

# Environmental sustainability and corporate performance: The shareholders' perception

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## ABSTRACT

This study examined the effect of environmental sustainability on corporate performance from shareholders perception. The activities of companies had usually adverse impacted the environment. Business organisation and the environment cannot exist in isolation without demands for each other. Sustaining the environment where businesses operate create value for the organisation. Theoretically, shareholders are concern about returns on the short term while environmental sustainability is concern about meeting future needs of the stakeholders based on present use of the ecosystem. Therefore, managers of manufacturing companies are concerned with how to maximize the wealth of shareholders while engaging in environmental sustainability. This necessitated the study. The study adopted *ex-post facto* and content analysis research design. The population of this study is made up of 35 quoted manufacturing companies listed on Nigerian Stock Exchange (NSE) as at the end of June, 2018. Purposive sampling technique was adopted in selecting the sample size of 12 companies that were able to meet up with the criteria. Secondary source of data was used. Corporate performance was measure by proxy of financial performance (EPS). Environmental sustainability was measured by considering guidelines as stated in GRI and NSE sustainability framework in relation with the environmental practices disclosed in the annual reports. Control variable is company size. The study adopted descriptive statistics and pooled Ordinary Least Square (OLS) to analyse the data. The result of the study indicated that there is a positive relationship between environmental sustainability and corporate performance. The study recommends that in making decisions on which organisation to invest in, investors should not consider individually environmental sustainability practices or the size of quoted manufacturing firms in Nigeria, rather, consider them alongside social sustainability practices, governance sustainability practices and other financial sustainability practices.

**Keywords:** environmental sustainability, corporate performance, EPS, shareholders' perception

## 1.0 Introduction

The environment where businesses operate is a dynamic and complex one which determines the goals and outlooks of the business organisations. The business organisation and the environment cannot exist in isolation without demands for each other. Few years back, there was an experience of climate change and global warming which were adverse effects of organisations' operations to the environment (Haanaes, Arthur, Balagopal, Kong, Reeves, Velken, Hoppins & Kruschwitz, 2011). Sustainability involves satisfying present needs in such a way that it will not adversely affect satisfying the needs of future generations. As well, environmental sustainability involves protecting and maintaining environmental or natural resources for the needs of future generations (Pettinger,

2018). It is necessary for businesses to operate within environmental standards so as to maintain continuous relationship with its society.

Environmental sustainability can be ensured by firms, by analyzing the input and output indicators in the course of the supply chains so as to minimize environmental impacts. Firms consider inputs such as energy, material and water as well as outputs such as wastes, emissions and effluents in their operations (Gunathilaka & Gunawardana, 2015). Globally, there is increase in the pursuit for sustainability and environmental awareness. Many companies are developing interests in environmental sustainability to enjoy competitive advantage so as to enhance their corporate performance (Acti, Lyndon & Bingilar, 2013). However, the pursuit for environmental sustainability is a bit low within the developing countries due to lack of organized pressure groups and weak government regulations to regulate the behaviours of the companies (Vinayagamoorthi, Murugesan & Kasilingam, 2015).

In the 1800s, the business environment in Nigeria was exploited by some firms during the period of oil boom. The businesses used the environment to their own advantages (Eruemegbe, 2015). In recent times, organizations realized that the natural resources can be utilized in such a way that value will be created for its shareholders and other stakeholders, and there will still be minimum impact on the environment. This is because a reduction of the environmental hazard or impact will lead to an increase in a firm's profitability (Gunathilaka & Gunawardana, 2015). From shareholders' perception, companies are to ensure environmental sustainability by utilising its resources and recycling of wastes to minimize cost and increase profit so that on the long-run it can maximize shareholders' wealth (Che-Ahmad, Osazuwa & Mgbame, 2015). Also, shareholders like to associate with companies that engage in environmental protection activities. Studies such as Gunathilaka and Gunawardana (2015) suggested that companies that engage in environmental protection should be recognised and additional significant value should be added to them.

Sustaining the environment where businesses operate create value for the stakeholders. The recycling of waste, treatment of liquid effluents, reuse of materials, production of sustained quality goods and controlling emissions through reduction in furnace oil consumption, all lead to innovation and cost savings for the companies. Nowadays, organizations try to differentiate themselves by being environmentally concern which adds values to their products. Theoretically, shareholders are concern about returns on the short term while environmental sustainability is concern about meeting future needs of the stakeholders based on present use of the ecosystem. Therefore, shareholders are concerned with how managers of manufacturing companies can maximize their wealth while engaging in environmental sustainability. This study seeks to determine the relationship between environmental sustainability and shareholders' perception of corporate performance of quoted manufacturing firms in Nigeria.

The research hypothesis is stated as:

H<sub>0</sub>: Environmental sustainability has no significant relationship with corporate performance of quoted manufacturing firms in Nigeria from shareholders' perception.

## **2.0 Literature Review**

### **2.1 Conceptual Review**

#### **Environment**

Environment in totality can be referred to as the surroundings where a business operates. Environment consists of various factors and conditions that affect the development of a business (Atsegbua, 2002). It determines what an individual or an organisation can achieve. An organisation exists in the environment. No firm is an island or operates in vacuum and therefore needs environment to survive its existence. Organizations are to consider the environment while setting their goals and carrying out their operations (Eruemegbe, 2015). It provides inputs to the firms and receives their outputs. In a nutshell, environment provides all the elements a firm needs to support its existence including the market for its products and services (Oginni & Adesanya, 2013).

## **Sustainability**

Sustainability can be referred to as the ability to maintain something for future use. There are several definitions of sustainability (Ehrenfeld, 2008). It also means not making the future generation suffers the adverse effect of the actions of previous generations. The concept of sustainability development, corporate social responsibility, sustainability and triple bottom line are often used synonymously though they have different historical backgrounds (Ucheagwu, 2019). However, they all aim at being ethically, socially, environmentally and economically responsible. At firms` level, sustainability encompasses economic, social and environmental sustainability which can be translated into the '3Ps' namely profit, people and planet respectively (Oginni & Adesanya, 2013).

## **Shareholders` perception of environmental sustainability and corporate performance**

Environmental sustainability is a component of sustainability practices. From the explanations of environment and sustainability above, environmental sustainability is the ability to meet the needs of individuals and firms in the environment without adversely affecting the capacity to meet future needs. It is crucial to social, economic and governance sustainability. Specifically, environmental sustainability means meeting the needs of current and future generations without jeopardizing the health of the ecosystem (Morelli, 2011). Organizations operate in ecological environment and their operations do have destructive impact on the ecosystem (Okafor, 2018). Some firms engage in proactive measures to ensure environmental management of pollutions and wastes while others don't. The proactive measures include emission reduction, waste treatment, reduction of pollution, production of quality products, conservation of energy, reuse of materials and treatment of water. According to Agan, Acar and Borodin (2013), disposal of waste without treatment can cause air pollution and contamination of ground water.

In the long-run, engaging in environmental sustainability will save companies some expenses. For instance, a firm that is energy efficient will be able to save substantial amount from its energy expenses. In the modern business world, investors and customers are aware of environmental and social issues. They will prefer to be associated with and invest in environmentally sustainable businesses (Pettinger, 2018). Environmental sustainability will rather increase the profitability of companies than having a negative impact on them. This is because there will be reduction in expenses (such as cost of compensating for destruction and cost of litigation) and increase in competitive advantage (Failte Ireland, n.d).

## **Environmental Regulation in Nigeria**

Prior to 1988, there were no mechanisms in Nigeria to ensure protection of environmental resources and enforce environmental laws. An attempt by a foreign company to drop toxic waste in Niger Delta changed the situation and led to the establishment of Harmful Waste Decree 42 of 1988 which makes dropping of harmful waste in Nigeria a criminal offence. This also led to the establishment of an agency to oversee the protection of environment in Nigeria. The agency is Federal Environmental Protection Agency (FEPA) as established through decree 58 of 1988 and decree 59 of 1992 (as amended) (NESREA, n.d). In 1999, FEPA and some other relevant departments in other ministries were merged to form Federal Ministry of Environment though without an enabling law. Filling this gap led to the establishment of National Environmental Standards and Regulations Enforcement Agency (NESREA) which annulled the FEPA. All these were in respect of ensuring that Nigeria environment is protected and conserved (Acti, Lyndon & Bingilar, 2013).

### **Global Reporting Initiatives (GRI) and Nigerian Stock Exchange (NSE) Sustainability Framework.**

The GRI guideline provides the principle for reporting and also, the standards to guide organizations in the disclosure and preparation of sustainability reports. The guidelines also provide the manual for implementation of sustainability practices and reporting for firms irrespective of their sector, size and location (Isa, 2014). The GRI guideline serves as international reference for firms that want to disclose their economic, social, environmental and governance practices. The guideline was developed through a process of multi-stakeholders involvement globally including the representatives of government agencies and regulators. The guideline aim at ensuring that information disclosed in sustainability reports by firms are accurate, transparent and comparable for stakeholders` decision making (GRI, 2011).

The Nigerian Stock Exchange (NSE) commenced the implementation phase for sustainability reporting in 2015. NSE sustainability framework provides the guideline for disclosure of sustainability practices by its listed firms to provide the information to their stakeholders for decision making. Also, the framework set out the indicators of economic, environmental, social and governance practices that the quoted firms are to report in their annual reports. Reporting the sustainability indicators show that the companies engaged in sustainability practices (NSE, 2016).

## **2.2 Theoretical Framework**

### **Shareholders` Theory**

The shareholders` theory was proposed by Friedman (1970). The theory holds that maximization of profit accruing to shareholders is the primary objective of carrying on a business. The theory assumes that the aim of profit making makes the market vibrant and such drives the well-being of the economy. The assumption of the theory is also that the role of a business in its existence is majorly to increase the wealth of its shareholders through increase in dividend or increased share price. Therefore, any activity engaged in by the managers of firms is for the purpose of increasing shareholders` wealth (Ucheagwu, 2019).

When firms engage in environmental sustainability, they carry out recycling of waste, treatment of liquid effluents, conservation of energy, reuse of materials, production of sustained quality goods and controlling emissions through reduction in furnace oil consumption. When such activities are done within the stipulation of the law, they results to strategic benefits for the firms. Environmental sustainability leads to reduction in expenses/costs to the companies because resources will be used maximally and the firms will have to incur no or minimum cost of compensating the environment for destructions. In the medium or long term, this will accumulate to increase in profit for the organizations. The increased profit will result to increase in shareholders wealth, thereby; managers are able to use environmental sustainability to satisfy shareholders` interest.

### 2.3 Empirical Review

Okafor (2018) studied the effect of environmental cost accounting and reporting on the financial performance of quoted oil companies in Nigeria. The study found out that a significant and positive relationship exists between environmental cost accounting and reporting on the financial performance. This implies that spending on matters of environment improves the financial performance of quoted oil companies in Nigeria.

Hassel, Nilsson and Nyquist (2005) studied the effect of environmental information on the market value of listed companies in Sweden. The study adopted a residual income valuation model. The findings show that there is value relevance for disclosure of environmental responsibility done by the sampled companies. This is because the disclosure affects positively the future earnings of the listed companies. The study recommended that companies that pollute the environment from their operations may be eroded of their future solvency which will result to reduction in earnings.

The International Federation of Accountants (IFAC) (2005) in its guideline document stated that many firms are looking for creative and cost-efficient ways of reducing environmental impacts due to environmental pressure. Companies realized that engaging in reduction of environmental impacts through efficient use of raw materials, energy and water has its monetary rewards and as well improves environmental performance.

Ezejiofor, John-Akamelu and Eucharia (2016) examined the effect of sustainability environmental cost accounting measure on the performance of corporate organizations in Nigeria. The study adopted *ex-post facto* research design. Time series data were sourced from annual reports of the company for the period 2009 to 2013. the data were analysed using regression analysis. The findings of the study shows that environmental cost impact positively on revenue and profit generation of companies in Nigeria. The study recommended that multinational and indigenous companies in Nigeria should ensure strict adherence to environmental policies so as to have continuous increase in their performance.

Okoye and Ezejiofor (2013) also examined the impact of sustainability environmental accounting in enhancing corporate productivity and economic performance. The study adopted Pearson Product Movement Correlation Co-efficient to test its hypotheses. The study found out that sustainable environmental accounting has significant impact on corporate productivity of companies which as well promote corporate growth.

Acti, Lyndon and Bingilar (2013) examined the effect of environmental cost on corporate performance of oil companies in the Niger Delta States of Nigeria. The study analysed data collected from annual reports of twelve selected sample oil companies in Niger Delta  
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for the period 2001 to 2011. The multiple regression analysis was adopted. Corporate performance was proxy with Return on Total Asset (ROTA) and environmental practices was proxy with Community Development Cost (CDC), Waste Management Cost (WMC) and Employee Health and Safety Cost (EHSC). The study found out that environmental cost and corporate performance has significant relationship. Also, corporate conflict with the host communities can be resolved by engaging in environmental sustainability. The study recommended that to have a peaceful atmosphere needed by companies to enhance their productivity and performance, the oil companies should adopt an environmental costing system.

Gunathilaka and Gunawardana (2015) carried out a study on “an impact of environmental practices on financial performance: A literature review”. The study reviewed both quantitative and qualitative studies that examined the impact of environmental practices on financial performance of firms. Total numbers of 120 previous studies were reviewed by considering the variables of environmental practice and financial performance, the sample size, statistical methods and the findings of the studies. The findings of the reviewed studies were mixed in nature, some has positive results, some has negative and some has no result with insignificant relationships. From the sample studies, 52% has positive relationship while the remaining 48% showed negative or no relationship. The study concluded that the inconsistency in outcomes of the studies reviewed may be due to absence of a framework that clearly state what constitutes environmental practices.

The related studies reviewed above considered either environmental practices, financial performance or both variables. However, their proxy for financial performance includes Return on Assets, Profit Margin and Tobin`s Q. The studies did not consider corporate performance by looking at it from Shareholders perception. There is also scanty of studies focused mainly on environmental sustainability as most recent researches focus on the entire dimensions of sustainability practices. This study has filled in these gaps by considering the proxy Earnings Per Share (EPS) which is a financial aspect of corporate performance and focusing on environmental sustainability.

### **3.0 Methodology**

This study adopted *ex-post facto* and content analysis research design to examine the impact of environmental sustainability on corporate performance from shareholders` perception. The population of this study is made up of 35 quoted manufacturing companies (consisting of 21 consumer goods and 14 industrial goods companies) listed on Nigerian Stock Exchange (NSE) as at the end of June, 2018. Manufacturing sector is selected because of the frequent consumption of environmental inputs of energy, material and water as well as frequent release of outputs such as wastes, emissions and effluents. Purposive sampling technique was adopted in selecting the sample size. The technique was used to select the companies that meet up with the following criteria: (1) the company must have been listed on NSE from 2008 to 2017 and (2) the company must have its annual report accessible on its website for the period under study and it must contains report on environmental sustainability.

The sample size is made up of 12 companies (that is, 10 consumer goods companies and 2 industrial goods companies) that were able to meet up with the criteria. The companies are listed out in Appendix 1. Secondary source of data was adopted for the study by extracting data from the published annual reports of the sampled companies, Global Reporting Initiatives (GRI) framework and Nigerian Stock Exchange (NSE) sustainability framework. The content analysis was used to generate a checklist on environmental sustainability from both Global Reporting Initiatives (GRI) framework and Nigerian Stock Exchange (NSE). The environmental sustainability practice includes: Product/service responsibility, water, energy, waste management and efficient, compliance, environmental grievance mechanism and emissions.

Corporate performance is measure by proxy of financial performance. This is because financial performance is a primary measure of corporate performance to the shareholders. Therefore, financial performance was proxy with Earnings Per Share (EPS). Environmental sustainability was measured by considering guidelines as stated in GRI and NSE sustainability framework in relation with the environmental practices disclosed in the annual reports. Ching, Gerab and Toste (2017) method was adopted for environmental sustainability where: (a) when all information is disclosed, a score of 1 is give; (b) when almost all information is given, a score of 0.75 is given; (c) when information is partially disclosed a score of 0.50 is given; (d) when information is briefly disclosed a score of 0.25 is given and (e) when there is no information given a score of 0 is given. With this, a final score is obtained for each year of each company by obtaining the average score of the total score for the environmental sustainability indicators adhered to as illustrated in Appendix 2. The control variable used for the study is company size represented by log of total assets. Earnings Per Share (EPS) is calculated by using the formular:

$$\text{EPS} = \frac{\text{Profit After Tax less Preference dividend}}{\text{Average Outstanding Shares}}$$

The model is specified as:

$$\text{EPS}_{it} = \beta_0 + \beta_1 \text{ES}_{it} + \beta_2 \text{CSZ}_{it} + U_{it}$$

Where:

EPS =Earnings Per Share (Dependent variable)

ES = Environmental Sustainability (Independent Variable)

CSZ = Company Size (Control Variable)

$U_{it}$  = Error Term

#### **4.0 Data Analysis and Interpretation**

The data gathered from 2008 to 2017 annual reports of the 12 sampled companies on corporate performance (proxy with financial performance, that is EPS), company`s size and environmental sustainability (measured with average compliance with indicators of product and services responsibility, waste management, water, energy. emission, environment grievance mechanism and compliance) were analyzed and the result is discussed below.

#### **Descriptive Statistics**



The descriptive statistics shows the mean, maximum, minimum and standard deviation of the data collected from the 12 quoted companies over 10 years (2008 to 2017) for the dependent variable (EPS), independent variable (Environmental sustainability) and control variable (Company's Size).

**Table 4.1: Summary of Descriptive Statistics**

Variable	Mean	Max.	Min.	Std. Dev.	Obs.
EPS	7.3548	291	-251	47.3991	120
ES	.4135	.86	.11	.2595	120
CSZ	7.5493	8.99	-.33	1.5643	120

**Source: Author's computation (2019). Stata Output.**

For EPS, the mean value is 7.3548. This means that on the average, the sampled manufacturing companies generated high returns for their shareholders and therefore, they have the capacity for distributing high dividends. The standard deviation of 47.3991 shows that there is high difference in the capacity of the sampled firms in generating profits. The maximum value of 291 shows that some quoted manufacturing firms are generating high returns for their shareholders while the minimum value of -251 shows that some firms are making losses.

For the ES, the mean is 0.4135. This means that on the average, the sampled manufacturing firms engaged in environmental sustainability practices to the extent of 41% as contained in the Global Reporting Initiatives and Nigerian Stock Exchange sustainability framework. The Standard deviation of 25.9% means that there's low level of disparity in practices of environmental sustainability by the sampled firms. The maximum and minimum values of 0.86 and 0.11 respectively means that some firms practices environmental sustainability on the high level while some does it on the low level.

The CSZ is represented by the logarithm of total assets and it has the mean value of 7.5493. This implies that on the average the assets of the sampled firms are enough to carry on their activities. The standard deviation of 1.5643 means that there is high dispersion in the volume of assets held by the firms. This is supported by the maximum and minimum values of 8.99 and -0.33 respectively.

### Regression Analysis

This aspect presents and discusses the regression result based on pooled Ordinary Least Square (OLS). Prior to the choice of using pooled OLS, the study estimated the fixed and random effect models to capture the individual firm effects. Hausman test was conducted to determine the efficient model from the fixed and random effect models. However, the Hausman test result indicated that the model fitted on these data fails to meet the asymptotic assumptions of the Hausman test. This lead to the conduct of the Breusch-Pagan Lagrangian multiplier test for random effect, of which if it is significant, random effect will be used for the analysis and if not



pooled OLS will be used. The result of Breusch-Pagan Lagrangian multiplier test shows that  $Pob > \chi^2$  is 1.0000 which is insignificant; therefore, pooled OLS was used for the analysis.

**Table 4.2: Pooled OLS Result**

Variable	Co-efficient	Std. Error	t	Prob.
C	-1.3490	4.9563	-0.27	0.786
ES	3.8895	21.0068	0.19	0.853
CSZ	0.9399	1.2400	0.76	0.450
Prob>F	0.0221*			
R <sup>2</sup>	0.16			

Source: Author`s computation (2019). Stata Output.

\*: significant at 5% level

Based on the pooled OLS result, the model can now be written as  $EPS = -1.3490 + 3.8895ES + 0.9399CSZ + \epsilon_{it}$ . Table 4.2 provides answer to the question of the study which seeks to determine the relationship between environmental sustainability and corporate performance from shareholders` perception. The result indicates that the explanatory variables, which are the environmental sustainability and company`s size of the 12 sampled manufacturing companies are positively related to earnings per share. This is observed from the regression coefficients of 3.8895 and 0.9399 respectively. This implies that an increase in environmental sustainability practices will lead to 388.95% increase in earnings per share. The coefficient of company`s size of 0.9399 implies that an increase in firm`s size will leads to 93.99% increase in EPS. The result also shows that the explanatory variables are not statistically significant with the dependent variable such that the Prob. of 0.853 and 0.450 are greater than 0.05 level of significant. In addition, the R<sup>2</sup> is 0.16%, this implies that environmental sustainability and company`s size are responsible for 0.16% variation in EPS while some other factors are responsible for the remaining 99.84%. The insignificant of the explanatory variables and the low level of the R<sup>2</sup> means that when the shareholders are on the lookout for viable and sustainable companies to invest in, environmental sustainability and company`s size individually are not significant factors for changes in corporate performance which is not different from the view of Gunathilaka & Gunawardana, (2015). The Prob>F is used to explain the overall significance of the explanatory variables. The F-statistics is 0.0221 which is significant at 5% level. This implies that the explanatory variables are jointly significant in explaining the dependent variable (EPS).

Based on the results in table 4.1 and 4.2 above, environmental sustainability with the mediating role of company size has positive significant relationship with corporate performance from shareholders` perception. This is as indicated by the coefficients and F-statistics which is positive and significant at 5% level. This is not different from the views of Ezejiofor, *et al.* (2016) and Ucheagwu (2019). Thus, the study rejects the null hypothesis that environmental sustainability does not have significant effect on corporate performance of quoted manufacturing firms in Nigeria from shareholders` perception and accept the alternative hypothesis that environmental sustainability has significant effect on corporate performance of quoted manufacturing firms in Nigeria from shareholders` perception.

## 5.0 Conclusion and Recommendation

This study examined shareholders' perception of how environmental sustainability has been able to influence corporate performance of quoted manufacturing firms in Nigeria. Earnings per share (EPS) was used to proxy corporate performance since it is suitable for shareholders' perception. The result of the study indicated that there is a positive relationship between environmental sustainability and corporate performance. The relationship is also statistically significant when the explanatory variables are jointly considered. The study concludes that when manufacturing firms engage in environmental sustainability in line with the size of the firm, there will be maximization of shareholders wealth which is also as stated by shareholders' theory.

Therefore, the study recommends that in making decisions on which organisation to invest in, investors should not consider individually environmental sustainability practices or the size of quoted manufacturing firms in Nigeria, rather, consider them alongside social sustainability practices, governance sustainability practices and other financial sustainability practices.

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## APPENDIX 1

### List of Sampled Companies

S/N	Sampled Firm	Sector
1.	Dangote cement	Industrial goods
2.	Lafarge Nigeria	Industrial goods
3.	Dangote sugar refinery Nigeria Plc	Consumer goods
4.	Cadbury Nigeria Plc	Consumer goods
5.	Honeywell Flour Mills Plc	Consumer goods
6.	Flour Mills Nigeria Plc	Consumer goods
7.	Dangote flour Mills Plc	Consumer goods
8.	Guinness Nigeria Plc	Consumer goods
9.	PZ Cussons Nigeria Plc	Consumer goods
10.	Unilever Nigeria Plc	Consumer goods

11.	Nigeria breweries Plc	Consumer goods
12.	Nestle Nigeria Plc	Consumer goods

Source: Researcher`s compilation (2019).

## APPENDIX 2

### Environmental Sustainability Indicators

S/N	Indicators	Year
1	Product/service responsibility	
2	Water	
3	Energy	
4	Waste management and efficient	
5	Compliance	
6	Environmental grievance mechanism	
7	Emissions	
	Total score	
	Average score	

Source: Sustainability framework of GRI4 (2015) and NSE (2016)

## APPENDIX 3

Variable	Obs	Mean	Std. Dev.	Min	Max
crossid	120	6.5	3.466527	1	12
years	120	2012.5	2.884324	2008	2017
eps	120	7.354775	47.39914	-251	291
es	120	.4135	.2595233	.11	.86
csz	120	7.549333	1.564291	-.33	8.99

. hausman random fixed

---- Coefficients ----

	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	random	fixed	Difference	S.E.

es	3.889521	8.997017	-5.107496	.
csz	.9398762	.4279625	.5119137	.

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b = consistent under Ho and Ha; obtained from xtreg  
 B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

$$\begin{aligned} \text{chi2}(2) &= (b-B)'[(V_b-V_B)^{-1}](b-B) \\ &= -0.12 \quad \text{chi2} < 0 \implies \text{model fitted on these} \\ &\quad \text{data fails to meet the asymptotic} \\ &\quad \text{assumptions of the Hausman test;} \\ &\quad \text{see suest for a generalized test} \end{aligned}$$

. xttest0  
 Breusch and Pagan Lagrangian multiplier test for random effects

$$\text{eps}[\text{crossid},t] = Xb + u[\text{crossid}] + e[\text{crossid},t]$$

Estimated results:

	Var	sd = sqrt(Var)
eps	2246.679	47.39914
e	2456.331	49.56139
u	0	0

Test: Var(u) = 0  
 chibar2(01) = 0.00  
 Prob > chibar2 = 1.0000

. xtserial eps es csz

Wooldridge test for autocorrelation in panel data  
 H0: no first order autocorrelation

F( 1, 11) = 449.613  
 Prob > F = 0.0000

. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance  
 Variables: fitted values of eps

chi2(1) = 11.16  
 Prob > chi2 = 0.0008

. reg eps es csz, robust

Linear regression                      Number of obs = 120  
 F(2, 117) = 3.94  
 Prob > F = 0.0221  
 R-squared = 0.0016  
 Root MSE = 47.763

	Robust					
eps	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
es	3.889521	21.00676	0.19	0.853	-37.71327	45.49232
csz	.9398762	1.239958	0.76	0.450	-1.515796	3.395549
_cons	-1.348981	4.956292	-0.27	0.786	-11.16466	8.466696

