilities and SME performance was 0.349. For the measuring significance of this relationship, the t-value was 2.345 which is greater than critical value of 1.96. Similarly, the p-value of 0.007 was also found significant and less than the threshold value of 0.05 [44]. These statistics presented sufficient empirical evidence that the hypothesis H1c is accepted and the present study determined a significant relationship between innovation capabilities and SME performance. When it comes to the role of the moderating variable, it was significant only in moderating the relationship between sensing capabilities and firm performance. In assessing the significance level of the impact of the interaction between networking capabilities and market dynamism on SME performance, the reported t-value was 1.386 which is less than critical value of 1.96 and the p-value of 0.063 was higher than the threshold value of 0.05 as indicated by Hair *et al.* [44]. Guided by these results, H2a is rejected and the present study determined no significant impact of market dynamism on the relationship between networking capabilities and SME performance. The result in testing H2b revealed that path coefficient between sensing capabilities and SME as moderated by market dynamism performance was -0.268. In assessing the significance level of the impact of the interaction between sensing capabilities and market dynamism on SME performance, the reported t-value was 1.662 which is lower than the critical value (1.96) and the p-value of 0.047 which is lower than the threshold value of 0.05 as indicated by Hair *et al.* [44]. Guided by these results, H2b is accepted and the present study determined a significant impact of market dynamism on the relationship between sensing capabilities and SME performance. Finally, in testing H2c, the result revealed that path coefficient was 0.124. In assessing the significance level of the impact of the interaction between innovation capabilities and market dynamism on SME performance, the reported t-value was 0.722 which is lower than critical value of 1.96 and the p-value of 0.316 which is higher than the threshold value of 0.05 as indicated by Hair *et al.* [44]. Guided by these results, H2c is rejected and the present study determined no significant impact of market dynamism on the relationship between innovation capabilities and SME performance.

To assess the hypothesized moderating impact of market dynamism on the relationship between networking, sensing and innovation; and SME performance, the interaction terms were created through the application of the case-wide multiplication with regard to scores of underlying standardized constructs for independent variables and moderating variable. Later, the market dynamism as a moderator along with the interaction terms were inserted in SmartPLS. Research findings in Table 5 revealed that only the moderating effect of market dynamism on the relationship between sensing capabilities and SME performance was significant and therefore H2b is accepted while H2a and H2c are rejected.

Further, this research intended to identify whether there is a statistically significant difference between SME's manager/owner characteristics: age, gender, and experience, and SMEs performance. The findings revealed that path coefficient results between manager age and SMEs performance, gender and SMEs performance, and experience and SMEs performance were -0.049, 0.085, and 0.029 respectively. The reported p-values and t statistics for age (t = 1.134, p = 0.237), gender (t = 0.768, p = 0.639), and experience (t = 0.492, p = 0.813). Accordingly, none of the owner/manager characteristics had association with their SMEs performance.

From Figure 2, it is evident that market dynamism strengthens the positive relationship between sensing capabilities and firm performance. The testing of the moderating impact of market dynamism was reported in Table 5. The results of this test indicate that the moderating variable is proven to moderate only the effect of the sensing on the dependent variable, *i.e.*, SME performance.
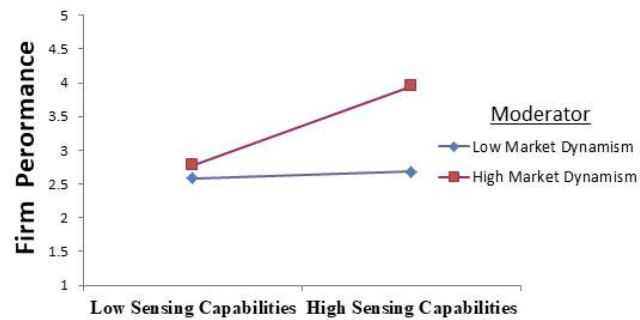
**Figure 2**　Moderating analysis: sensing capabilities and SMEs performance

# 5　Discussion and conclusion

The study found a significant positive relationship between networking capabilities and firm performance. The results indicate that hypothesis H1a is supported, stating that the sampled SMEs need to further develop their networking capabilities to improve their firms' performance. This result confirms prior studies which found a positive association between networking capability and knowledge creation to enhance firm performance [17] and networking experience and success rate [12]. Networking, also called *guangxi*, is prevalent in Chinese business culture. The study also found a significant positive relationship between sensing capabilities and firm performance. Essentially, sensing capability is vitally important for firms and especially for SMEs in today's dynamic and globally competitive environments [19]. Thus, the importance of this particular managerial capability cannot be overstated. In numerous cases, the extant research has backed the claim that sensing is essentially relevant to SMEs' performance. Tseng and Lee [21] report that a firm's sensing capability has a positive correlation with the performance of SMEs that have applied knowledge management. Other authors, however, argue that the effect of sensing capability on firm performance is not significant. Hernández-Linares *et al.* [20] for example contend that the relationship between sensing and performance is not significant.

Sensing is a highly relevant capability for SMEs because such firms need to stay competitive especially in environments of high velocity and rapid technological change. New knowledge and new information can help the firm come up with innovative products thereby meeting its customers' needs while at the same time building up its competitive edge. In recent years there has been a surge in developing sensing capabilities and the once not-so-significant capability in terms of strategic position has gained tremendous momentum [7].

The positive association the study found between innovation capabilities and firm performance is also in conformity to previous studies. Albaladejo and Romijn [45] maintain that SMEs having strong innovation capabilities are able to make a valuable contribution to a country's competitiveness. Raymond, Bergeron and Croteau [46] in their study in relation to manufacturing SMEs stated that developing a product innovation capability is expected to allow manufacturing SMEs to uphold their position in the market while developing product innovation capability also improves SMEs' competitiveness by lowering production costs and enhancing the flexibility of their productive apparatus. This is important finding because it regards the market and importantly the firm's customers. The present study backs these findings.

The study did not support the hypotheses that market dynamism moderates the relationship between both innovation capabilities and networking capabilities and firm performance. With regard to innovation, a possible explanation is that in environments of high market dynamism, firms are unable to maintain constant innovation due to constant variation in customer demand and, as Porter (1985) suggested, may render such investment in new innovations futile [47]. Some studies attest to the fact that market dynamism does not influence innovativeness [47]. Pertaining the insignificant effect of the moderating role of market dynamism in the relationship between networking and firm performance is that networking is already prevalent in the Chinese business culture [48] that it is not intensified in situations where the market is highly dynamic. However, further empirical investigation is required to further explain the outcome.

## 5.1　Theoretical and managerial implications

This study makes several contributions to the dynamic capabilities' literature. First, this study in line with several previous studies [17, 22, 24], albeit in most cases univariate, has asserted that dynamic capabilities are relevant and applicable to SMEs. This study makes major

contributions to theory in that it explained the relationship between managerial capabilities and firm performance considering the role of market condition (dynamic or otherwise). Thus, it could be applicable not just for Chinese SMEs but also for firms operating in any other developing/emerging countries with a dynamic market environment. This is because China shares a number of characteristics and similarities with other emerging economies and therefore it can be an appropriate representative context of those economies [22].

Secondly, this present study highlighted the role of managers/owners in enhancing the performance of their firms. The research problem was defined as the failure rate of SMEs is so high that such firms need to come up with a mitigating measure to lower the rate. This is particularly important because SMEs hugely contribute to the national economy. As stated before, one of the main reasons of their substantial failure rate is managerial practice. Thus, this study indicates that managers/owners of such businesses ought to focus on developing their dynamic capabilities thereby mitigating the adverse effect of market conditions to not only survive but win competitive advantages.

Thirdly, the literature-based selection of the study variables proved vital. Networking, sensing, and innovation capabilities though present in the literature have not been studied in such a way that they are applicable in SMEs with a dynamic market environment and in an integrated model. Additionally, the moderating variable market dynamism studied in link with these capabilities is uniquely important. This study can be regarded as an addition to the dynamic capabilities' literature. It has been stated that there is lack of empirical studies with regard to dynamic capabilities view [49]. This way, the present study has filled the research gap. In terms of managerial contribution, the results of this study provide guidance for managers on how to build and employ dynamic capabilities. It provides avenues for owners/managers of SMEs on how to use the capabilities relevant to particular market situation. Of the three managerial capabilities studied, sensing was especially relevant in environments of high market dynamism. This indicates that SME owners/managers should give more emphasis to sensing capability, but not to the neglect of networking and innovation capabilities.

## 5.2 Limitations and further research

As with most studies, this research is not without limitations. These limitations should be taken into account before generating inferences from the results. On the other hand, the limitations of this study suggest several possible avenues for further research.

First off, the present study attempted to examine the effect of dynamic managerial capabilities on firm performance by using convenience/purposive sampling which is often used in line with time and funding constraints. Other sampling methods, particularly probability-based covering a wider population of respondents might yield a better representation. The cross-sectional nature of the data also makes it impossible to determine the influence of dynamic capabilities on SME performance overtime and therefore could not definitively establish causality.

This study relied on data obtained from an industrial zone in Jiangsu province of China. As a result, generalizability of the results to other regions in China or other countries depends on further research despite the assertion made above. Cross-country comparison could also provide an avenue for a broader application of such analyses. Assessing the performance of firms in developing countries versus their counterparts in developed nations can help draw valuable inferences to improve practice and policy.

## 5.3 Concluding remarks

In conclusion, this empirical study helps to explain how dynamic capabilities influence firm performance. Based on the findings, we can conclude that manufacturing SMEs need to employ dynamic managerial capabilities to improve their performance. It is also worthwhile to implement necessary practices in view of the environment a firm operates within. It is believed that this study has contributed to the Dynamic Capabilities literature and is expected to spur further empirical studies on the subject.

# Conflict of interest

The author declares no conflict of interest regarding the publication of this paper.

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**RESEARCH ARTICLE**

# Impact of overall equipment effectiveness on return on investment in the Nigerian cement manufacturing industry

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**Abstract:**  The formidable challenge of maintenance of heavy duty equipment for the day-to-day manufacturing activities informed this research investigation. The study examined the impact of overall equipment effectiveness on return on investment in the Nigerian cement manufacturing industry. It focused on the key indicators of overall equipment effectiveness and their impact on return on investment. Ex-post facto research design was adopted in conducting the empirical investigation. The firms in the industry quoted in the Nigeria Stock Exchange (NSE) were studied. Longitudinal data of 15 years observation (2005-2019) were obtained and analyzed with ordinary least squares regression (system-OLS). The key indicators of overall equipment effectiveness subjected to empirical test proved positively significant to return on investment at the Coefficient values $a_1$, $a_2$ & $a_3 > 0$; Prob.-values $a_1$, $a_2$, & $a_3 < 0.05$ and t-Statistic values $a_1$, $a_2$, & $a_3$ absolutely $\geq 2$. These analysis results suggested that machine availability rate (MAR), machine production rate (MPR), product quality rate (PQR) variables of overall equipment effectiveness have significant linear effect on ROI. Based on these results, the study therefore recommends among others for top management's support and commitment to proactive and continuous improvement production facilities maintenance for improved overall equipment effectiveness and sustainable corporate performance of firms in the industry.

**Keywords:**  Overall Equipment Effectiveness (OEE), Machine Availability Rate (MAR), Machine Performance Rate (MPR), Product Quality Rate (PQR), corporate performance, Return on Investment (ROI)

## 1    Introduction

The increased global competition in today's manufacturing industry necessitates the need for manufacturing firms to effectively and efficiently maintenance their production facilities to gain competitive advantage. Also, the advent of manufacturing philosophies and the increased use of automation in today's manufacturing have led to network of maintenance services for overall equipment effectiveness [1].

Effective performance of a production system lies not only on the operational design of the system; it requires maintenance function either to keeps the system in an operational condition or to restore the system back to functional stage after breakdown has occurred [2]. Maintenance function is an organization-wide strategy that adds to effectiveness of production environment, customers' value and organizational performance [3].

One of the major challenges in today's manufacturing is the state of production facilities. The effectiveness of manufacturing firms is sub-optimized at the instance of poor maintenance. The concept of overall equipment effectiveness evolved from production facilities maintenance and it rests on the premise that no facility can operate at peak efficiency without being maintained. Thus, the philosophy behind overall equipment effectiveness is for the manufacturing firms to move into World Class Performance (WCP) where advanced manufacturing strategies such as just-in-time, agile manufacturing, lean manufacturing; flexible manufacturing and continuous improvement can be effectively adopted to meet the market demand of products and services for organizational corporate performance [4].

The corporate performance of manufacturing firms is premised on overall equipment effectiveness and is measured on the basis of non-financial and financial performance. Ricardo

& Wade (2001) [5] see performance of a firm as the ability to attain goals by using human, material, machine and technological resources in an effective and efficient manner.

Poor maintenance affects overall equipment effectiveness of manufacturing firms. In the Sub-Saharan African countries, evidence of overall equipment ineffectiveness abounds in the use of industrial facilities. According to the World Bank Reports (2019) [6], poor state of facilities maintenance in Sub-Saharan Africa is high and it cuts national economy growth by 2% points every year and reduces productivity by 40%.

Poor maintenance culture is responsible for a worrisome issue in many developing countries and is a major factor responsible for premature wear and tear of machines and equipment, frequent breakdown of production machines, poor capacity utilization of installed machines, production losses, economic losses and low industrial development. Ejiofor (1987) [7] notes that the state of overall equipment effectiveness of manufacturing firms is a critical issue in Nigeria and that due to poor production facilities management, many manufacturing companies have lost their production efficiency and have witnessed induced inefficiency over the years. Some of the operating companies in the Nigerian cement manufacturing industry have low maintenance culture and do not give adequate attention to production facilities maintenance for overall equipment effectiveness, owing to the fact that the management often looks at maintenance function as a non-value added and cost consuming activity and this has led to loss of their competitive advantage, as well as poor corporate performance.

## 2    Research objectives and hypotheses

### 2.1    Research objectives

The specific objectives of this study are to:

(1) Examine the effect of OEE machine availability rate on ROI in the Nigerian cement manufacturing industry.

(2) Determine the effect of OEE machine performance rate on ROI in the Nigerian cement manufacturing industry.

(3) To evaluate the effect of OEE product quality rate on ROI in the Nigerian cement manufacturing industry.

### 2.2    Research hypotheses

The study seeks to validate the following hypotheses:

(1) OEE machine availability rate has significant positive impact on ROI in the Nigerian cement manufacturing industry.

(2) OEE machine performance rate has significant positive impact on ROI in the Nigerian cement manufacturing industry.

(3) OEE product quality rate has significant positive impact on ROI in the Nigerian cement manufacturing industry.

## 3    Literature review

The concept of overall equipment effectiveness is not new in the discourse of zero waste production, total productive maintenance, production systems availability and reliability, optimization of production facilities, product quality management and maintenance measurement metric. In meeting up with the challenges of world-class manufacturing, overall equipment effectiveness has become an important subject in the literature of maintenance management and manufacturing performance. In the contemporary industrial phase, overall equipment effectiveness is gaining weight as evidenced in the numerous research works [8–10].

Overall equipment effectiveness is a measure of plant improvement which focuses on the concept of zero waste [11]. Pradhan & Bhol (2006) [12] posit that overall equipment effectiveness is the total productive maintenance metric for measuring equipment effectiveness or productivity. The optimization of equipment, productivity and continuous improvement of equipment for manufacturing process is what Ding & Kamaruddin (2015) [10] depict as overall equipment effectiveness. Normariah, Salina, Shuib & Hasnida (2017) [13] view overall equipment effectiveness as a metric that is a function of equipment availability, quality rate and equipment performance efficiency.

Studies by Muchiri & Pintelon, (2008) [14], Marcello, Marco & Francesco (2009) [15], Jose, Steve, Kelvin & Horacio (2010) [16], Muchiri, Pintelon, Gelder & Martin (2010) [17],

Vijayakumar & Gajendran (2014) [18]. Ding & Kamaruddin (2015) [10] admit that overall equipment effectiveness (OEE) is expressed as a function of availability, performance and quality i.e OEE= f(A x P x Q). They further express that other terms which can be used to express overall equipment effectiveness (OEE) are utilization, efficiency and yield. Utilization (U) is the usage rate of the equipment, which is the rate of actual running of the equipment versus availability; efficiency (E) is the output rate of the equipment, that is the ratio of actual sped versus the rated speed of the equipment while the yield (Y) is the quality rate of the equipment, the ratio of good units output versus total units input of the equipment.

Overall equipment effectiveness measures the effectiveness and efficiency of a machine centre or process line in manufacturing operations on the basis of availability, performance and quality. The value of overall equipment effectiveness (OEE) of 1 or 100% represents the absolute best performance of a machine. Overall equipment effectiveness as a concept has key objective of eliminating or minimizing losses in a production system, caused by machine failures and stoppages. As many manufacturing organizations focus on minimization of losses resulting from downtime, which affect production schedules, the need for overall equipment effectiveness becomes critical in measuring the effectiveness of planned production schedules and determining the overall plant efficiency.

In today's cement manufacturing industry, overall equipment effectiveness serves as one of the key benchmarking tools that focus on improving the performance and efficiency of machinery and manufacturing process. The capital intensive cement plant machinery that comprises of crusher, grinder, mixer, kiln, silo, loader, conveyor, shovel loader and control room machines that do not receive adequate maintenance tends to drift away from optimum operational performance, asset productivity or capacity utilization and financial performance. This may also lead to degraded manufacturing process control and production losses and wastes, which may affect the profitability objective function of business. Osama (2010) [19] studied "Total productive maintenance reviewed and overall equipment effectiveness measurement" in Jordan and the result of the study depicts that loss of OEE is due to poor maintenance function and it negatively affect the performance of a manufacturing company. Fore & Zuze (2010) [20] executed a study in Zimbabwe on "Improvement of overall equipment effectiveness through total productive maintenance". The investigation also finds out that overall equipment ineffectiveness has significant negative relationship with manufacturing performance.

Bangar, Hemlata & Jagmohan (2013) [21] carried out a research investigation in Indian on "Improving overall equipment effectiveness by implementing total productive maintenance in auto industry" The results of the study shows significant positive relationship between OEE that is above 85% and manufacturing performance. Kumar, Soni & Geeta, (2013) [22] conducted a study in Bhopal on "Maintenance performance metrics for manufacturing industry". The finding of the study shows that overall equipment effectiveness at 90% is a critical success factor influencing survival, profitability and competitive advantage of manufacturing organization.

Disha, Vijaya, Naidu & Veena (2013) [23] performed a study in Indian on "Evaluation of OEE in a continuous process industry on an insulation line in a cable manufacturing unit". The result of the empirical analysis of the study shows that 52.96% OEE of the company, which was below OEE bench mark had significant negative relationship on manufacturing performance. Pradeep, Raviraj & Lewlyn (2014) [24] conducted a study in India, investigating "Overall equipment efficiency and productivity of a newspaper printing machine of a daily news paper company: A case study". Thus the result of the investigation reveals no significant relationship between OEE and manufacturing performance while the work of Lalit, Gupta & Zanwar (2014) [25] carried out in Nagpur on "Overall Equipment effectiveness improvement: A case of injection moulding machine" indicates that a 1% increase in OEE has significant positive effect on manufacturing performance.

## 4   Conceptual framework model

The model below is the conceptual framework of the study. In the model, the study variables are operationalised, indicating the relationship between indicators of overall equipment effectiveness and return on investment index of financial performance. (See Figure 1)

The above conceptual framework model is an exposition of this present study. In the context of this study, the relationship between financial performance (return on investment - ROI) and overall equipment effectiveness indicators (machine availability rate, machine performance rate and product quality rate) form the domain and main thrust in conducting this investigation.

The indicators of overall equipment effectiveness are the unique strengths and core competencies that allow a manufacturing organization to achieve efficiency in production, quality, cost effectiveness or low cost leadership, on-time-delivery (OTD) and flexible manufacturing system
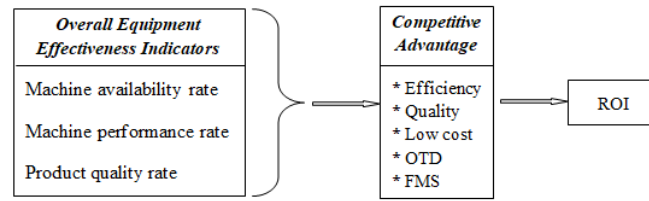
**Figure 1**    Researchers' conceptual framework model (2020)

(FMS) for optimal performance. The competitive advantage as depicted in the framework model describes the attributes that allow a manufacturing organization to outperform its competitors. It is a superior performance relative to other competitors in the same industry. The competitive advantage arising from the indicators of overall equipment effectiveness enable a manufacturing firm to remain in business in the face of intense competition resulting from globalization of manufacturing activities and markets.

The financial performance of a manufacturing firm is a measure of how well the firm can use its assets to generate revenue or profit. Thus, financial performance is a performance measure or metric that is expressed as overall profits or losses from its business activities over a period of time. Due to a firm's competitive advantage as a result of overall equipment effectiveness, high return on investment that is above the industrial average is earned. Maintenance of production facilities which allows for overall equipment effectiveness remains one of the business functions that serves and supports the primary manufacturing processes through which significant increase in profit can be achieved.

The study therefore sought to explore the extent at which indicators of overall equipment effectiveness as exogenous variables exert impact on ROI financial performance (endogenous variable) in the Nigerian cement manufacturing industry.

# 5    Research methodology and model

## 5.1    Methodology

The study adopted ex-post facto research design in conducting empirical investigation of cause-and-effect relationship of the study's variables. The study used 15-year period (2005-2019) panel data derived from annual financial reports, maintenance scorecards and production scorecards of cement manufacturing companies quoted in the Nigerian Stock Exchange. The Ordinary Least Squares (OLS) estimator was adopted for the regression analysis of the study.

## 5.2    Model specification

$$\mathrm{RQI}_{it} = \mathrm{a}_0 + \mathrm{a}_1\mathrm{MAR}_{it} + \mathrm{a}_2\mathrm{MPR}_{it} + \mathrm{a}_3\mathrm{PQR}_{it} + \mu_{it} \tag{1}$$

Where:

ROI = Return on investment as a proxy for financial performance and the dependent variable.

MAR = Machine availability rate as a proxy for overall equipment effectiveness and independent variable.

MPR = Machine performance rate as a proxy for overall equipment effectiveness and independent variable.

PQR = Product quality rate as a proxy for overall equipment effectiveness and independent variable.

$\mathrm{a}_0$ is the autonomous variable (constant or intercept) while $\mathrm{a}_1$, $\mathrm{a}_2$, and $\mathrm{a}_3$ are the coefficients of the explanatory (independent) variables of the model; $\mu$ is the error term; $_i$ is the individual dimension and $_t$ is the time dimension.

# 6    Results and interpretation

The results of Augmented-Dickey-Fuller (ADF) unit root test in table 1 above indicate that at 5% significant level, the statistical properties of indicators of OEE (MAR, MPR, PQR) have no unit root, which implies that they are stationary or constant over time. (See Table 1)

**Table 1**    Augmented-Dickey-Fuller (ADF) unit root test

|  |  |  | t-Statistic | Prob.* |
|---|---|---|---|---|
| Null Hypothesis: D(MAR) has a unit root | Augmented Dickey-Fuller test statistic |  | -3.274197* | 0.0386 |
| Exogenous: Constant |  | 1% level | -4.057910 |  |
| Lag Length: 0 (Automatic - based on SIC, maxlag = 3) | Test critical values: | 5% level | -3.119910 |  |
|  |  | 10% level | -2.701103 |  |
| Null Hypothesis: D(MAR) has a unit root | Augmented Dickey-Fuller test statistic |  | -3.913871* | 0.0112 |
| Exogenous: Constant |  | 1% level | -4.057910 |  |
| Lag Length: 0 (Automatic - based on SIC, maxlag = 3) | Test critical values: | 5% level | -3.119910 |  |
|  |  | 10% level | -2.701103 |  |
| Null Hypothesis: D(MAR) has a unit root | Augmented Dickey-Fuller test statistic |  | -3.824684* | 0.0149 |
| Exogenous: Constant |  | 1% level | -4.057910 |  |
| Lag Length: 0 (Automatic - based on SIC, maxlag = 3) | Test critical values: | 5% level | -3.119910 |  |
|  |  | 10% level | -2.701103 |  |

**Notes**: * Significant at 5% level (stationary/has no unit root)

Table 2 is the heteroskedasticity test results of OEE indicators (MAR, MPR & PQR). The F-statistic value (1.314317) > Critical chi-square value (16.919) and it signifies that the error terms have the same variance (i.e the variance is constant). In this case, the indicators of OEE have no heteroskedasticity, meaning it is homoskedasticity. (See Table 2)

**Table 2**    Heteroskedasticity test

| F-statistic | Obs*R-squared | Scaled explained SS |
|---|---|---|
| 1.314317** | 10.72609 | 3.365906 |
| Prob. F(9.5) 16.919** | Prob. Chi-Square(9) | Prob. Chi-Square(9) |
| 0.3662 | 0.2914 | 0.9479 |

**Notes**: Null Hypothesis: OEE indicators have no heteroskedasticity; Heteroskedasticity Test: White; ** No significant heteroskedasticity (homoskedasticity)

The regression test results in table 8.3 above depict that in the Nigerian cement manufacturing industry, MAR, MPR & PQR indicators of OEE have positive coefficient signs of 0.59, 0.61 & 0.53. With these coefficient signs, it means a percentage increase in MAR, MPR & PQR have direct proportional positive impact on ROI. The Durbin-Watson statistic value of 1.86 signifies positive relationship between the dependent variable (ROI) and the independent variable(s) (OEE - MAR, MPQ & PQR). Also, the R-squared value of 88% and the Adjusted R-squared value of 86% are clear indication that there is a strong evidence of goodness of fit of the regression model. Since the F-statistic and the Prob (F-statistic) are 32.82 & 0.00, it means that the estimated model is significant. The p-values of the independent variables indicate statistical significance of the hypothetical test results. Thus, OEE machine availability rate, OEE machine performance rate and OEE product quality rate have significant positive impact on ROI in the Nigerian cement manufacturing industry. (See Table 3)

**Table 3**    Heteroskedasticity test

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | -107.184200 | 13.494080 | -7.943053 | 0.000000 |
| MAR | 0.591555 | 0.512871 | 2.373496 | 0.015900 |
| MPR | 0.610972 | 0.327275 | 2.500183 | 0.016100 |
| PQR | 0.527537 | 0.486470 | 2.618880 | 0.013800 |
| R-squared | 0.880168 | Mean dependent var | | 19.253130 |
| Adjusted R-squared | 0.868154 | S.D. dependent var | | 8.038261 |
| S.E. of regression | 2.735801 | Akaike info criterion | | 5.013556 |
| Sum squared resid | 92.739240 | Schwarz criterion | | 5.201429 |
| Log likelihood | -31.724210 | Hannan-Quinn criter. | | 4.811374 |
| F-statistic | 32. 82947 | Durbin-Watson stat | | 1.864152 |
| Prob (F-statistic) | 0.000000 | | | |

**Notes**: Dependent Variable: ROI; Method: Least Squares; Sample: 2005 - 2019; Included observations: 15

# 7   Discussion

This study estimated the impact of overall equipment effectiveness on ROI in the Nigerian cement manufacturing industry. With the coefficient value $> 0$, Prob.-value $< 0.05$ and t-Statistic value $\geq 2$ in the regression results in table 8.3 above, overall equipment effectiveness has significant positive impact on return on investment in the Nigerian cement manufacturing industry. The three independent variables (MAR, MPR & PQR) have proved significant in ROI determination in the Nigerian cement manufacturing industry. These independent variables tend to have corresponding impact on ROI, as increase in machine availability rate, machine performance rate and product quality rate as a result of overall equipment effectiveness lead to ROI growth and vice versa.

# 8   Conclusion and recommendations

The study has been able to examine the impact of overall equipment effectiveness on ROI in the Nigerian cement manufacturing industry. Results indicate that the determinants of overall equipment effectiveness (MAR, MPR & PQR) is significant in determining ROI ratio in the industry. Based on the finding results, the study concludes that the key indicators of overall equipment effectiveness significantly impact on ROI in the industry. The study therefore recommends among others for top management's support and commitment to proactive and continuous improvement production facilities maintenance for improved overall equipment effectiveness and sustainable corporate performance of firms in the industry. Further research should focus on the indicators of production plant uptime, which could impact on ROI in the industry.

# 9   Contribution to knowledge and implications

The contribution to knowledge arising from this study is presented in Figure 2. In the graph, linear correlation exists between the key indicators of OEE and ROI profitability index. As indicated in the graph, the random fluctuation in the OEE and ROI profitability index postulates linear correlation. As the curve which represents indicators of OEE fluctuates, the bar chart that represents ROI proportionally fluctuates. The implication arising from this is that OEE determine the extent of ROI growth and with this, manufacturing companies that use heavy duty equipment can apply this model to make stochastic forecast of trend of OEE and ROI in maximizing their corporate goals.
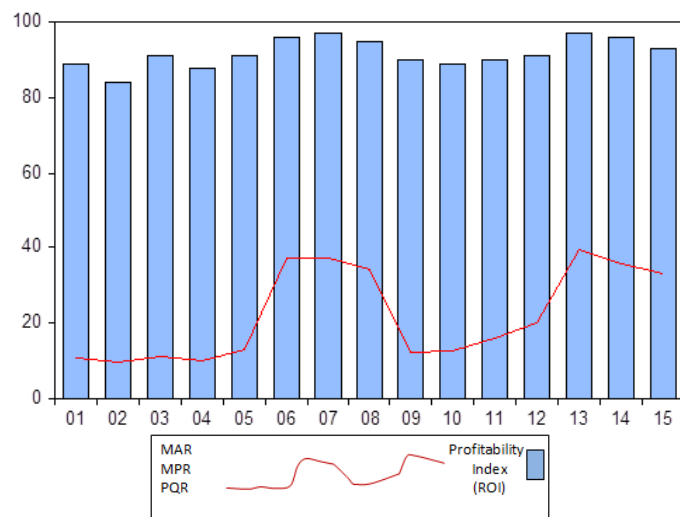


**Figure 2**   OEE-ROI stochastic graph

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RESEARCH ARTICLE

# Accounting reform of higher education: A social and managerial analysis in the era of digital intelligence

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**Abstract:** The purpose of this paper is to discuss the accounting reform of higher education in China with a socio-managerial analysis in the digital intelligence era. It will enable students to actively adapt to the development need of the market economy. This article uses an exploratory research method and analyzes the challenges faced by Higher Education in the era of digital intelligence from the three dimensions of corporate profit model, webcast rewards, and changes in the environment. With the development of digital intelligence, new industrial formats and business models are constantly emerging. Digital transformation has brought severe challenges to accounting theory and practice. Now green finance is emerging with the concept of sustainable development. Based on this analysis, the article proposes a training framework for accounting and management talents in the era of digital intelligence.

**Keywords:** green finance, innovation, corporate social responsibility, accounting framework

## 1  Introduction

Relationship between economy and management has attained the attention of researchers and practitioners in recent years. The more the economy develops, the more important accounting becomes [1]; and for the continuous development and progress of the accounting discipline, it is necessary to effectively link accounting theory and accounting practice, use accounting theory to guide accounting practice, and use practice to promote the development of accounting theory. Accounting education should have grown in terms of training objectives. However, with the rapid development of China's economy, some scholars have put forward different views on the training of accounting talents.

It is the need of time to pay attention to the application of real cases in accounting [2], and as a recommendation, training of accounting talents should be guided by the needs of economic development [3]. The purpose of accounting talent training is to enable students to actively adapt to the development need of the market economy. Yu Yulin (2011) [4] mentioned that modern accounting teaching methods can adopt accounting creative teaching method, accounting discovery teaching method, accounting discussion teaching method, accounting empirical teaching method, accounting experiment teaching method, and accounting case teaching method *etc*. He Yurun *et al*. (2013) [5] believe that to improve the training of accounting talents, the starting point should be to obtain and improve the professional abilities and qualities of students. Zhang Yongjie *et al*. (2019) [6] pointed out that to promote the cultivation of excellent accounting talents to achieve supply-side reforms, and to accelerate the quality of the cultivation of excellent accounting talents in line with industry needs, professional competence should be the guide. The research of these scholars mainly discusses the training model of accounting talents from a macro perspective, and provides a reference direction for the training model of college talents.

However, since the beginning of the 21st century, with the rapid development of digital technologies such as internet, cloud computing, big data, and artificial intelligence, and their full integration with the national economy, the new economy [7] and drivers have developed rapidly, and digital transformation has been regarded as a source of "New Engine" of economic growth. In recent years, the Organization for Economic Cooperation and Development (OECD) has put forward the international issue of "Going Digital", clarifying the strategic positioning of digital transformation to promote economic growth and welfare [8]. The European Union, the United

States, Canada, Australia and other regions and countries have also made the digital economy as the focus of their development strategies. In China, the Party Central Committee and the State Council attach great importance to the development of the digital economy. General Secretary Xi Jinping emphasized the development of the digital economy at important meetings such as the "One Belt, One Road" International Cooperation Summit Forum, the BRICS Leaders' Meeting, and the G20 Summit. An important statement was made by General Secretary: "The digital transformation of the world economy is the general trend, and the new industrial revolution will profoundly reshape human society." Driven by digital technology, new industries, new formats and new business models have brought several challenges to accounting theory and demand reformation of accounting talents.

# 2    Accounting theory in the era of digital intelligence

Driven by digital technology, many new phenomena have emerged in the economy and society. For example, with the rapid development of information technology and the internet, data have shown explosive growth and have become an important asset. Under the background of digital transformation, corporate profit models continue to innovate, and free Internet content has become easily available. Webcasting appears as a common phenomenon. As part of people's social life, rewards of webcasting emerge as the source of income for live broadcast platforms [9]. Corporate social responsibility has emerged as the bright source of people motivation and vice versa [10]. Digital technology is rapidly and continuously updated and iterated, and new products are constantly emerging. The rapid development of digital technology has brought about rapid expansion of the original scale of entertainment, literature and art. Hence human factor is required to be assessed in adoption of technological developments [11].

## 2.1    The challenge of corporate profit model innovation to accounting theory

In the context of digital transformation [12], corporate profit models continue to innovate. Many internet companies provide residents with a large number of free or low-cost services to attract users and make profits through advertising and other businesses. Take Tencent's WeChat service as an example, it provides consumers with free services, through which to gather user traffic. Thus it brings a large number of customers to other businesses such as advertising, finance, and games. Sustainable financing is converting to green finance now. Tencent obtains huge profits through advertising and other businesses, and uses advertising fees and channel service fees to indirectly compensate the operating costs of WeChat and other businesses. The innovation of enterprise profit model brings challenges to statistical theories such as production statistics, income statistics and consumption statistics. In terms of challenges to the production statistics theory, this new type of profit model has changed the profit mechanism of directly using product sales revenue for the production and operating costs, making the productivity of free or low-cost services hidden in the innovative structure of the corporate profit model. There are production statistics that fail to fully reflect this, which leads to underestimation. It is necessary to explore the theoretical framework of production statistics for free or low-cost services provided through internet, based on which theories and methods are explored by using big data to estimate free or low-cost services.

In terms of challenges to income statistics theory, internet websites provide residents with free or very low-priced services, not only causing residents' consumption of these services to be ignored or seriously underestimated, but the corresponding residents' disposable income is also ignored or seriously underestimated. Corresponding statistical theories and methods are explored here by using big data to estimate the income of residents brought by free and low-cost services. In order to cope with the challenges brought by the innovation of corporate profit model to statistical theory, it is necessary to consider a virtual calculation of an output on platforms such as online search engines, video websites and social media, and the output is provided to users "for free" in the form of physical transfer; For users, it is necessary to calculate a virtual income, which is used to "consume" the free products provided by the platform.

Increasing changes in technology are changing business processes, bringing different ways to expand the market, and customers can be attracted in different ways. At the same time, scientific and technological means are analyzing data in a brand-new way and continuously improving traditional financial reporting practices, which can help financial support teams in decision-making statements from a more strategically-supported perspective.

## 2.2    Changes in the demographic structure and transformation of the accounting industry

China's labor force has been declining since 2012, and it is estimated that the proportion of the labor force will drop by 23% by 2050. All agencies must plan ahead for such changes. Accounting practitioners should take important responsibilities in this change and ensure that they can play a leading role in the development and automation. Resource utilization for development should be sustainable manner meeting social and environmental needs [13]. The sustainable development of the industry is also very important to practitioners. Customers will also consider their own business and the impact on the environment from a longer-term perspective. In 2015, the United Nations issued a sustainable development program, which will have an impact on all people in the world. By 2030, the world must be built in a sustainable way. In this process, the government will certainly shoulder more responsibilities, but the government alone cannot complete the sustainable development plan. It needs the cooperation of other stakeholders to finally achieve the 2030 sustainable development goal. At present, more new thinking emerges. At the same time, accounting practitioners should think about what role they should play in society. How to measure the impact of the accounting industry on the overall environment? Whether accounting can bring inclusiveness and diversity to the world? Whether the industry has done a good job of responding to technology? Whether the preparation for change can allow employees and businesses to perform their abilities in the process of continuous automation, or not? Can accounting use economics and other academic theories to prepare people for retirement enabling people for their future lives earlier? After all, the good performance of a company depends not only on financial management, but also on other governance aspects to achieve the desired results.

## 2.3    The challenge to accounting theory of Online Live Rewards

In 2011, webcasting platforms began to emerge in China. After nearly 9 years of development, webcasting has become a part of many people's social life. At present, the income sources of major domestic live broadcast platforms are not the same, but users reward revenue is the most concerned source of income for live broadcast platforms [6]. Regarding the nature of reward income, there are two main views in Chinese domestic academic circles: the theory of gift and the theory of service contracts. The former thinks that the reward is to decide whether to pay the reward and the amount after enjoying the service, and it is not mandatory, so it cannot be regarded as a service contract. While the latter believes that reward is a two-way and mutually beneficial behavior, that is, the recipient provides performance services or thought-inspiring services, and the recipient pays the service fee to the recipient (Tan Fengyi *et al.*, 2018).

If the revenue from live streaming is used as the income created by service production, the factor input in the live production activities will form factor rewards accordingly. The livestreaming reward income is incorporated into the primary income distribution system through the income gained by anchors, the profits gained by anchors' contract companies and broadcast platforms, the depreciation of fixed assets, and the tax gained by the government. Regarding the new business model of webcasting, the qualitative nature of revenue was unclear. Cross cultural management and understanding of corporate social responsibility [9] has helped having a look at new business social model. There are still controversies as to whether the income of the anchor is treated as labor remuneration or as the operating income of self-employed households. At the same time, it is not clear what kind of tax is applicable to the live streaming reward income by the relevant government departments. Moreover, due to the lack of information in the tax collection and management of the live streaming reward income, it is very difficult to measure the corresponding tax. The income from live streaming has brought challenges to the theory of income statistics, and the theory and methods of income statistics must be constantly innovated to adapt to the new situation. If the live broadcast reward income is taken as the income created by service production, then the reward expenditure shall be taken as the tipper's consumption of live broadcast service. As there is currently no consensus on the determination of revenue from live streaming, traditional consumption statistics based on household surveys have not yet included household tipping expenditures into the category of consumption statistics, which poses challenges to consumption statistics. Therefore, inclusion of big data usage on the live broadcast platform will benefit the tipper's consumption of this new service activity into the household consumption expenditure statistics [12, 14, 15].

# 3 Training plan for new financial talents in the era of digital intelligence

## 3.1 Determine the training concept of new financial talents

In the financial department of an enterprise, accounting activities do not create value, while activities such as planning, budgeting and forecasting, investment and financing can help enterprises create value. It is no longer enough for the financial staff of the future to have financial and accounting expertise. Only with a wide range of involvement, they can literate from the books and become the talents needed by the enterprise. Moreover, with the continuous progress of science and technology, the emergence of some new industrial technologies represented by "Internet +", big data and cloud computing, and the emergence of "financial sharing center" and "shared accounting" have greatly reduced the manual workload. With the use of financial robots and accounting work such as confirmation and measurement, recording and reporting has been gradually replaced by artificial intelligence. Financial analysis will become the main work of financial personnel in the future, and financial workers in enterprises will face unprecedented opportunities and challenges. Therefore, future financial personnel, who want to keep up with the times, can no longer simply base on financial accounting knowledge, but need to integrate various relevant aspects of financial knowledge. They should also be quite familiar with economics, taxation, marketing, management, and law etc in order to adapt to the needs of the financial industry development and transformation in the new era.

At the same time, under the background of new economy, the boundary between the three industries is becoming more and more blurred, and the phenomenon of inter-industry integration and development is becoming more and more common. Moreover, with the prosperity of transnational cooperative trade, the accurate professional judgment and good professional control ability of financial personnel play a crucial role in the development of enterprises. What all stakeholders need is no longer the integration based on historical data, but more forward-looking and effective data extracted by financial personnel based on the situation of the enterprise itself, the market situation and the analysis of competitors. Attention should be paid to the unity of theoretical teaching and practical teaching. Therefore, financial personnel need to think using the knowledge of management accounting and the relevant knowledge of management accounting to deal with the economic business of enterprises.

## 3.2 Unity of theory teaching and practice teaching

The training of talents implements the new model of "trinity", that is, focusing on the value shaping, ability training, and knowledge imparting to students. At the same time, classroom ideology and politics are introduced into the classroom, that is, the basic principles of being doing things, the requirements of socialist core values, and the ideals and responsibilities of realizing national rejuvenation are integrated into various courses. Actively promoting online education is the school's strategic development for the future.

In the design of talent training programs, schools should combine the goals of talent cultivation of financial management major and increase the proportion of experiment and practice teaching on the premise of ensuring theoretical teaching. Schools can improve the practical teaching content from three aspects: professional cognitive education, professional skills training and employability training. First of all, schools should increase the number of hours of practical teaching of financial management. For example, the newly enrolled college students conduct professional cognitive learning and social practice through practical projects to strengthen their learning through practical training courses. Students' professional experience can be gained through teaching practice graduation practice and graduation thesis *etc*. Secondly, the school should carry on the overall design to the practical teaching link arrangement. For example, the purpose, specific tasks, content and assessment requirements of practice teaching should be included in the teaching plan, and teachers should strengthen the supervision and guidance of the whole practice process to serve the goal of talent cultivation. Finally, the time for students to work in the enterprise as teaching practice and graduation practice should be increased so that students can really get in touch with the work of enterprise financial management, combining the learned theoretical knowledge with practice, improving students' innovation and practical ability.

### 3.3  To cultivate the lifelong learning ability of accounting personnel

Things are constantly changing and evolving in green finance. Especially in recent years, many changes have taken place in China's financial policy. At the accounting level, the "New Accounting Standard" was only released in 2007 and some adjustments were made in 2017. Later several adjustments were made in 2018, the policies have undergone great changes from the income statement and balance sheet to the adjustment of accounting standards. In terms of taxation, the "business tax to value-added tax" was issued in 2016 and the personal income tax reform was taken in 2018. The State Administration of Taxation has issued 76 new policies since December 2018, and the VAT rate adjustment took place in 2019. . . Regardless of accounting level or tax level, this series of changes require financial personnel to constantly update their knowledge structure. Maybe the students just graduated and haven't gone to work, they have knowledge which is no longer applicable, so financial personnel must continue to learn, enrich their minds, update their own ideas. It's not enough to rely on blood transfusions and it should also have the function of hematopoiesis. Therefore, the cultivation of financial personnel's learning ability is far more important than imparting knowledge itself.

## 4  Conclusion

To cultivate learning ability, the consciousness of lifelong learning must be first established. The era of knowledge economy is also the era of information, various advanced information technologies are being increasingly used, and information technology is developing at a rapid pace. As for how to keep up with the pace of development and not be eliminated, financial personnel need to have the consciousness of lifelong learning and the ability to learn new technologies. School education should incorporate the cultivation of the learning ability of the educated people into the talent training program. In terms of teaching methods, teachers often use questioning methods to teach. Asking questions can promote students to think about problems and thus form their own unique way of thinking about problems. In terms of learning methods, from traditional book-to-face teaching to mobile classroom teaching, students are gradually developing their independent learning ability.

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**RESEARCH ARTICLE**

# The motive behind the demand for cryptocurrencies: Theoretical and empirical analysis of the Bitcoin price

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**Abstract:** The blockchain technology and cryptocurrency are now in the centre of the financial market. The raise of the cryptocurrencies represented by Bitcoin have attracted a large group of scholars to analyze the underlying dynamics of their price fluctuations. Intensive debate emerged on the intrinsic features of Bitcoin. In theoretical analysis, we developed the principle of monetary convention to define the concept of monetary consensus, capturing the nature of monetary system, and categorize it into three types: traditional, algorithm and hybrid. Based on the Wavelet Coherence Analysis, we try to analyze Bitcoin price dynamics in both time and frequency domains, comparing Bitcoin with financial assets, economic and financial indexes, and other cryptocurrencies.

**Keywords:** cryptocurrency, price dynamics, wavelet coherence

## 1   Introduction

Digital currency and digitization of currency are two intertwined but different concepts. The former is a form of money, while the latter is a trend of money development with the development of modern computer technology and the evolution of financial innovation. In such sense, digital currency is not only the carrier of currency digitization, but also the result of currency digitization. We are no stranger to traditional currency digitization and digital currency (or electronic currency, EC). In daily life, transactions and transfers using digital currency are carried out all the time. Different from the traditional currency digitization based on the central bank-commercial bank account system (When studying the modern payment system, we also need to include the third-party payment institutions. However, this change is still a limited expansion of the traditional central bank commercial banking system. Both central banks, commercial banks and third-party payment institutions use centralized methods to support customer transactions. This is essentially different from the decentralized monetary system represented by digital cryptocurrency.), cryptocurrencies represented by Bitcoin is committed to establishing a decentralized and super sovereign currency system based on blockchain technology and consensus principle, aiming to achieve safe and convenient P2P payment. Transactions are completed through smart contracts, and the ledger information of transactions is saved in the blockchain without being stored in a central institution (such as the current commercial bank database and third-party payment database). The customer's personal and transactional information are effectively isolated, so the protection of user's personal information is realized while solving the double-spending problem. In such a cryptocurrency system, the main body of currency issuance will no longer be the banking system dominated by the central bank, and the support of national credit is no longer needed behind currency issuance. This subversive concept of tradition has aroused fierce discussion from the beginning.

In the past few years, the expansion of cryptocurrencies represented by Bitcoin has exceeded most people's expectations. Bitcoin has quickly become a priority research object for market participants and research institutions. Moreover, with the rapid growth of Bitcoin price, more and more investors began to pay attention to and participate in Bitcoin investment. The popularity of Bitcoin as a search keyword in search engines increased sharply, and the breadth and depth of cryptocurrency expanded explosively in a very short time. Facebook's Libra white paper focused people's attention on digital cryptocurrency to a higher level. Major monetary authorities and central banks regard it as a core research topic. The US Federal Reserve, the

European Central Bank, the people's Bank of China and other institutions have all paid close attention to cryptocurrencies.

Reviewing the history and prices of cryptocurrencies represented by Bitcoin is of great significance for understanding the specific attributes of cryptocurrency. The aim of this research is to identify the role of cryptocurrencies represented by Bitcoin in the economic system and the financial market and to find the factors determine the price volatility of Bitcoin. By comparing the dynamic characteristics of the price change of cryptocurrency with that of other traditional assets (such as gold, oil, stocks, bonds, *etc*.), we can more accurately answer the question whether Bitcoin is a safe haven asset, digital gold, or a speculative tool. At the same time, we also investigated the dynamic correlation between Bitcoin and monetary indicators, which can help us understand the monetary attribute of Bitcoin and its relationship with real economic activities. Therefore, this study has strong theoretical and practical significance, and it is also the frontier of research in the field of monetary finance. The main content of this paper is divided into six parts: after the introduction, the theoretical analysis is discussed in part 2. The background and existing research of Bitcoin price is summarized in part 3. The fourth part introduces the models in details; The description of the data samples used in this study is placed in part 5, which also includes the results of empirical analysis; The final part concludes the article.

# 2    Theoretical approach to money and cryptocurrency

With the continuous updating of payment technology, a large number of transactions today are completed by electronic payment (EP) system, especially in the fields of business activities, large amount payment and e-shopping. The use frequency and transaction amount of physical currency, including coins and notes, are decreasing day by day. In this sense, modern society has actually entered the era of electronic currency. However, e-money in the field of modern payment is still based on the traditional bank account framework: the central bank (monetary authority), as the only legal tender issuer in an economy, issues base currency to deposit financial institutions, which then use it to generate derivative currency. Different from the precious metal backed currency, modern currency itself has little value. Behind it is the national sovereign credit, so it is called fiat money. In most cases, the main composition of deposit financial institutions is commercial banks, and the issuance, derivation and flow of money are based on the bank account system. Therefore, this modern social credit money generation system is often called the "central bank-commercial bank account system". At this stage, digital money and electronic money are just the carriers of credit money, which does not change the original modern money payment framework with the central bank-commercial bank account system as the core. However, the raise of cryptocurrency has fundamentally broken through this original framework.

## 2.1    System entropy decrease, information entropy increase and monetary consensus

From a deeper perspective, regardless of traditional currency or cryptocurrency, the reason why currency becomes currency depends on the broad belief of the public. Friedman and Schwartz (1963) [1] called it "Convention". As Friedman (1992) [2] pointed out, the emergence, existence and evolution of money are rooted in this convention: the reason why people hold and use money for transactions is not because the substance as the currency carrier itself has value, but because they unanimously believe that the currency will also be accepted by others (Friedman (1992) [2] pointed out when discussing why US dollar notes can become a widely accepted trading intermediary:" ... private persons accept these pieces of paper because they are confident that others will. The pieces of green paper have value because everybody thinks they have value. Everybody thinks they have value because in everybody's experience they have had value – as is equally true for the stone money ... The United States could barely operate without a common and widely accepted medium of exchange (or at most a small number of such media); yet the existence of a common and widely accepted medium of exchange rests on a convention: our whole monetary system owes its existence to the mutual acceptance of what, from one point of view, is no more than a fiction." (P.18)). The process of the emergence and development of money is the process of establishing this "Convention" from scratch, from chaos to order in the economic system. In thermodynamics, the concept of entropy is used to measure the degree of chaos within a system: the larger (smaller) the entropy, the higher (lower) the degree of chaos of the system. It is easy to see that the process of realizing the monetary

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"Convention" in the economic system is equivalent to the process of entropy reduction of the system.

Further thinking, modern monetary theory holds that the essence of money is bookkeeping of transaction. Through the study of substitution effect, Kocherlakota (1996) [3] directly pointed out that money is the record of information (Kocherlakota (1996) clearly pointed out in the article 'money is memory' that "The main proposition is that any allocation that is feasible in an environment with money is also feasible in the same environment with memory." (P. 1) [3]). Just as Friedman (1992) [2] described stone money in Caroline Islands, transactions using money do not need to change the physical location of money, but only affect the bookkeeping of related parties. In modern economy, behind every transaction is the ledger recorded in currency. Therefore, the concept of information entropy can be used to investigate the evolution of money. According to the definition of Shannon (1948) [4], the fundamental function and value of information is to eliminate the uncertainty of people's cognition of things, and information entropy is to measure the amount of information needed to eliminate such uncertainty.

Suppose an information source has n possible states $x_i$, $i = 1 \cdots n$, the probability of each state is $p(x_i)$, the information entropy of the corresponding information source is

$$\mathrm{H(X)} := -\sum_{i=1}^{n} p(x_i) \log_b p(x_i)$$

Generally, b = 2 is selected so that the unit of information entropy H (x) is byte. It is easy to see that the more chaotic a system is and the more information sources it contains, the higher the corresponding information entropy, which means that more information needs to be generated and saved to eliminate uncertainty to establish a "Convention". With the continuous occurrence of new transactions in the economic system, the information entropy of the system tends to increase. Accordingly, the information entropy needed to eliminate uncertainty and establish the "Convention" will continue to grow. According to the second law of thermodynamics, the entropy reduction process from disorder to order, that is, the process of meeting the continuously increasing information entropy, can only be realized by continuously doing work to the system.

In this article, we define this monetary "convention" as a new concept "monetary consensus". Further, according to the different mechanism and preconditions, we divide such monetary consensus into three categories: (1) Traditional monetary consensus; (2) Algorithm monetary consensus; (3) Hybrid monetary consensus. The current EC/EP system corresponds to the first type of monetary consensus, which is built on the basis of the central bank-commercial bank account system, financial infrastructure and taxation, laws and regulations, as shown in the left half of Figure 1. In order to realize this monetary consensus, the process of entropy reduction is the process of establishing and operating the grand financial system; The second type of currency consensus is the core foundation of the cryptocurrency (pure DC system) not issued by central bank. The mechanism to ensure the correctness of the ledger information recorded by the currency and the related system is no longer a centralized bookkeeping system, but an algorithm to automatically update the distributed bookkeeping system, as shown in the right half of Figure 1. The more transactions using cryptocurrency, the greater the total information entropy within the system. The work process required by the second law of thermodynamics to achieve consensus corresponds to the computational resources invested in running the algorithm (In the particular case of Bitcoin, such computational activity is called "mining".); The third type of currency consensus is the combination of the above two consensus. The digital legal currency issued by the central bank (Central Bank Digital Currency, CBDC) is an example of this mixed currency consensus, that is, DC/EP system: keep the original central bank commercial bank account system and related financial infrastructure at the EP end, and the DC side still follows the system and regulations of the central bank as the issuer of legal currency, and at the same time uses certain technology advantages of cryptocurrency, for example the distributed ledger technology (DLT).

Reviewing the history of money, the form of currency has experienced great changes, from clay (appeared around the 17th century BC), stone, shell and metal to the current paper money and electronic currency. As predicted by Friedman (1992) [2], digital currency will become the future of currency evolution (Friedman (1992) [2] pointed out when reviewing the development of money : "The 'something' that connects the two transactions is called money, and it has taken innumerable physical forms—from stones to feathers to tobacco to shells to copper, silver, and gold to pieces of paper and entries in ledger books. Who knows what will be the future incarnations of money? Computer bytes?"(P. 9)). At present, we are in a critical period from EC/EP to DC/EP, and we need to conduct more in-depth research on digital currency.
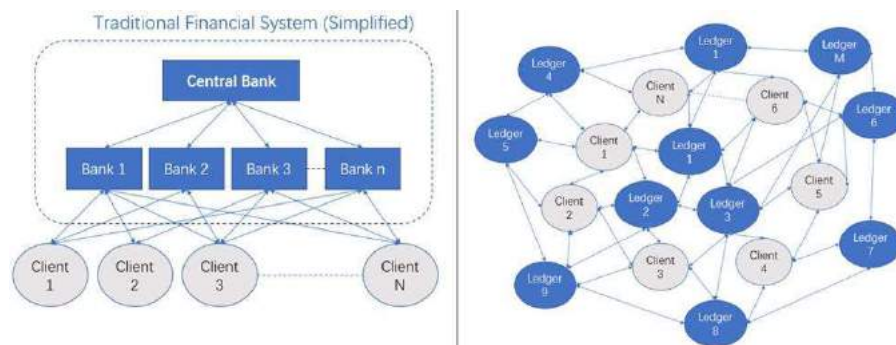
**Figure 1**　Currency consensus EC / EP system based on traditional financial system (left figure) and algorithm-based currency consensus distributed DC system (right figure) (Source: Own Construction)

## 2.2　Pros and cons of cryptocurrencies

Intensive debate has been occurred ever since the raise of cryptocurrencies as they are in sharp deviation to the fundamentals of modem monetary system. In the cryptocurrency system, central banks are no longer the issuer of money. Rather, private entities play active roles in providing cryptocurrencies to facilitate transactions. According to statistics, there are more than 7,800 cryptocurrencies in circulation today. The liquidity, accessibility, and thus the popularity are supported by active exchanges, in which new coins are issued and existing coins are traded, providing supply and liquidity for cryptocurrencies. In 2021, there are over 12,000 cryptocurrency exchanges (including listed and over-the-counter markets) around the world and cryptocurrencies can be used as the medium of payment in more than 100 countries.

The advocators of cryptocurrencies insist that the intrinsic nature of cryptocurrency assures the stable, or at least predictable, growth of supply [5] and thus contain the high level of inflation pressure incurred by loose monetary policy which is a "common" phenomenon in modern fiat money system after the 2008 global finance crisis. In addition, the distributed ledger technology provides a strong peer-to-peer payment mechanism that is able to work without a centralized authority and related data centers to maintain and manage huge amount of transaction data [6]. Such mechanism keeps cryptocurrencies from large scale data leakages frequently happened in the past and protect the privacy of the participants of the transaction as it is designed to be anonymous [7]. The blockchain technology also benefits the economy by lowering the cost of transactions, especially considering cross-border transactions. Empirical evidence indicates that Bitcoin lowers the transaction cost in retail foreign exchange market [8]. As summarized by the Bank of England (See the full report), distributed ledger technology that underpins cryptocurrencies "has the potential to enhance system resilience; improve the efficiency of end-to-end settlement processes and reporting, auditing and oversight; and enable greater automation." (p. 21) The rapid growth of cryptocurrency market reflects the evolution of cryptocurrency and the increasing involvement in financial market [9].

Many institutes and researchers hold concerns and even critiques on cryptocurrency, due to its designed structure, technological details and market implications. The anonymous feature of cryptocurrency give rise to severe regulatory issues, best represented by fraud and money laundering. Cryptocurrency market is now one of the largest unregulated markets in the world. According to Foley et al. (2019) [10], approximately one-quarter of Bitcoin users are involved in illegal activity. In sum, it is estimated that around 76 billion USD illegal activities per year (roughly 46% of Bitcoin transactions) are conducted using Bitcoin. The feasibility of cryptocurrencies as the medium of payment is also challenged because of the extremely high level of price volatility [11] and considerably low capacity of processing transactions (Technical reports indicate that the maximum process capacity of DLT-based Bitcoin can hardly reach 10,000 transactions per second, while current payment systems, such as Alibaba and Visa, can handle up to 600,000 transactions per second) [6, 12]. In a report (See the full report at https://www.bis.org/press/p201009.htm), jointly released by 7 major central banks and the Bank of International Settlement (BIS), cryptocurrencies are considered as one of the major potential threats to a coherent and well-regulated global financial system, undermining the fundamentals of domestic and international monetary system. In general, as stated by the Bank of England, "There is limited evidence of current generation of cryptoassets delivering benefits, but . . . benefits may arise in the future." (p. 3)

## 2.3    Research hypotheses

Based on theoretical analysis of the nature, technical features, and market implications of cryptocurrency, 5 hypotheses can be drawn in this research. In the first place, the acceptance of cryptocurrency as the medium of payment relies heavily on the consensus among individuals. Therefore, a positive connection between Bitcoin price and public awareness is expected. In addition, such correlation can amplify the volatility of Bitcoin price in a positive feedback circle. Such loop pushes up Bitcoin price, attracting more participants to cryptocurrency market, pursing capital appreciation rather than pure payment purpose. In this sense, Bitcoin has become an investment/speculative asset. Thus, a positive correlation between Bitcoin price with stock and bond market indices is expected. Second, as cryptocurrency develops and becomes more widely used, it tends to demonstrate positive correlation with traditional monetary and economic indices. More specifically, the more transactions used Bitcoin as payment, the higher level of connection between Bitcoin price with monetary indices, such as M0, M1, or M2. Third, due to the limited supply of Bitcoin and the technical mechanism of mining, the blockchain fundamentals of Bitcoin network, such as mining difficulty, hash value and transactions per minute, are expected to move in the same direction with Bitcoin price. Fourth, price beyond the level determined by fundamental drivers, the "fair value" of Bitcoin, can be considered as the speculative bubble, "mispricing" of Bitcoin, as shown in the work of Jia (2019) [11]. It is hypothesized that Bitcoin at current stage is more of a speculative asset rather than safe haven investments. Thus, the connection between the price of Bitcoin and of Gold is weak or even negative. Finally, certain major events may lead to the changes of Bitcoin prices, such as implementation of cryptocurrency in an economy and a revolutionary reform causes highly unstable domestic currency. These events encourage more users substitute domestic currency with cryptocurrency, thus pushing up Bitcoin price.

# 3    Dynamics of Bitcoin price

Although the concept of cryptocurrency can be traced back to a long time ago, it is generally believed that Nakamoto (2008) [13] is the first article to completely describe the architecture and practical methods of cryptocurrency. In this article, the author puts forward the theoretical basis, mathematical expression and implementation of Bitcoin. Based on the theory and method constructed by Nakamoto (2008) [13], Bitcoin was officially launched in January 2009. In the first year of online operation, the use of Bitcoin was limited to a small number of enthusiasts and had no substantive impact on the market. Until 2010, the first Bitcoin trading platforms and exchanges represented by Bitcoinmarket.com and MtGox (As once the most influential Bitcoin exchange, MtGox was officially registered and closed in February 2014. See Decker and Wattenhofer (2014) [14] and Ingram (2015) [15] for discussion and Research on the reasons for the closure of MtGox and the development of Bitcoin.) were established. The emergence of a large number of online trading platforms and exchanges (For the evolution of the exchange during the development of Bitcoin, interested readers can see https://thebitcoinnews.com/bitcoin-history-part-6-the-first-bitcoin-exchange/.) has greatly expanded the trading convenience and liquidity of Bitcoin, attracted more institutions and individuals to join the Bitcoin system, and brought more resources and services. After such a positive cycle, the Bitcoin system continues to expand. As summarized by Kondor et al. (2014) [16], the cryptocurrency system represented by Bitcoin is an evolving network. With the increase of included nodes, the scale, convenience and influence of the network system will accelerate to enlarge, so as to absorb more nodes and resources into the system and realize positive feedback amplification. With the continuous development of Bitcoin, its price trend has also experienced great fluctuations (as shown in Figure 2), which has also attracted a large number of researchers to analyze the mechanism of Bitcoin price fluctuation.

Bouoiyour and Selmi (2017) [17] studied the main determinants of Bitcoin price using Bayesian quantile regression. The results show that hash value, geopolitical factors, macroeconomic indicators and important events are the fundamental factors that determine the price fluctuation of Bitcoin. Ciaian, Rajcaniova and Kancs (2014) [18] pointed out that the attraction of Bitcoin to investors is the main driving force of Bitcoin price. Vacha and Barunik (2012) [19] used wavelet correlation model to study the price fluctuation characteristics of energy commodity market, which is an earlier attempt using wavelet analysis method to analyze the price of investment assets. Based on similar methodology, Kristoufek and Scalas (2014) [20] analyzed the driving factors of Bitcoin price fluctuation.

Another perspective to explore the dynamics of cryptocurrency price is transparency. For financial investments, information transparency determines the quality of the underlying assets
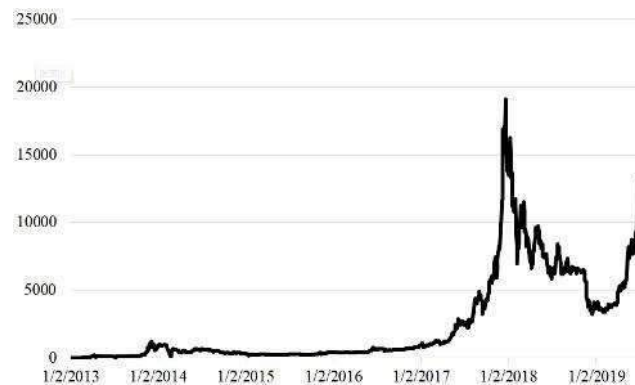
**Figure 2**   Bitcoin price index (USD, 20130102-20190708; Source: Bitcoinity)

and thus the intrinsic value. As shown in the work conducted by Wang et al. (2017) [21], firm value is improved by higher level of information transparency when property rights protection is in place. In the context of international trading, domestic earning transparency plays the key role in the formation of listed firm's fair value [22]. Considering the taxation and accounting standards in different regions, Ding et al. (2007) also conclude that earnings transparency is positively correlated with the fair value of listed firms. Cryptocurrencies and Bitcoin in particular can be traded around the world in various of markets and exchanges. In such sense, they are similar to listed firms. Therefore, the fair value of cryptocurrency is expected to be correlated with domestic transparency. It is a promising perspective to understand the fair value and mispricing of cryptocurrencies.

These works have achieved rich theoretical and practical results, which provides valuable inspiration and experience for this paper. On this basis, the wavelet correlation model is selected to study the time-domain and frequency-domain correlation between time series. The model of this type can accurately describe the degree of correlation, leading and lagging properties between original time-domain signals. This study also expands the scope of the original research, and introduces hedging assets, such as gold, and relevant indicators representing the international economic and political situation, such as oil price and market volatility index VIX, into the wavelet correlation analysis. In addition, we also study the relationship and difference between Bitcoin and several other major cryptocurrencies.

# 4   Methodology and empirical model

## 4.1   Wavelets model

Spectrum analysis is an effective methodology for accurate analysis of complex signals. It is widely used in electronic signal processing, electronic engineering, optics, analytical chemistry, acoustics, medicine and many other fields. In economic analysis and financial research, because the fluctuation of time series can be regarded as the result of the joint action of many factors (i.e. wavelet analysis of different spectrum), more and more researchers are committed to using wavelet analysis model in spectrum analysis to study the dynamic characteristics and mechanism of economic and financial indicators. Gallegati, Ramsey and Semmler (2011) [23] used wavelet analysis model to study the U.S. labor market, which confirmed the existence of Phillips curve. Aguiarconraria and Soares (2011) [24] used wavelet analysis model to study the fluctuation of European economic cycle.

The basis of wavelet analysis is Fourier transform, as shown in Equation (1): the original time domain signal $x(t)$ is transformed into frequency domain signal $X(f)$ by Fourier transform. This is a reversible transformation. As shown in Equation (2), the inverse Fourier transform converts the frequency domain signal into the time domain signal. In this way, the original signal can be switched between time domain and frequency domain. However, Fourier analysis cannot give the time domain and frequency domain information of the signal at the same time. Wavelet analysis model is developed to fill this gap, so that researchers can obtain both time-domain and frequency-domain information of the original time series signal at the same time.

$$X(\mathrm{f}) = \int_{-\infty}^{\infty} x(t) \cdot e^{-2i\pi ft} dt \tag{1}$$

$$x(\mathrm{t}) = \int_{-\infty}^{\infty} X(f) \cdot e^{2i\pi ft} df \tag{2}$$

As shown in Equation (3), the wavelet analysis model converts the original time series signal $x(t)$ into a function of time ($\tau$, the position of the original signal on the time axis) and frequency (s) - $\Psi_x^{\varphi}(\tau, s)$ (Here s is the reciprocal of the frequency, that is, s = scale = 1 / F.). Here, function $\varphi$ is the wavelet function, which meets the square integrability condition $\int_{\infty}^{\infty} \varphi(t)^2 dt < \infty$, and $\varphi^*$ is the conjugate of this function. Because all wavelets are derived from functions $\varphi$, it is often cited as the generating function. As can be seen from Equation (3), function $\Psi_x^{\varphi}(\tau, s)$ gives the similarity between the original signal at time $\tau$ and the wavelet $\varphi$ with frequency of 1/s. By constantly changing the time value $\tau$ and $s$, the information of the original signal in the whole time period and the whole frequency period can be obtained.

$$\Psi_x^{\varphi}(\tau, s) = \frac{1}{\sqrt{|s|}} \int_{-\infty}^{\infty} x(t) \cdot \varphi^* \left( \frac{t - \tau}{s} \right) dt \tag{3}$$

As shown by Addison (2002) [25], there are many choices of wavelet functions $\varphi$ according to different research objects and research purposes, as long as the Admissibility Condition, $\int_0^{\infty} \frac{|\Psi(f)|^2}{f} df < \infty$, is satisfied. In economic analysis, analytical Morlet wavelet is widely selected. Its definition is as follows:

$$\varphi^M(t) = \frac{1}{\pi^{1/4}} e^{i\omega_0 t} e^{-t^2/2} \tag{4}$$

In this equation, parameter $\omega_0$ represents the center frequency of wavelet. Accoding to Vacha and Barunik (2012) [19], we set $\omega_0 = 6$. By substituting Equation (4) into Equation (3), the time-domain and frequency-domain functions of the original time series $x(t)$, $\Psi_x^{\varphi^M}(\tau, s)$, can be written using Continuous Wavelet Transform (Equation (5)):

$$\Psi_x^{\varphi^M}(\tau, s) = \frac{1}{\sqrt{|s|}} \int_{-\infty}^{\infty} x(t) \cdot \frac{1}{\pi^{1/4}} e^{i\omega_0 \frac{t-\tau}{s}} e^{-\left(\frac{t-\tau}{s}\right)^2/2} dt \tag{5}$$

So far, a group of time series is transformed into signals containing both time-domain and frequency-domain information through continuous wavelet transform. Due to the generating wave function $\varphi^M$ is a function in the complex field, so the amplitude and phase information can be obtained by studying the real part and imaginary part. In next section, we will use this property to study the correlation of two groups of time series signals after continuous wavelet transform.

## 4.2   Wavelet coherence model

Based on the wavelet model, we further construct the wavelet coherence model, and then calculate the wavelet coherence. Referring to the research of Vacha and Barunik (2012) [19] and Kristoufek and Scalas (2014) [20], the cross wavelet transform should be constructed first. Cross wavelet transform $\omega_{xy}(\tau, s)$ corresponding to two continuous wavelet transformed time series signals $x(t)$ and $y(t)$ is

$$\omega_{xy}(\tau, s) = \omega_x(\tau, s)\omega_y^*(\tau, s) \tag{6}$$

Equation (6) indicates that the modulus of Cross Wavelet Transform $|\omega_{xy}(\tau, s)|$ captures the degree of coherence of two time series signals at each frequency s and time $\tau$. Referring to the method used by Torrence and Webster (1999), the wavelet correlation coefficient is defined as

$$R_{xy}^2(\tau, s) = \frac{\left| S \left( \frac{1}{s} \omega_x(\tau, s)\omega_y^*(\tau, s) \right) \right|^2}{S \left( \frac{1}{s} |\omega_x(\tau, s)|^2 \right) S \left( \frac{1}{S} |\omega_y(\tau, s)|^2 \right)} \tag{7}$$

In Equation (7), is the smoothing operator. This equation defines the square of the correlation value of two original time series in time domain and frequency domain, with the condition of $0 \leq R_{xy}^2(\tau, s) \leq 1$. As described in the previous section, when the generating function in the complex domain is used for continuous wavelet transform, the phase difference between the two signals can be studied by analyzing the real and imaginary parts of the signal $\vartheta_{xy}$ (Equation (8)):

$$\vartheta_{xy} = \tan^{-1} \left( \frac{Im \left\{ S \left( \frac{1}{S} \omega_{xy}(\tau, s) \right) \right\}}{Re \left\{ S \left( \frac{1}{S} \omega_{xy}(\tau, s) \right) \right\}} \right) \tag{8}$$

The functions $Re\{\cdot\}$ and $Im\{\cdot\}$ return the real part and imaginary part of the corresponding value, respectively. In empirical analysis, the phase difference is represented by an arrow. When the arrow points to the right (left), it indicates that the two groups of signals are positively correlated (negatively correlated) in this area; When the arrow is up (down), it indicates that the first group of signals leads (lags) the second group of signals in this area.

# 5    Data and empirical analysis

## 5.1    Data

To carry out empirical analysis, we need sufficient data samples.  In order to study the dynamic characteristics of Bitcoin price fluctuations, especially compared with other assets, we collected six groups of data information sets:

1) Bitcoin specific data, including price, bid ask spread, price volatility, trading volume, hash rate, mining difficulty, trading volume per minute, *etc*;

2) Typical asset prices, including gold, oil, stock market index and bond yield;

3) Variables characterizing economic situation and market environment: dollar index and market volatility index (VIX);

4) Traditional monetary statistics, the year-on-year growth rates of US dollar M0, M1, and M2 are used in this article;

5) Public attention to Bitcoin, mainly includes the changes in the popularity in Google search using keyword "Bitcoin" in a certain region;

6) Time series of price of other digital cryptocurrencies. Considering the data availability and market influence, this article includes Ripple (XRP), Ethereum (ETH), Stella (STE) and Litecoin (LITE) with Bitcoin to study the similarities and differences of the price trajectory of cryptocurrencies.

The first group of indicators capture the unique endogenous attributes of Bitcoin. Bitcoin index comes from Bitcointy (https://data.bitcoinity.org/). Comprehensive index based on the prices of Bit-x, Bitbay, Bitfinex, Bitstamp, cex.io, CoinBase, exmo, Gemini, itbit, Kraken and other platforms; Similarly, the bid ask spread and price volatility are calculated by calculating the average value of the corresponding data in the above exchanges; The trading volume is obtained by summing up the trading volumes of all above exchanges; Bitcointy gives the hash value information of antpool, btc.top, BTCC pool, bitclub network, bitfury, bitminter, bitcoin.com, f2pool, Kano ckpool, slushpool, solo ckpool, viabtc and other platforms. Based on this, we get the comprehensive aggregate hash value; Bitcointy also provides daily data on the difficulty of Bitcoin mining.

The asset price index in the second group, market volatility index and US dollar index in the third group can be obtained through public data sources. In this article, we use Yahoo Finance and CEIC database. Among them, the gold price is the London Bullion Market Association gold price (AM), and oil price the West Texas Intermediate Cushing crude oil spot price. In this paper, the CBOT volatility index (VIX) is used to characterize the market volatility index. The larger (smaller) the VIX value, the stronger (weaker) the investor's expectation of future market volatility, and the greater (smaller) the market panic.

Bitcoin is designed to function as a currency to facilitate various transactions. Does it already have such a function or potential?  A good tool is to measure its dynamic relationship with traditional currencies. In this paper, we use the M1 growth rate of US dollar to represent the traditional currency, and the data source is CEIC database. At the same time, since M1 is highly correlated with the activity of real economic activities, observing the growth rate of Bitcoin and M1 can also measure the dynamic relationship between Bitcoin price and macroeconomic activities from the monetary level.

In order to measure the public attention of Bitcoin, this study uses Google Statistical heat index data (https://trends.google.com) of keyword "Bitcoin".  In order to more accurately describe the regional differences and the impact of certain countries, we used the search heat data of the world, the United States, India and Venezuela.

Finally, in order to study the dynamic relationship between the price fluctuation of Bitcoin and other major digital cryptocurrencies, we extract the price time series of four major digital cryptocurrencies in the market.  Considering that some cryptocurrencies have been actively traded for very short period of time, we select four cryptocurrencies: Ripple (XRP), Ethereum (ETH), Stella (STE) and Litecoin (LITE). The data source for the daily price of these four cryptocurrencies is coindesk (https://www.coindesk.com).

## 5.2    Empirical analysis

The wavelet coherence model introduced in the research method part is used to empirically analyze the above data, and the wavelet coherence graph can be obtained. The correlation strength of the two signals in the specified area (time is abscissa and frequency ordinate) can be read from the wavelet correlation diagram. The higher (lower) the correlation between the two signals in a certain area of the graph, the hotter (colder) the corresponding color. Referring to the research of Vacha and Barunik (2012) [19], in economic field, generally only the fluctuation

correlation within one year of the cycle is considered. Therefore, this study limits the ordinate range to 256 days (close to the working day time in a year). The meaning of the arrow in the wavelet correlation diagram is exactly the same as that described in the research methods section.

The debate on Bitcoin attribute and holding motivation is the main concern of the market and academia. On the one hand, many supporters of blockchain technology and cryptocurrency, especially those of Bitcoin, believe that Bitcoin is digital gold (In a sense, Bitcoin and gold do have similarities. The most important similarity is that Bitcoin and gold are limited supply growth). in the information society (refer to Popper's (2015) [26] research on the development of Bitcoin), which is a new digital currency and digital asset; On the other hand, with the rapid expansion of the cryptocurrency market represented by Bitcoin, more and more individual and institutional investors regard it as an important investment asset and occupy an important position in the portfolio; In addition, due to the extreme volatility of Bitcoin price in the short term, a large number of market participants and researchers believe that Bitcoin is a speculative asset. In order to answer a series of questions about what the attribute of Bitcoin is and why investors hold Bitcoin, we first analyze the monetary attributes of Bitcoin.

Bitcoin is designed to facilitate payment and perform the main functions of traditional currency. In terms of payment means and transaction media functions of currency, cryptocurrency has a substitution effect on traditional currency. The more transactions using digital currency, the greater the impact on the currency in traditional circulation (i.e. M0). At the same time, due to the relatively fixed supply, the price of Bitcoin tends to rise over time. From this point of view, the price of cryptocurrency has a negative correlation with the traditional currency in circulation. In terms of the value storage function of money, with the increase of economic activity and social wealth, the value stored in traditional money and digital money will increase. Therefore, there is a positive correlation between Bitcoin price and the growth rate of traditional money (M1 and M2). The differential relationship between Bitcoin price and the growth rate of traditional currencies at different levels can be clearly observed in Figure 3 and 4: since the end of 2017, Bitcoin has a high negative correlation with the growth rate of US dollar M0 and a high positive correlation with the growth rate of US dollar M1, which is reflected in the wavelet coherence graph, that is, there are large red areas in the medium and long-term frequency band. The close correlation between the price of Bitcoin and the growth of M0 and M1 also shows that Bitcoin is rapidly entering the real economy. The substitution effect on M0 is obvious. It can also be found from Figure 4 that the relationship between Bitcoin price and US dollar M2 growth is not as obvious as M0 and M1, which also shows that the replacement of traditional currency by privately issued cryptocurrency represented by Bitcoin is still at the development stage. Using the concept of currency consensus defined in the second part of this paper, it can be considered that the cryptocurrency issued by the non-central bank entities is in the second type of currency consensus, that is, the establishment stage of algorithm-based currency consensus.
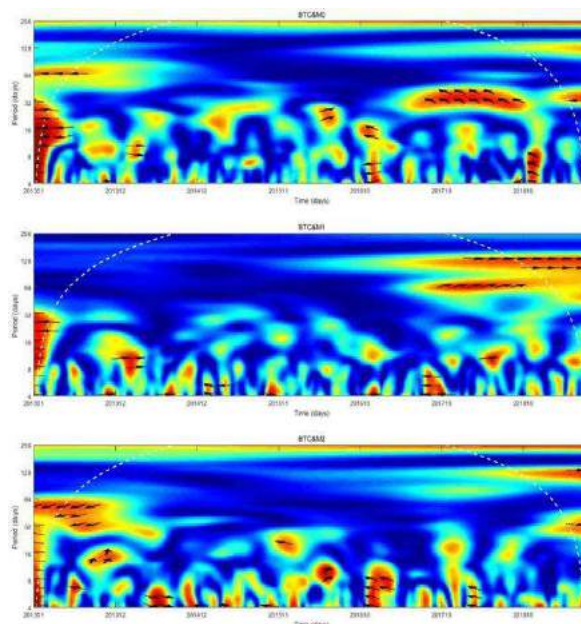


**Figure 3**    Coherence distribution between Bitcoin price and dollar growth at all levels
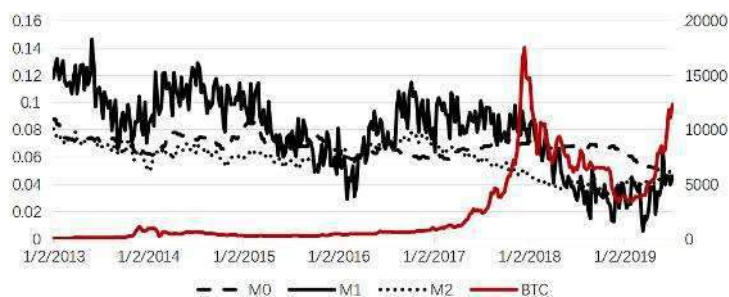
**Figure 4**   Bitcoin price and USD M0, M1, M2 growth rates

The functioning of Bitcoin market is an important aspect to investigate the price fluctuation mechanism of Bitcoin. In Figure 5, the correlation distribution between Bitcoin price index and Bitcoin market transaction variables is depicted. Consistent with the operating mechanism and theoretical expectation of Bitcoin, there was a high positive correlation (medium frequency to high frequency range) between Bitcoin price and price volatility and the number of transactions, from 2017 to 2018, which was a period of rapid growth of Bitcoin price. It can be seen that the increase of Bitcoin price has attracted more investors to enter the Bitcoin market, further pushing up the trading volume and price volatility. Similar to the research results of the Bitcoin currency attribute discussed earlier, Bitcoin price is highly positively correlated with the number of transactions carried out by Bitcoin (Figure 5, lower image). It once again shows that the cryptocurrency has the basic function of traditional currency as a means of payment and transaction medium, and the currency consensus of digital currency is in the formation stage.
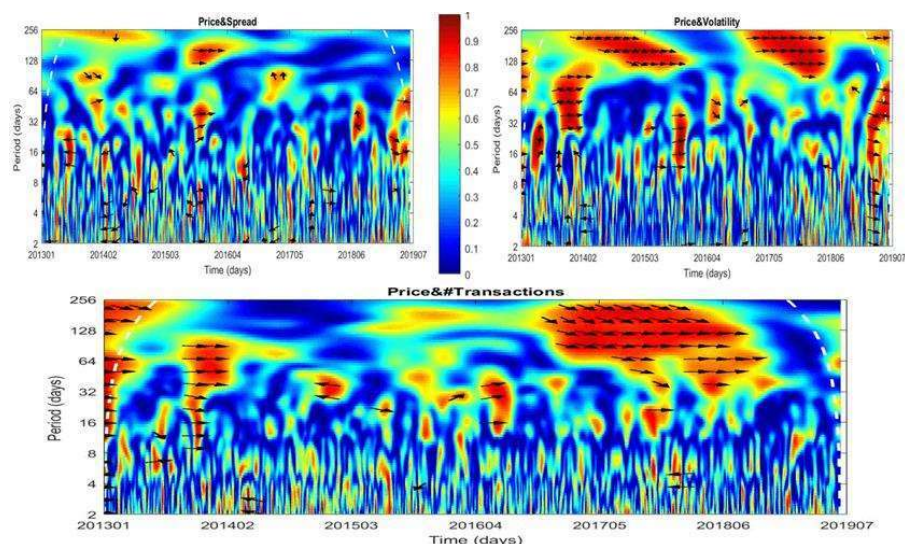


**Figure 5**   Coherence distribution of Bitcoin and its market transaction variables

To study the investment asset attribute of Bitcoin, we need to quantitatively study the dynamic correlation between its price and other related traditional assets and indicators. In this paper, we select three types of four typical traditional investment categories: commodity investment represented by gold and oil (at the same time, gold is also widely regarded as a safe haven asset), equity investment represented by S&P 500 and bond investment represented by one-year US Treasury bond yield.

Figure 6 depicts the coherence between Bitcoin price and four asset prices from January 2, 2013 to July 8, 2019. The following main conclusions can be seen from the figure: (1) The correlation between Bitcoin and gold and other assets is not obvious in the short-term frequency period (the time length is less than one and a half months); (2) From 2015 to 2016, Bitcoin and crude oil prices were highly negatively correlated in the medium term (one and a half to six months), and oil prices moves ahead of Bitcoin prices. After that, the coherence weakens; (3) After 2018, the coherence between Bitcoin assets and stock market and bond market indicators has significantly increased in the medium and long-term (one and a half months to one year) band. This shows that with the rapid expansion of Bitcoin system and the increase in the number of investors, Bitcoin is becoming a potential investment asset in parallel with the stock market,
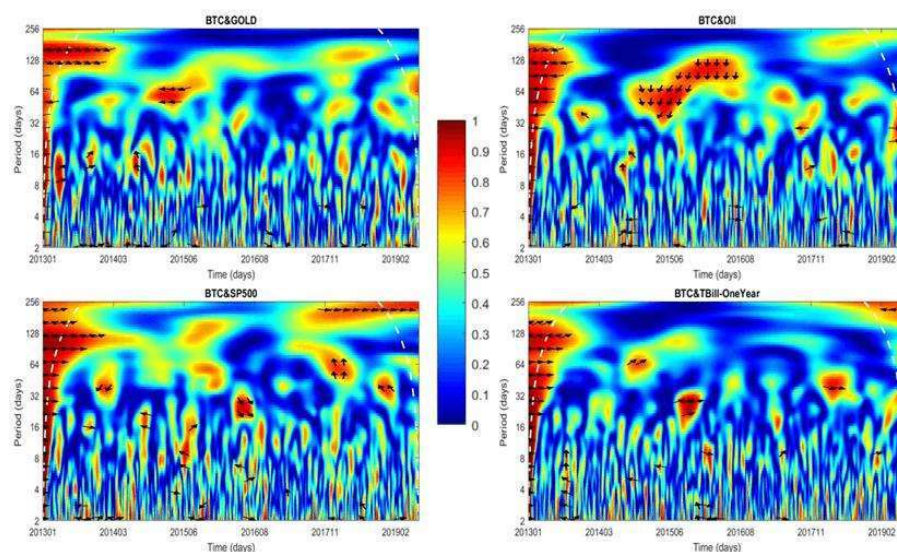
bond market and commodity market.



**Figure 6** Coherence distribution of Bitcoin price with gold, oil, S & P500 and US one-year treasury bond yield
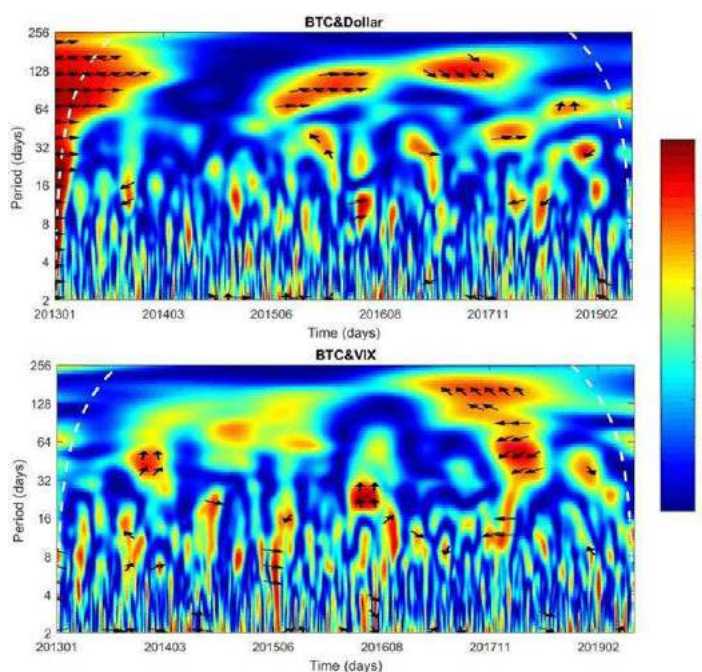


**Figure 7** Coherence distribution of Bitcoin price with us dollar index and market volatility index

In Figure 7, it can be found that there is a strong positive correlation between Bitcoin price and US dollar index in the medium and long-term frequency band since 2015. The possible explanation for this result is that if Bitcoin is regarded as an investment product with substitution effect with traditional assets, the improvement of the US dollar index puts downward pressure on the price of commodities denominated in US dollars. At the same time, the economic growth of developed economies outside the United States weakens, making part of the investment funds flow from the traditional market to the Bitcoin market. It can be seen from Figure 7 that around the end of 2017, Bitcoin and market panic index VIX showed an obvious negative correlation in the medium and long-term frequency band. This can be explained by the wealth effect of US dollar assets and stock investment. The appreciation of US dollar assets and the return of stock investment increase the investable capital of investors. At the same time, the optimistic expectation of the market further promotes the investment willingness. Therefore, more funds can be invested in the Bitcoin Market. At the same time, the negative correlation

between Bitcoin price and market panic index also shows that Bitcoin does not have strong characteristics of safe haven assets. This conclusion is consistent with the conclusion that there is no obvious correlation between Bitcoin and gold price shown in Figure 6.

As mentioned earlier, Bitcoin is a cryptocurrency based on blockchain technology, so its price change is also related to the operation of the blockchain. In Figure 8, we summarize the distribution of the correlation between Bitcoin price and blockchain operation indicators in time domain and frequency domain. In this figure, it can be seen that in 2013, Bitcoin price is highly related to the long-term trend of blockchain operation fundamentals such as hash value, mining difficulty and transaction volume per minute. However, after that, the correlation decreased sharply. Especially during the period of Bitcoin price surge in 2017 and 2018, the correlation between Bitcoin price and blockchain fundamental data is very low. Therefore, the rapid increase in prices at this stage can be interpreted as a bubble driven by investment and speculation, rather than fundamentals.
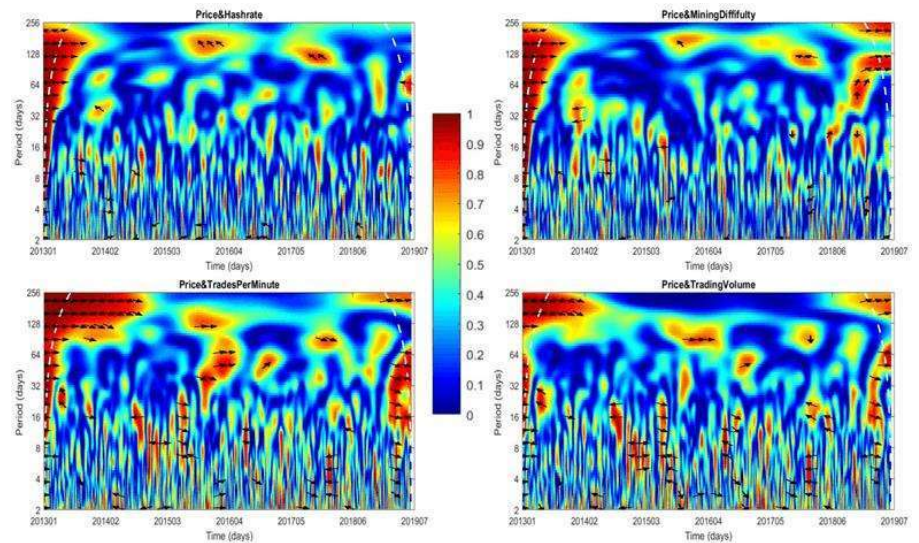


**Figure 8**   Coherence distribution of Bitcoin and blockchain variables
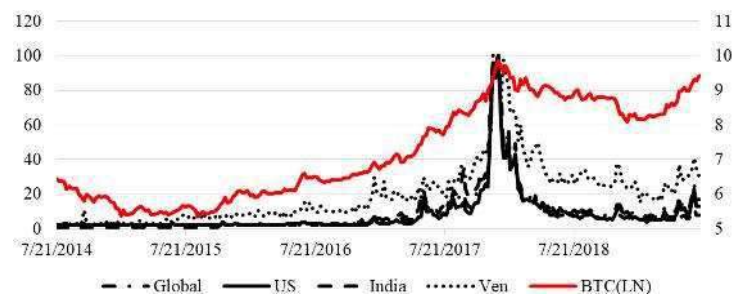


**Figure 9**   Bitcoin price (take the logarithm of its natural base, right axis) and changes in Google search popularity in the world (global), the United States (US), India and Venezuela (left axis)

As Bitcoin is still in the stage of development and expansion, the increase in the number of Bitcoin investors and users has played a decisive role in the trend of Bitcoin price. Therefore, the higher the attention of the public group to Bitcoin, the greater the number of potential investors and users of Bitcoin, and thus higher Bitcoin price. This trend can be clearly seen from Figure 10. Bitcoin price is highly positively correlated with the operation trend of search popularity. Referring to many previous studies, in this paper, we use the popularity of the search keyword "Bitcoin" in the search engine to characterize this index. We can clearly see this trend. Bitcoin price is highly related to the trend of search popularity. Figure 11 shows the analysis results of wavelet coherence. It can be seen that since 2015, there has been a high positive coherence between Bitcoin price and search popularity in all frequency bands, indicating that public awareness is one of the main driving factors of Bitcoin price, and the addition of new investment has increased the volatility of Bitcoin price. This conclusion is consistent with our hypothesis and empirical evidence that there is a positive correlation between Bitcoin price and

its volatility, especially from 2017 to 2019 when Bitcoin price fluctuates sharply (as shown in Figure 7). This also shows that the Bitcoin market is still in a period of rapid expansion, and the main driving force for the growth of Bitcoin price is incremental investment. This conclusion is in good agreement with the previous research results and our expectations, and also supports the research conclusions of Ciaian, Rajcaniova and Kancs (2014) [18].

It is worth noting that for economies with extremely unstable domestic currencies (represented by India and Venezuela in this study), the correlation between search heat index and Bitcoin price in the short term is much higher than the global average and developed countries. India launched the "banknote reform" in November 2016 and abolished large Rupee banknotes; Venezuela started currency reform in December 2016 and August 2018. As shown in Figure 9, at these time points, the Bitcoin price is highly positively correlated with the country's Google search popularity in both medium and high frequencies, also indicating that the Bitcoin price can be driven by major events, confirming our hypothesis.
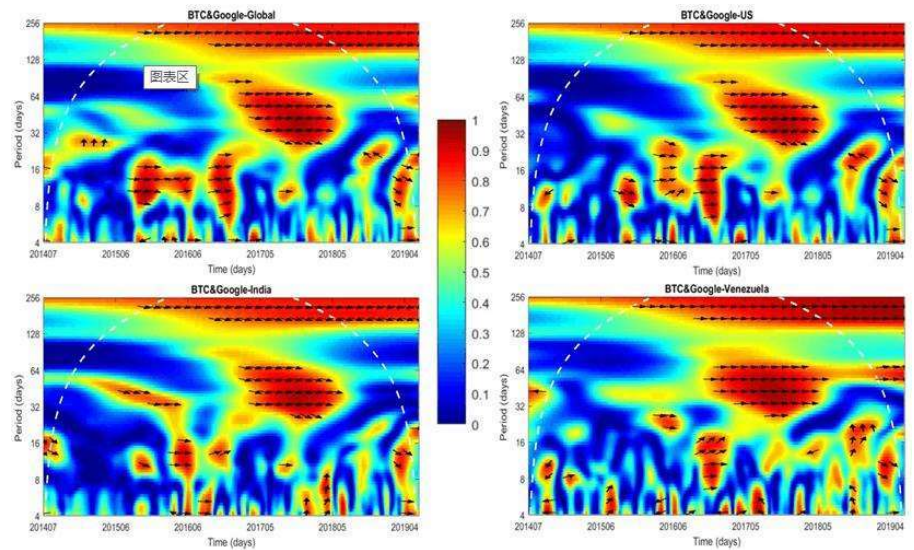


**Figure 10**   Coherence distribution between Bitcoin price and Google search popularity
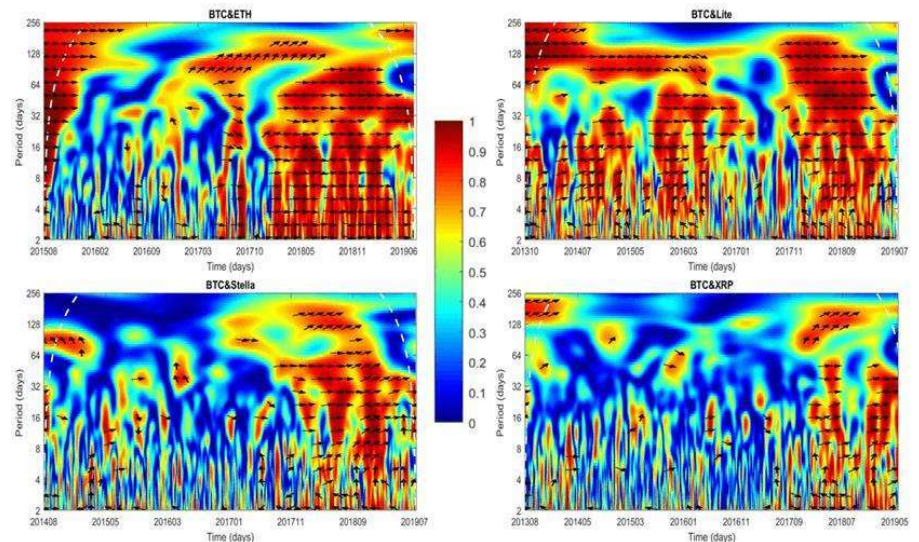


**Figure 11**   Distribution diagram of price fluctuation coherence between Bitcoin and other four digital cryptocurrencies

To study the dynamic relationship between the price fluctuation of Bitcoin and other major cryptocurrencies, we extracted the price trend information of four major cryptocurrencies in the market. We select four major cryptocurrencies: Ripple (XRP), Ethereum (ETH), Stella (STE) and Litecoin (LITE). Figure 10 shows the coherence distribution of price fluctuations between Bitcoin and the four cryptocurrencies. It can be seen that Bitcoin has a high positive

correlation with Ethereum and Litecoin, while it has a low correlation with Stella and XRP. It should be emphasized that after 2018, the coherence between Bitcoin and all the four cryptocurrencies has increased significantly in almost all frequency bands, indicating that the price trend consistency of cryptocurrencies has been rapidly strengthened. With the rapid popularization of cryptocurrency represented by Bitcoin after 2018, the cryptocurrency market is moving from dispersion to concentration. Therefore, the price trajectory of each cryptocurrency has becoming more and more consistent.

# 6    Conclusion and discussion

With the development of payment system, e-money has become the main monetary carrier of various transaction activities in social production and life. The use frequency and transaction amount of real currency, including coins and notes, are decreasing day by day. In this sense, modern society has actually entered the era of electronic money and electronic payment (EC/EP). Cryptocurrency issued by private entities is committed to establishing a new monetary and financial system based on blockchain technology. This system adopts decentralized distributed processing mechanism and makes full use of existing Internet nodes and computing resources, which can greatly reduce transaction costs, effectively solve the double-spending problem and protect users' personal information. Bitcoin, as the most influential cryptocurrency and the currency with the highest market share, has attracted the attention of the market in a short time. In particular, the sharp rise in the price of Bitcoin in the past 2-3 years has attracted extensive attention, and also intensified the debate on the currency attribute and the motivation of holding cryptocurrency. In theory, by introducing entropy subtraction and information entropy of economic system, combined with monetary theory, this study puts forward the concept of "monetary consensus", and defines three types of monetary consensus. In terms of empirical analysis, by comparing the dynamic characteristics of the price change of cryptocurrency with the growth rate of traditional currencies at different levels (USD M0, M1 and M2) and the price change of other traditional assets (such as gold, oil, stocks, bonds, *etc*.), we can more accurately answer the question about whether Bitcoin has the attribute of currency and investment assets.

The analysis of the dynamic correlation between time series needs to calculate the dynamic relationship in time domain and frequency domain. The correlation model in wavelet analysis model just meets this demand. In this paper, the original time series signals are transformed into complex functions in time domain and frequency domain by continuous Morlet wavelet transform. At the same time, the intensity and phase angle of wavelet correlation coefficient are defined by cross wavelet transform, so that the correlation distribution of two time series signals in time domain and frequency domain can be analyzed. Empirical analysis shows good consistence with research hypotheses. In conclusion, the following theoretical and empirical findings are obtained:

Firstly, we define the essence of modern money as a new concept "monetary consensus", and divide it into three categories according to the generation mechanism and preconditions: (1) Traditional monetary consensus; (2) Algorithm monetary consensus; (3) Hybrid monetary consensus. The current EC/EP system corresponds to the first type of monetary consensus, which is based on the central bank-commercial bank account system, the construction of large-scale financial infrastructure and the construction of taxation, laws and regulations. In order to realize this monetary consensus, the process of entropy reduction is the process of establishing and operating system; The second type of currency consensus is the core foundation of the cryptocurrency (pure DC system) issued by the non-central bank entities. The mechanism to ensure the correctness of the ledger information recorded by the currency is no longer a centralized accounting system, but automatically updates the distributed accounting system by relying on the algorithm. The more transactions using cryptocurrency, the greater the total information entropy within the system. The work process required by the second law of thermodynamics to achieve consensus corresponds to the computational resources invested in running the algorithm; The third type of currency consensus is the combination of the above two consensus. The digital legal currency issued by the central bank is an example of this mixed currency consensus, that is, DC/EP system: utilize the original central bank commercial bank account system and related financial infrastructure at the EP end, while the DC side still follows the system and regulations of the central bank as the issuer of legal currency, and uses certain technical features of cryptocurrency.

Secondly, since the end of 2017, Bitcoin has been highly negatively correlated with the growth rate of US dollar M0 and highly positively correlated with the growth rate of US dollar M1, indicating that Bitcoin is rapidly entering the real economy, has obvious substitution effect on M0 and has considerable value storage function. This finding verifies our hypothesis that

as cryptocurrency becomes more widely used in transaction, its connection with traditional monetary indices enhances as well. The relationship between Bitcoin price and the growth rate of US dollar M2 is not as obvious as M0 and M1, which also shows that the replacement of traditional currency by cryptocurrency issued by non-central bank entities represented by Bitcoin is still in the development period. It can be considered that the cryptocurrency issued by non-central bank entities is in the stage of establishing currency consensus based on algorithm.

In the third place, the correlation between Bitcoin and assets such as gold is not obvious in the short term (less than one and a half months). However, after 2018, the correlation between Bitcoin assets and stock market and bond market indicators has significantly increased in the medium and long-term band. This shows that with the rapid expansion of Bitcoin system and the increase in the number of investors, Bitcoin, as our first hypothesis predicted, has becoming a potential investment asset in parallel with the stock market, bond market and commodity market;

Fourth, since 2015, there has been a strong positive correlation between Bitcoin price and US dollar index in the medium and long-term frequency band. Around the end of 2017, Bitcoin and market VIX showed an obvious negative correlation in the medium and long-term frequency band. This can be explained by the wealth effect of US dollar assets and stock investment. The appreciation of US dollar assets and the return of stock investment increase investable capital. At the same time, the optimistic expectation of the market further promotes the investment willingness. Therefore, more funds can and tend to be invested in Bitcoin Market. At the same time, the negative correlation between Bitcoin price and market panic index also shows that Bitcoin does not have strong characteristics of safe haven assets to a certain extent, further supporting the hypothesis that Bitcoin is of speculative/investment asset rather than safe haven asset;

Fifth, the increase in the number of Bitcoin investors and users has played a decisive role in the trend of Bitcoin price: since 2015, there has been a high positive correlation between Bitcoin price and search popularity in all frequency bands. The public popularity of Bitcoin is one of the main driving factors of its price, and the addition of new investment has amplified price volatility. This finding verifies our hypothesis that Bitcoin price is positively correlated with public awareness of Bitcoin. It is worth noting that for economies with extremely unstable currencies (such as India and Venezuela), the search heat index has a far higher correlation with Bitcoin price in the short-term than the global average and developed countries. At the time of currency reform in India and Venezuela, the high-frequency positive correlation between Bitcoin price and search popularity in that country has increased rapidly in the short-term, which also reflects that the fluctuation of Bitcoin price is affected by major events. This is consistent with our final hypothesis that major events may give rise to the fluctuations of Bitcoin price;

Sixth, during the period of rapid growth of Bitcoin price in 2017 and 2018, the correlation between Bitcoin price and blockchain fundamentals is low. The rapid increase in prices at this stage can be interpreted as a bubble driven by investment and speculation rather than a price growth supported by fundamentals. Therefore, Bitcoin assets have strong speculative tool attributes at present. This is consistent with our fourth hypothesis and the findings of Jia (2019) [11];

Seventh, with the accelerated popularity of cryptocurrencies represented by Bitcoin after 2018, the cryptocurrency market is moving from dispersion to concentration. Therefore, the price indices of cryptocurrencies converge.

In short, the theoretical contribution of this research is the concept of "monetary consensus" with three types, based on reviewing the evolution of money. By applying such concept, we can identify and evaluate the stage and trend of monetary system, providing valuable information for policy makers and system designers. At present, China is in the key stage of moving from EC/EP to DC/EP. In order to better realize the safe and stable substitution of CBDC for M0, we need to realize the monetary consensus of CBDC, combing the legal tender consensus and the algorithm consensus. The empirical analysis shows good consistence with theoretical hypotheses in terms of the connections between Bitcoin and market indices, quantitively identify the monetary and investment attributes of Bitcoin. These findings help market participates and researchers better understand the dynamics of Bitcoin prices and the motives behind the demand for Bitcoin. The limitation of this research is that it focuses on the monetary and investment attributes of Bitcoin, by investigating the time and frequency correlation between Bitcoin and market indices. The next step is to analyze the dynamics of Bitcoin, or cryptocurrencies in general, in the context of economic and financial system, building dynamic models explicitly contain cryptocurrency to capture a more comprehensive image of cryptocurrency.

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COMMENTARY

# On classic and modern ethical issues in business and management academic research

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**Abstract:** Ethical issues are critical to researchers, and this has been a hot topic in decades. Many classic ethical issues, such as plagiarism and fabrication, are repetitively discussed, but some contemporary ethical issues are still problematic and overlooked for researchers, especially those young scholars. The purpose of this paper is to analyse and discuss ethical issues around contemporary business and management academic studies. This paper found that first, scholars are internally and externally pushed to produce rigorous theory development papers, neglecting the relevance of practice. Second, researchers devoted themselves in improving their academy degree or meeting requirements from their employers instead of dealing with practical problems and their interests in research. Third, some 'self-plagiarism' behaviours, such as segmented publication, are arguable in the academy study, which leads to a waste of publication, but it is hard to discern and needs to be tackled.

**Keywords:** ethic issues, self-plagiarism, rigour and relevance

## 1  Introduction

Research ethical issues are a common topic in the academic realm, and many scholars are first taught to be academicians who are integral, honest, upright, careful, and persistent. In this sense, scholars should be free from bias, conflicts of interest, and other factors that affect the scientific process. However, in the face of external pressures, 15.5% of scientists change the design, methodology, and/or results of a study coping with financial pressures from funds, while 12.5% of them are neglected to other flawed data and problems in research [1].

Despite subjective intentions towards ethic misconducts among scientific researchers, organisations or institutions also play a pivotal role in moderating scientists' perceptions of academic integrity because of institutional unfairness [2], rigid performance management towards academic publications [3, 4], and political agenda [1].

In this regard, this paper discusses ethical issues around contemporary business and management studies, but instead of discussing conventional ethical issues, *i.e.*, plagiarism, this paper mainly looks at three ethical issues related to management science, including the (a) the dilemma of practical relevance and theoretical development, (b) conflicts between research rigour and relevance, and (c) some arguable 'self-plagiarism' actions. Therefore, it may not be properly called ethical problems from scholars, but it may be labelled as problems from business and management academical studies. We argue these misconducts may severely undermine management science regarding future studies and development.

## 2  Management research dilemma, between relevance and theory development

Modern management study emerged in the 1950s, and is closely linked to industry and business development, however, with many years of development and evolvement, it is still arguable whether management studies should be claimed as 'science'. Those leading universities, *i.e.*, Cambridge University, which were reluctant to set up the business school, have to face mounting pressures from successful business schools in those young universities, *i.e.* Warwick University; consequently, they surrendered to external pressure and opened the business school to teach people "skills of making money, though they would see it as 'skills' instead of 'knowledge or science'" [5].

The debate on relevance and theory development continues, and it will never cease. Bai (2020) [6] argued, in *Research Studies Redirecting Practice-Oriented*, that management theory should closely connect with management practices. Qi et al. (2010) [7] argued, in the initiative *The Forecast: Facing the Chinese Management Practice*, that academic studies should serve the practices, since without the practices, management theories are of no use.

To connect the theory with the practice, the priority is to clarify the relationship between business academic research and practices. Bai (2020) [6] asserted that management practices are the fundamentals of management theories development, which implies that the theory development should be meaningful for the management practice. In other words, management theories should be beneficial for management practitioners. Jia and Kong (2020) [8], reviewed the papers in an academy management forum, found that China management theory development still faces pressures in connecting theory development with real practice, and abundant research works are lack of practice value. As Qi (2012) [9] stated, it exists in China that a dual system where management theories growth and management practices development are separated. Which is to say that management theories cannot effectively guide management practices. Though some management researchers claimed the plausibility of existing two paralleling systems is derived from the different languages used in academy and practice, this separation is critiqued as the value of management theories and theoretical development are depreciated since the difficulty in application [9].

Presumably, the derail of academy studies and business practices is rooted in the scarcity of theoretical breakthrough. It could be interpreted from two dimensions: first, it cannot explain phenomena. From management theory application perspective, the Taylorism and standard-isation of management empirically promote productivities. Tourish (2019) [10] pointed out that Taylor's science of management greatly boosts the productivities of manufacturing and contributes to manpower release. However, entering into 5G, AI, Blockchain, IoT era, the current management theories related to firm or business management are improper and hard to explain these advancements. Actually, management theories are too far from these technology fields.

From a management development point of view, it is of tremendous difficulties to make breakthroughs and to interpret complex and correlated management issues. For instance, outdated leadership theories were critiqued for its continuing application [11, 12], while the gap between theory building and theory application has been widening [13]. The changing environment and upgrading technology worked together, continually challenge the theories. As Latham (2014) [12] urged, it is evident that the need of upgrading and integrating leadership academic research, whereas scholars need to step out of their comfort zone to integrate with existing theories and evolve theories to solve practical issues in the real world.

From management research inertia perspective, subject to the contemporary business world, vertical and horizontal business integrations incessantly challenge theories development in business and management. Professor Zhang Jin Long, in his report *Thinking of China prac-tice management studies*, pointed out that the innovations and creativities made by Chinese enterprises should be studied by Chinese management scholars, where more interpretations and in-depth research are needed, therefore subject to rapid changing environment, management theory should be reconstructed, and more studies from multiple dimensions and perspectives are needed [8]. Scholars may fall into dead-end, because it is obviously difficult to overthrow a well-established rigorous research paradigm and tries to adopt others for the purpose of solving the 'relevance' problem [3]. Therefore, they have to concede that they cannot explain complexities in terms of current management research paradigms.

The second problem is a probability that the management theory does not 'want' to closely link with business practices. In reality, the rationale of management science is questioned and critiqued. To maintain management theories reputations and prestige, management scientists try to consolidate its industry characteristics and raise its barriers. Tourish (2019, p. 7) [10] concluded that many problems related to management research originate from the outset of the discipline, which includes 'a political agenda that obscures issues of power and so serves dominant interests', and 'poorly designed studies' that employ an assumption that theories generated by a small sample to a big population that consists of everyone who has a job in the world. In simple words, the management research propelled by political interests (*i.e.*, exploiting labour forces by so-called management science) is critiqued by its axiology stance. He puts the example of Taylor and illustrates how Taylor is critiqued both as a revered and appalling figure as a management scientist.

In addition, the research on management is centric at the studies of 'people', and since the 1950s, the hypotheses of human nature shifted five times in western management theories, including 'Tool man', 'economic man', 'social man', 'ethic man', and 'innovation man' [14]. Though in a different era, the labour force has been regarded as different 'objects' to study, it

is arguable whether these propositions should be adopted as true hypotheses for management studies as a 'science' [14–16]. Given the research objects are 'people', it is very difficult to continually push the advances of 'productivities' by unethically exploiting 'people'. Therefore, this is why management scientists are reluctant to study some sensitive people productivities issues.

In terms of research design, management scientists attempted to utilise the research paradigm to solve the real practice problems while these theories methodological designs do not apply to a wider extent, which causes the tensions between business practitioners and academy practitioners. Chen concerned the rigorous thinking and studies in the management discipline and expressed that 'the rise of big data and artificial intelligence, the Mechanistic Materialism overemphasised the information, data, and mechanic information processing system, which leads to inflexible and rigid research paradigms that cannot insightfully interpret unstable and ever-changing management practices, and cannot solve real and flexible management problems' [8]. For instance, scholars just copy modes from economics and finance, and quantitatively analyse and discuss data (interpreting phenomena into constructs and then numerical data), and heavily rely on software such as SPSS, EMOS, Stata, to explain implicit phenomena such as innovations, office politics, and employee engagement.

Lv (2011) [17] concluded that regarding China management study paradigm, it mainly encounters three problems from business relevant perspectives: (a) focusing on tools and measures of management instead of studying ontology; (b) highlighting management science instead of the art of management, for example, mainstream publications and other management academic studies and education neglect the publications and studies of the art of management, however, in practice, the art of management is significantly important. In fact, management is not only a science but also an art. Tylor contends that 'management is the art of knowing what you want to do and then seeing that they do it in the cheapest and the best way.'; and (c) often adopting empirical studies. Empirical studies take advantages to test and correspond theories development; however, it fails to explain those intangible and unexplained situations. Professor Xie Yong Zhen questioned whether empirical studies should be regarded as the measures to hypothetically test management theories and she claimed that many management theories are impossible to empirically falsify, but they are found to be useful and beneficial in real practice [8].

Measures and means of management are confined to multiple conditions, affected by the economy, politics, culture, and other external and holistic factors. In contrast, the effects between theoretical modes and real practices are drastically varied when there are minor disparities. Hence, if management researchers turn blind to those implicit and intangible facts and use a rigid and so-call 'scientific' paradigm to solve management issues, it deliberately overlooks the 'relevance' of management studies but produces 'sound' results [6, 9].

To conclude, management scientists may both have problems in developing theories due to rapid change environment and problems in academic studies towards real management practice because of sensitive ethical issues, abandoning research paradigm, turning into research management 'art' instead of 'science', and so forth.

# 3  Rigour and relevance, it is hard to balance

In a paper, for a Special Issue: Journal Rankings and the Notion of 'Relevance' within Business Research from *European Business Review*, Narasimhan (2018) [18] examines both ends of rigour and relevance, and he argues that '*Rigour without relevance is an intellectual exercise that an applied field such as ours can ill afford to persist in. Relevance without rigour renders the research less valuable due to the uncertainty surrounding the validity of the proposed ideas.*'

The debate of rigour and relevance lasts many years, and scientists are struggling to balance two ends, especially facing mounting pressures on 'publish or perish'. Narasimhan (2018) [18] asserts that some papers may be highly relevant if they adopt theories or frameworks to process a large amount of data or to create new theoretical frameworks, but these publications should be classified rigorous instead of relevant, as they possess little practical significance. He creates a 2×2 matrix to explain the classification of rigour and relevance of the paper (see Table 1).

In this matrix, both ends had its implications to readers, but he argued that the simultaneity of rigour and relevance is possible [18]. However, what business schools have produced is irrelevant to industry needs and 'business school scholarship can be a massive diversion of resources in ways that benefit faculty, not society' [19]. The impact of an article needs to be evaluated from both rigour and relevance ends, but not exclusively based on whether its publication on a 'top-tier' journal. According to Lambert (2019) [3] argued, without relevance,

**Table 1**    2×2 Matrix of rigour and relevance

| | | Rigour | |
| --- | --- | --- | --- |
| | | High Importance | Low Importance |
| Relevance | High | Seminal articles, high Impact, published in academic journals | Potentially rich insight of practical importance in some readings |
| | Low | Academic interests, published in the top-tier journal | Published for academic degree requirements or other authors' needs that irrelevant from both academic and practical implications |

**Source**: Narasimhan (2018) adapted by the authors [18]

academic management research will cease to be of practical importance. Actually, without practice implications, academic research is more than a pie in the sky.

Scholars found that from relevance perspective, many problems are related to business management research. After discussions with several executives from leading companies, such as IBM, Hewlett Packard, Schneider and Siemens, Storbacka (2014) [20] found that managers believe academic studies 'simplify matters beyond managerial relevance' and 'academics are interested in doing research on issues that managers consider were solved many years ago.' Stentoft (2017) [21], consistent with Storbacka (2014) [20], claimed that the research towards theories is not beneficial for management practitioners, as those basic and common problems are already solved. Obsessive investment into those irrelevant theories is wiseacre, as it goes to waste public funds and creates nonsenses from the relevance end [22].

The chief editor of an elite Chinese business journal *Nankai Business Review*, Bai (2020) [6], found that when reviewing manuscripts for publication, four salient problems of academic papers are found in terms of relevance. First, the hypothetic modelling is distant from a business application, which damages the value of the application. Second, the constructs adopted by some authors are oversimple, which is labour saving but impairs the observations and clarity of phenomena. Third, among some case studies and qualitative studies, the observations to real cases are not detailed and sufficient, contributed to the scarcity of evidence details and undermined theory-building foundations. In this sense, the theory constructed is drifted away from practices. The last is that most academic papers attempt to compile abundant literature reviews in the academic studies despite of the relevance of literature.

In the crossroad of relevance and theory development, researchers may do not want to 'pertain' their studies with problems in management practices, because this would not be awarded and accepted by academia and elite journals. Scholars are presumably 'lazy' to study real problems in practice but just closely follow the academic paradigms to solve 'relevant problems' that 'might' have implications to the industry. The attempts made in theoretical development are effective to themselves in terms of academic degree promotion and salary increment, but, it is of little effect to management practitioners as it does not 'deliver practical value in a specific context' and 'there are numerous works··· that utilize stylized models and execute known mathematical procedures flawlessly to develop "insights" that have little or no practical significance [18].'

According to CEEMAN Manifesto (The Central and East European Management Development Association), in terms of a management research realm, much interest has been drawn on research and publication instead of teaching; prefers quantitative research to qualitative studies; methodological precision over pertinent substance; theories over practices; and highlights the recognition of peer than business practices [23]. The noteworthy phenomenon is that an increasing number of quantitative research has become popular among scholars who excel at these techniques in their own research fields [24].

Aforementioned, the management study has its limitation as a science. Not until the later $20^{th}$ century, it became a subject that adopts the quantitative research method to promote its ideology and improve its reliability and trustworthiness [25]. Unlike nature science or formal science (*e.g.* mathematics), management science as the applied science or social science is lack 'scientific' spirits [26], because it studies the implicit and uncontrollable variables. Therefore, welcome is the quantitative research which adds variables and complicated formula and functions that turns the management research into rigorous and scientific research [25]. Latham (2014, p. 12) [12] argued that to generalise theories, the adoption of 'positivist and post-positivist methods with quantitative measurement and probability samples' is a desire of researchers who claim to be real scientific research in many social science disciplines like what other physical scientists do. However, it does not simply claim that using quantitative research paradigm can solve implicit and ambiguous management issues scientifically.

However, it is not attributed wholly to the researchers, because pursuing 'A' journals is an urgent need for schools and other stakeholders as well. As an important indicator, business schools often regard the publications of teachers or searchers as a tool of performance management. Lambert (2019) [3] asserts that the business schools attempt to improve their rankings

by publishing more articles in highly ranked journals, which leads to a biased performance management system, that is, pays too much attention to faculty productivity with a quantitative metric, but neglects real effects and contributions towards business community. McKinnon (2013) [4] concluded that the ranking of journals became influential in management as the institutions often regarded the journal ranking as a proxy to manage the performance of researchers and professors. In recognition of this, more researchers pursue publications in leading or important journals. In practice, to raise ranking, business schools employ those fruitful researchers for publications by assigning them little work in teaching with generous pay, while recruiting part-time and cheap labour force for teaching as much as possible [27]. Therefore, this performance and reward management mode inspire researchers to publish those 'nonsense' in practice but look good on paper. Therefore, what schools need to do is, as Lambert (2019) [3] concluded, that the imperative of writing and research is out of the author's interests instead of other indexes.

What is more? Editors of top journals are interested in those publications which are dedicated to vertical theory-building instead of horizontal practice exist; thus, this preference drives the scholars in business school to pursue the publication in 'A' journals from an academic perspective solely [28]. The background of editors has been a concern. It is found that the decreasing number or missing editors from business or industry background for three leading journals including *International Journal of Logistics Management*; *International Journal of Physical Distribution and Logistics Management;* and *Journal of Business Logistics* since last four decades [28]. More academic professors in editor positions lead to the changing appetites of journals from practices to theories, which, to a large extent, demotivates manuscripts submitted for business problems solutions and increases the likeliness of rejection.

In addition, elite journals are selected to languages in publication. From a wording perspective, as Grey and Sinclair (2006) [29] argued, in the business research field, much of the writing is 'jargon-ridden, laboured'. They contended that serious academic writing and an equally abstracted vocabulary decorates studies in a scientific and serious manner, contributing to scholars' qualifications. In this sense, management scientists voluntarily demotivate readers from those management practitioners from what they have been published. Billig (2013) [30] argued that management scholars have to use those big words and languages 'not to identify a discovery, but to cover over a lack of discovery' and in this strategy, they can survive from a competitive research society.

Language norms used in academic writing is contrary to what perceived valuable insights and those sparking implications, and disciplined imaginations are lapsed because of insufficient writing formats [25]. Though to either scholars or editors, to use these rigid and 'scientific' words may benefit the publications and acknowledgement from peers and academicians, but it derails from the 'relevance' track of management practices. For example, using big words and rigorous and picky terms possibly demotivates those management practitioners to digest those research results, as what Tourish (2019, p. 7) [10] claimed that 'the world faces major challenges across numerous issues. Many of these are organisational · · · it is my belief that management scholars can make important contributions to these issues. At present, we generally do not. Most managers don't read our research and most of the public is unaware that it even exists.'

Overall, management scientists are both internally and externally pushed to publish more theory-like papers than relevance papers. Their rigourous publications could be awarded extendedly academically and financially. Their employers, such as business schools, can have reputations in academia and recruit more students easily. The top-tier journals can be beneficial for those rigourous theory development papers because of more citations, which helps them to consolidate their ranking. Thus, these factors contribute to more publications from rigour end.

# 4  Self-plagiarism, a debated 'self-plagiarism' technique to produce papers

To prevent academic misconduct, in 2019, the *Academic publishing specification-Definition of academic misconduct of journals* (hereafter short for Specification), has been authorised and released by China National Press and Publication Administration [31]. The *Specification* defined academic misconducts come from various stakeholders including authors, reviewers, and editors. The regulation is the comprehensive, inclusive, standard, and detailed. Li Zhen Zhen, a researcher in Technology and Strategy Consulting Institute of China Academy of Science, commented that 'this is a first national standard of academic misconducts of China and it also provides a series of definitions to specific academic misconducts, including plagiarism, inappropriate authorship, falsification, fabrication, multiple submission, and overlapping publication,

which is beneficial for defining and assessing academic misconducts in real practices' [32].

Along with the *Specification*, two main official documents for the purpose of the prevention of academic misconducts in research fields are enacted by the Ministry of Education of the People's Republic of China including *Measures for the Handling of Acts to Falsify Dissertations* [33] and *The Measures for the Prevention and Punishment of Academic Misconducts in Institutions of Higher Education* [34]. These effective measures are proposed to solve academic misconduct in higher education institutions. Together, three regulations give implications in academic governance dealing with academic ethical issues.

However, per Li Zhen Zhen, some debated ethical issues, such as Segmented Publication which is also known as salami-slicing, have not been tackled with [32]. The segmented publication refers to an integral research paper that has been detached into several papers to publish in order for more publications, and it has been done by restructuring the topic, data, materials, and existing structures [35]. According to Committee on Publication Ethics (COPE), segmented publication occurs when researchers publish one experiment on two or more papers which prevents the readers from gaining more information on a single paper [36]. In fact, the segmented publication is a form of 'self-plagiarism', though writers prefer to call i 'text re-use' [37].

In the face of external pressures to academic publications, scholars have to publish the more papers on high-ranking journals. Due to heavy punishment towards copyrights infringements, scholars are aware of threats from copying and paste others' work intentionally, but the slicing publication is categorised into grey areas, whereas many researchers may use their existing publications as many as possible to expand their influences on the scientific field. Indeed, heated debate is raised, but in China, it is widely accepted by scholars that using their own properties is legitimate and legal [39]. Problems caused by 'Segmented Publication' have been underestimated by many researchers because they argue this kind of activity is 'for the purpose of spreading own knowledge and ideas to reach wider masses' [37]. Researchers may claim their copyright and use of existing research results, but they may neglect the repetitive publications and wastes the time of readers.

Zhang (2020) [38] argued that, though many ethnic associations and scholars have been discussing the segmented publications, it is a lack of assessment and impetus to evaluate salami publication. He pointed out that difficulties of identifying the segmented publication are evident, though publishers and peer reviewers try their best to discern the segmented publications by examining paper content, data reliability and trustworthiness, experiments process, the integrity of the paper, and so forth, it still needs the improvement of awareness from academic practitioners, and improved publications system, and academic ethical building of Academia.

Segmented Publication is an issue that misleads the judgement of research ethics. Researchers may argue that it would be regarded as minor errors when referring to Segmented Publication among the academic community as if this kind of self-plagiarism is not viewed as a condemnable act [36, 40, 41]. Though researchers decline to 'steal themselves', it is a possible way to deceive readers by repetitive and similar papers whereas can be considered as intellectual laziness [41].

Segmented Publication can pose threats to audience and other stakeholders. This kind of 'self-plagiarism' could lead to the waste of time because peer-reviewers may find that it is useless to review identical and published data which wastes their time [42]. Readers may feel be cheated as they may be familiar with previous data and methods when they expect to have new ones, so if authors reuse their previous texts and data without good citation, it leads to the waste time of readers to go over the whole sections again [43]. Those clean and integrous researchers may lose their opportunities to compete as their 'pale' resume with seldom publications compared to those 'productive self-plagiarism' scientists [37]. In some cases, serious self-plagiarism may result in copyright infringement without explicit permission from the publisher such as reuse of texts, figures, and other materials; and the manuscripts may be retracted from publishers after publications because thousands of readers will continually check the manuscripts after publications [42].

# 5  Conclusion

Management theory development is not always smooth, but many scholars worked hard to contribute to this development which is beneficial for our social development as a whole. However, due to various reasons, though many management students strive to be integrous, unblemished management scholars, it seems hard to pursue virtuous paragon. fact, some factors may hurt young scholars' impetus of being ethical scientists, while others may hinder the development and sustainability of our management studies in the long run.

This paper firstly discussed the detail of relevance and theoretical development and asserted

that our management theories may not be able to explain management practices, and our management scientists may 'intentionally' not to connect their studies with practices. Secondly, it went to discuss conflicts between rigour and relevance. We summarised that redundant research on useless theory, preferences of quantitative methods, desires for pursuing elite journals, pressures of academic performance appraisal, and requirements from top tire journals are some reasons why management scientists overvalued rigour to relevance. Lastly, we found that, though authorities enact various legislations and regulations, some 'self-plagiarism' behaviours, such as 'segmentation publication', are still debatable and prevalent, and we are still on the way to solve them.

Given this scenario, how do we address these problems is a vital problem not only for elite researchers and journals but also for every scholar and student in the management academy. This paper argues that necessities are the change of the rating system for the management and business scholars; the balance between theory development and practice-related studies; and the decrease of repetitive publications by raising authors' self-awareness.

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