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DETERMINANTS OF NON-PERFORMING LOANS OF DEPOSIT BANKS IN TURKEY

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ABSTRACT

This study empirically analyzes the factors that determine the non-performing loans (so-called bad loans) of 20 deposit banks in Turkey for 2006-2012 period using panel data analysis method. The analysis results reveal that solvency, profitability, credit quality, diversification, economic growth and the recent financial crisis are essential indicators of non-performing loans rate in Turkish banking sector. More specifically, greater profitability and revenue diversification significantly lowers non-performing loans rate, whereas greater capital and loan loss provisions significantly increase non-performing loans rate. In terms of macroeconomic variables, only economic growth has a negative effect on the non-performing loans (NPLs) ratio. Moreover, our results also uncover that deposit banks' NPLs ratio increases during the latest global financial turmoil period.

Keywords: Deposit banks, non-performing loans, panel data analysis, credit risk, Turkey.
JEL Classification: B22, C23, E44.

1. INTRODUCTION

The issue related to the relationship between the non-performing loans (NPLs) and bank-specific and macroeconomic conditions has drawn great deal of attention in the recent decades, because of results that the NPLs have on both banking system and the economy (Reinhart and Rogoff, 2011; Louzis et al. 2012; Castro, 2013; Makri et al. 2014; Chaibi and Ftiti, 2015; among others). The one of the main problems of the banking sector is the deterioration of the quality of the loan in asset side of balance sheet in banks in many bank-based financial systems (Demirguc-Kunt, 1989). Actually, the NPLs, a measure of both loan risk and asset quality, are signal for the deteriorating of banks' balance sheet and it is typically a pioneer for banking sector crisis and associated with fragility of the financial system. Potential increases in the amount of bad loans in the loan portfolio may cause banks to have difficulty in their financial intermediation process and this severely influences their liquidity and profitability. If the increases in loan defaults are not controlled, banking failures are inevitable (Bardhan and Mukherjee, 2016; Ghosh, 2015; Kasman and Kasman, 2015; Nkusu, 2011). Likewise, banks' asset quality deterioration could decelerate economic growth by weakening the stability of banking system (Ghosh, 2015; Zeng, 2012). But then, NPLs could be employed to mark the onset of a banking crisis and to test the vulnerability of the financial system (Sorge, 2004; Reinhart and Rogoff, 2011). Researchers have claimed that macroeconomic conditions can affect credit market and financial stability in the last decade. So, macroeconomic environment can be seen as one of the most important determinants of banking credit risk (Demirguc-Kunt and Detragiache, 1998; Castro, 2013; Messai and Jouini, 2013; Skarica, 2014; among others). As well as macroeconomic conditions, bank specific indicators are also used in many previous banking studies to explore the determinants of NPLs (Us, 2016; Abdioglu and Aytekin, 2016; Bardhan and Mukherjee, 2016; Dimitrios et al., 2016; Ghosh, 2015; Berger and DeYoung, 1997; among others).

We intend to understand this link between the macroeconomic developments, specific banking variables and the NPLs for Turkish banking industry in this paper. Our study contributes to the existing banking literature by investigating strictly regulated banking industry in Turkey. More specifically, as far as we know, our study is the first to examine the link between unemployment rate and income diversification and NPLs for Turkish banking system. Second contribution of our study is methodological. We lagged all of bank-specific variables by one year to cope with endogeneity issue in the traditional panel data models, i.e., the pooled-OLS, fixed-effects (FEs) and random effects (REs) models. Thirdly, because of the fact that the sample time period (2006-2012) we have selected contains the latest global economic crisis, the influence of this crisis on NPLs of Turkish deposit banks is also analyzed by way of a dummy crisis variable. Estimation results obtained from our study seem to imply that bank capitalization and loan loss provisions exert positive and significant influence on the NPLs, whereas profitability and income diversification are negatively associated with the NPLs. As for the impact of macroeconomic indicators, the results show that while there is a negative and significant relationship between economic growth and the NLPs, unemployment and inflation rate have no significant effect on the NPLs of deposit banks. The rest of this study is organized as follows. Section 2 overviews the literature review, our data and methodology used are presented in sections 3 and 4, respectively. Section 5 presents the empirical results and finally we present our conclusions in section 6.

2. LITERATURE REVIEW

There are lots of empirical studies which examine the effect of banking sector factors and macroeconomic determinants on the non-performing loans. Berger and DeYoung (1997) investigate four bank management-related hypotheses, which are related to the link among loan quality, cost efficiency and bank capital using Granger-causality techniques. Their results shows the bad management and moral hazard hypotheses were explaining an important part of the bad loans. Based on a sample of 46 banks from 12 countries in the MENA region during 2002-2006, Boudriga et al. (2009) examine how bank specific, institutions and business environment and macroeconomic environment indicators influence on the rate of the NPLs in the MENA region employing a random effects regression analysis. They report that the institutional environment, bank capital, loan loss provisions, credit growth, foreign participation are significantly associated with problem loans. Using a sample of 9 Greek deposit banks between the years 2003:Q1-2009:Q3, Louizis et al. (2012) analyze the factors influencing the ratio of the NPLs using the Blundell–Bond system GMM estimator. According to empirical results, They conclude that economic growth, the unemployment, public debt, and interest rate and profitability measured by ROE have a considerable influence on the ratio of NPLs of Greek banks for all loan classes (i.e. business, consumer and mortgage loans).The relationship between the macroeconomic variables and the banking credit risk measured by the ratio of non-performing loans to total loans in 5 European countries (namely, Greece, Ireland, Italy, Portugal and Spain) between 1997:Q1 and 2011:Q3 is investigated by Castro (2013) using dynamic panel data approaches. The empirical findings suggest that the credit risk represented by NPLs is negatively and significantly correlated with GDP growth, the share price indices and the housing prices, whereas it is positively and significantly correlated with the unemployment rate, interest rate, real exchange rate, and credit growth. Moreover, the author observes a considerable rise in the NPLs during the latest economic crisis period. Exploring the effects of macroeconomic indicators on the ratio of the NPLs in the 28 EU countries over the period of 2000-2013, Angela and Irina (2013) find that the real GDP growth rate, unemployment, domestic credit, government budget balance, and public debt are statistically significant in NPLs equations. Curak et al. (2013) empirically examine determinants of NPLs using a sample of 69 banks from 10 different countries in the banking industry of Southeastern Europe during 2003-2010. The results obtained from GMM estimation indicate that the credit risk measured by the NPLs ratio is influenced by bank-specific indicators like bank size, profitability measured by the ratio of net income to total assets and bank capital. Moreover, the NPLs ratio is affected by macroeconomic indicators such as economic growth, inflation and interest rate. Based on panel data for 9 Central, Eastern and Southeastern European (CESEE) countries over the period 2004-2012, Jakubik and Reininger (2013) study the determinants of the NPLs by using GMM estimations. They find that real GDP growth and national stock price index reduce the level of the NPLs, while a nation's exchange rate, private credit-to-GDP and past NPLs increase present period's NPLs. Messai and Jouini (2013) examine the issue for 85 banks that contain Italy, Greece and Spain, respectively, over the period from 2004 to 2008. They report that economic growth and bank profitability decrease the NPLs ratio, whereas real

interest rates, unemployment rates, and the quality of poor credit affect NPLs of banks positively. Using data of Eurozone's banking systems over 2000-2008, Makri et al. (2014) test the factors driving the NPL ratio in 14 different countries by using difference GMM estimation. They conclude that reveal strong correlations between ratio of the NPLs and various macroeconomic factors such as economic growth, public debt and unemployment and bank-specific indicators such as past NPLs rate, bank capital, and profitability measured by return on equity. Skarica (2014) explores the macroeconomic factors affecting the level of the NPLs using a fixed effects estimator for quarterly data for the period of 2007-2012 in 7 Central and Eastern European countries. The empirical results suggest both unemployment and inflation increase the development of NPLs, while real GDP growth has a negative effect on the NPLs. In a study on the French (market-based economy) and German (bank-based economy) banking industry, Chaibi and Ftiti (2015) empirically analyses what determines the non-performing loans of commercial bank operating in both economies belong to the same euro area for the period of 2005-2011 by using GMM and Roodman estimations. According to dynamic panel regressions results, Lagged NPLs' ratio, Loan loss provisions, Inefficiency, leverage, bank size, profitability represented by ROE are significant bank-specific determinants of NPLs. Their findings also show that for the inflation, GDP growth, Interest rate, unemployment, and exchange rate are significant macro-economic drivers of NPLs. Based on data of commercial banks from 15 euro-area countries for the period 1990:Q1-2015:Q2, Dimitrios et al. (2016) investigate the main determinants of non-performing loans by employing GGM estimator. Their empirical study is the first empirical study which investigates the role of taxation on the personal income and the output gap. They report that past NPLs, ratio of loans to deposits, profitability, unemployment, economic growth, debt, taxation and output gap are the main determinants of NPLs. In Indian banking sector between the years 1995–2011, Bardhan and Mukherjee (2016) focus on analyzing the effect of bank-specific indicator on the non-performing assets (NPAs) by using the System GMM technique. They report that the NPAs, bank size, inflation, and exchange rate in the next period influence the current NPAs positively, while bank capital, profitability, GDP growth in the next period influence the current NPAs negatively.

Other hand, there are several studies which investigate the effect of banking sector factors and macroeconomic determinants on the non-performing loans in Turkish literature. On Turkish banking system, İskenderoğlu and Tomak (2013) make an analysis that contains 15 deposit banks between the years 2002-2012 by using GMM estimator. They conclude that increases in the ratio of fixed assets to total asset and past NPLs are associated with a higher level of non-performing loans. Using static and dynamic models, Vardar (2015) finds that bank specific (size, liquidity, Lending, the ratio of off-balance sheet items to total assets) and macroeconomic indicators (growth of GDP and interest rate) are leading determinants of the rate of NPL of deposit banks for the period from 2002 to 2012. Investigating what determines the NLP rate of 26 Turkish deposit banks between 2002-Q4 and 2013-Q1, Yağcılar and Demir (2015) find that being listed in stock market, bank size, loans-to- total deposits ratio, liquidity risk and profitability. They are negatively associated with the NPLs, whereas foreign banks dummy variable, bank capital, economic growth and interest rates are positively related to the NPLs. Another study from Turkish banking industry, Kasman and Kasman (2015) report that economic growth, the ratio of loans to total assets bank size and the 2008 financial crisis are main determinants of NPLs over the period 2002–2012 in a recent study by Us (2016), analyzing the determinants of non-performing loans of deposit banks before and after the global economic crisis over the period from 2002Q4 to 2015Q4. The author reports that the NPLs rate is mostly influenced by bank-specific indicators before the crisis. However, the influences of these indicators disappear after the crisis. Besides, the association between bank-specific and macroeconomic factors and NPLs of 22 commercial banks from Turkey between the years 2002 to 2014 is explored in another recent study by Abdioglu and Aytekin (2016). Authors conclude that while past NPLs, net interest margin, capital adequacy ratio and bank capital have negative influences on NPLs, the ratio of loans to deposits using dynamic panel estimators in their study. The ratio of other operating expenses to total operating revenue, interest applied to loans and non-interest income-to-total assets ratio has positive influences on NPLs.

3. DATA

Following Us (2016), Chaibi and Ftiti (2015), Makri et al. (2014) and Curak et al. (2013), non-performing loans (NLPs), dependent variable, is calculated as the ratio of non-performing loans (gross) to total loans. Some Independent variables such as macroeconomic and bank-specific variables commonly employed in studies

regarding non-performing loans are included in the analysis. Our study includes the size of banks (BS) variable in our models to investigate the link between bank size and NPLs. Larger banks have more resources to make risk assessment efficiently, which resulting in dampening of asymmetric information. Additionally, larger banks having better diversification opportunities may also engage in more risky activities (Curak et al., 2013; Baselga-Pascual et al. 2015). As a consequence, we expect that the size has a positive influence on the NPLs of banks. Equity capital (EQTA) calculated as the ratio of shareholders' equity to total assets is regarded as banks' internal strength to absorb a variety of shocks especially during unstable macroeconomic conditions. Lower capitalized banks are more likely to take more risky credit activities, which ends up with an increase in problem loans (Makri et al., 2014; Ghosh, 2015). The ROA employed in this study as a profitability measure is considered as an important bank-specific determinant of ratio of the NPLs. The level of profitability in banks is influenced by their risk-taking behavior. Banks with more profitability tends to have less incentive to engage in more risky lending activities than the optimal level, leading to higher NLPs (Louzis et al., 2012; Curak et al., 2013; Makri et al., 2014; Dimitrios et al. 2016).Therefore, the link between profitability ratio and NPLs ratio is expected to be negative. Lending ratio (LTA) presented by the ratio of loans and receivables to total assets is also one of the investigated bank-specific variables in this study. This ratio is considered to be a crucial driver of credit risk. As the total loans-to-total assets ratio grows faster, conditions concerning credit standard weaken and thus stringent loan contract standards are more likely to end up with a high level of credit risk (Baselga-Pascual et al. 2015; Ghosh, 2015; Us, 2016). As a result, the lending is expected to be positively related to NPLs. We included credit quality variable, which demonstrates the link between credit quality and bad loans. As suggested by Chaibi and Ftiti (2015), predicting high levels of capital loss, banks are more likely to make higher provisions, which results in potentially higher credit risk. Thus problem loans in loans portfolio of banks increase banks' NPLs ratio. A positive relationship between provision for loan losses and NPLs is expected. The other bank-specific variable included in the regression model is income diversification (NII). Banks with diversified assets portfolios are more likely to avoid riskier behavior. Banks' diversification opportunities improve quality of loan and minimize credit risk. Besides, trusting varied types of revenue could cause banks to decline loans opportunities for lower quality borrowers (Hu, Yang and Yung-Ho, 2004; Louzis et al., 2012; Ghosh, 2015). Hence Income diversification variable is expected to exhibit negative association with the NPLs of banks.

With regard to macroeconomic factors used in this study, we used the growth rate of GDP to control for macroeconomic cycle, economic environment and to capture the economic activity of government. We expect a negative effect of the growth of real GDP on NPLs and negatively associated with NPLs in this study. If the economy of a country expands, the income of corporate borrower increases and they have powerful ability to service their loans and debts. The increases of growth rate means that it generally shows the rise of economic and financial stability. Otherwise, if the growth rate of GDP shrinks in an economy, so, credit is widened to low-quality debtors and this situation causes to an increase in NPLs tend in the end (Makri et al. 2014; Vardar, 2015; Ghosh, 2015; Bardhan and Mukherjee, 2016). We also employ the unemployment rate to dominate for macroeconomic cycle and economic environment which defines the behavior of the credit risk. The effect of increase of the unemployment rate on the NPLs is expected to be positive. Firstly, the unemployment cause to decrease the cash flow of households and it leads to make a lower consumption in the economy. Other hand, the unemployment rate also influences firm' cash flow and causes to decline of their production (Louzis et al., 2012; Makri et al. 2014; Chaibi and Fititi, 2015; Dimitrios et al., 2016). Finally it leads fragile debt position and then a rising an unemployment cause to extend in NPLs. Interest rate measured by percentage change of consumer price index is regarded as another macroeconomic driver of NPLs. Theoretically, a rise in interest rate may cause the repayment capacity of borrowers to weaken, which ends up with to a higher level of NPLs rate (Nkusu, 2011; Curak et al., 2013; Castro, 2013; Škarica, 2014; Ghosh, 2015; Bardhan and Mukherjee, 2016). So, we expect that the inflation rate has a positive influence on the NPLs of banks.

4. METHODOLOGY

Our goal is to determine the factors that influence non-performing loans rate of Turkish deposit banks for the period of 2006-2012. Our sample contains 20 deposit banks and other deposit banks operating in Turkey are dropped from our sample on account of missing values or inconsistencies. Annual financial data for deposit banks is mostly obtained from the Turkish Banking Association (TBA), the macroeconomic variables, namely inflation rate, economic growth rate and unemployment rate are taken from the Central Bank of the Republic

of Turkey (CBRT) database. The following econometric model which is similar to that of Ghosh (2015), Baselga-Pascual et al. (2015), Makri et al. (2014) and Curak et al. (2013) is used to investigate the factors influencing non-performing loans rate of deposit banks in Turkey:

$$\mathrm{NPLs}_{it}=\alpha_0 + \alpha_1 \mathrm{BSV}_{it-1} + \alpha_2 \mathrm{MEV}_t + \alpha_3 \mathrm{CRISIS}_t + \mu_i + \epsilon_{it} \quad (1)$$

In this specification, NPLs_{it} is the independent variable employed to measure the ratio of non-performing loans of bank i at year t; $\alpha$is a constant term; BSV_{it-1} donates bank-specific variables; MEV_t refers to macroeconomic variables; CRISIS_t represents a crisis dummy variable that takes the value 1 if the years are equal to 2007, 2008 and 2009, otherwise 0. μ_i is unknown bank-specific effect and ϵ_{it} is a random disturbance; the coefficients α_1, α_2 and α_3 are the parameters to be estimated. Furthermore, all bank-specific variables are lagged by one year to address endogeneity issue. The definition and summary statistics for the variables employed in Equation (1) to explore the association between bank-specific and macroeconomic indicators and NPLs in Turkish banking system are presented in Table 1, Table 2 and Table 3, respectively.

Table 1: Definition of the Variables

Name of Variables	Symbol	Description
Panel A: Dependent variable		
Non-performing loans	NPLs	Non-performing loans (gross) over total loans
Panel B: Bank-specific variables		
Bank size	BS	Natural log of total assets
Bank capital	EQTA	Shareholders' equity over total assets
Profitability	ROA	Net income over total assets
Lending activity	LTA	Total loans and receivables over total assets
Credit quality	PLLTA	Provision for loan losses over total assets
Revenue diversification	NII	Non-interest income over total assets
Panel C: Macroeconomic variables		
Inflation	INF	Annual inflation rate (CPI, year by year % change)
Economic growth	GDP	Annual real GDP growth rate
Unemployment	UNEMP	Annual unemployment rate
Panel D: Crisis control variable		
Global economic crisis	CRISIS	Dummy variable that takes the value of 1 if the years are 2007, 2008 and 2009, 0 otherwise

Descriptive statistics for the bank-specific and macro-economic variables employed in this study between the years 2006-2012 are reported in Table 2. The mean (median) of NPLs ratio of banks in our sample is 4.23% (3.69%).The maximum value of NPLs ratio is 0.77%, whereas the minimum value of this ratio is 19.27%. In comparison with NPLs in banking sector of some developed and developing countries, the mean value of NPLs ratio for banks in Turkey is relatively smaller when compared to those reported by Bardhan and Mukherjee (2016) for banks in India (4.5%), Chaibi and Ftiti (2015) for banks in France (5.82%) and Germany (4.36%), Ashraf et al. (2016) for banks in Pakistan (12.32%), Sawada (2013)for banks in Japan (5.77%) and Hu, Yang and Yung-Ho (2004) for banks in Taiwan (4.76%).

The mean (median) of BS in our sample banks is 9.6259 (9.7349) with a range between 12.0751 and 6.2653. The mean (median) of EQTA of banks in our sample is 13.27% (12.3) with a minimum of 6.7% and a maximum of 49.2%. ROA's mean (median) value is 1.76% (1.64). While the minimum value of this ratio is 0.49%, the maximum value is 8.02%. The mean (median) of LTA of banks in our sample is 54.32% (58.54%), with a minimum of 3.61% and a maximum of 76.21%. The mean (median) of sample banks' PLLTA ratio is 1.07% (0.9%), with a range between 0 and 3.8%. On NII, the mean (median) of this variable is 2.29% (1.79%), with a minimum of 2.56% and a maximum of 22.12%. As far as macroeconomic variables are concerned, the average (median) value of INF, GDP and UNEMP in Turkey is 8.23% (8.39%), 3.93% (4.67), 10.51% (9.9), respectively.

Table 2: Descriptive Statistics for Variables

Variable	Mean	P50	Std. Dev.	Min	Max	N
NPLs	.0423	.0369	.0278	.0077	.1927	133
BS	9.6259	9.7349	1.636	6.2653	12.0751	140
EQTA	.1327	.123	.0562	.0670	.4920	140
ROA	.0176	.0164	.0119	-.0049	.0802	140
LTA	.5432	.5854	.1551	.0361	.7621	140
PLLTA	.0107	.0090	.0076	0	.0380	140
NII	.0229	.0179	.0276	-.0256	.2212	140
CRISIS	.4286	0	.4966	0	1	140
INF	.0823	.0839	.0173	.0616	.1045	140
GDP	.0393	.0467	.0466	-.0483	.0916	140
UNEMP	.1051	.0990	.0143	.0900	.1270	140

Notes: Variable BS represented by banks size is in logarithmic form. See Table 1 for definition of the rest of the variables.

The evolution of the mean values of the bank specific and macroeconomic variable in each year is presented in Table 3. When we look at the means of the variables in Table 3, we see that while the mean values of the NPLs ratio and the PLLTA ratio increase between the years 2007-2009, the mean value of the LTA ratio decreases in the same time period. Both the increases in the NPLs and the PLLTA ratios and the decreases in the LTA ratio are attributable to the global financial crisis, which begins around mid-2007. These results confirm that the latest global economic crisis has increased the level of the NPLs in a large number of developed and developing countries (Makri et al. 2014; Ghosh, 2015; Baselga-pascual et al. 2015). For this reason, we employ the crisis dummy variable in Equation (1) to investigate whether or not the global economic crisis variable has an influence on deposit bank's NPLs ratio.

Table 3: Year-by-Year Mean Values for Variables

Year	Obs.	NPLs	BS	EQTA	ROA	LTA	PLLTA	NII	INF	GDP	UNEMP
2006	19	.0352	22723.15	.1123	.0190	.4788	.0091	.0343	.0965	.0217	.0950
2007	20	**.0310**	26220.40	.1382	.0225	**.5413**	**.0090**	.0320	.0839	.0877	.0990
2008	20	**.0399**	33070.35	.1405	.0165	**.5323**	**.0120**	.0231	.1006	.0916	.1270
2009	20	**.0669**	36318.74	.1450	.0202	**.5233**	**.0188**	.0245	.0653	-.048	.1260
2010	20	.0488	45308.05	.1315	.0156	.5574	.0082	.0194	.0640	.0066	.1060
2011	20	.0389	54955.45	.1215	.0117	.5723	.0071	.0131	.1045	.0467	.0900
2012	20	.0366	61352.00	.1423	.0174	.5966	.0111	.0144	.0616	.0689	.0930

Notes: This table reports the mean values of the bank specific and macroeconomic variables over the sample period. See Table 1 for variable definitions.

5. FINDINGS AND DISCUSSIONS

Correlations between dependent and independent variables are reported in Table 4. As reported in Table 4, the correlation matrix of variables used in this study indicates statistically significant correlations between all the regressors and NPLs ratio except for BS, ROA and LTA. More specifically, EQTA, PLLTA and NII are positively and significantly correlated with NPLs. Similarly, the same holds true for UNEMP. The correlation coefficients between NPLs and the other macroeconomic variables (INF and GDP) are negative and statistically significant. BS, ROA and LTA are not significantly associated with NPLs. As shown in Table 4, the maximum sample correlation value is .68, showing that there is no sign of multicollinearity among the regressors. As presented in the last column of Table 4, the VIF values regarding regressors range from 1.18 to 3.21. These results also show that VIF values are well below the acceptable upper limit of 10 (Guajarati, 2004). As a consequence, we can deduce that the multicollinearity among the independent variables is not a serious issue in Equation (1).

Table 4: Correlation Coefficients and Variance Inflation Factor (VIF) Values

Variables	1	2	3	4	5	6	7	8	9	10	11	VIF
(1) NPLs	1											-
(2) BS	-.16	1										1.95
(3) EQTA	**.26***	**-.49***	1									1.50
(4) ROA	-.05	**.25***	**.35***	1								1.91
(5) LTA	-.04	.13	**-.30***	**-.27***	1							1.18
(6) PLLTA	**.50***	.01	-.06	-.07	**.34***	1						1.93
(7) NII	**.26***	**-.25***	**.68***	**.60***	**-.36***	-.02	1					1.69
(8) CRISIS	.10	-.16	-.01	.15	-.11	-.08	**.19***	1				3.19
(9) INF	**-.19***	-.05	-.01	.12	-.001	**-.22***	.10	.05	1			1.44
(10) GDP	**-.34***	-.03	-.12	.04	-.01	**-.28***	.07	.08	**.43***	1		1.71
(11) UNEMP	**.26***	-.10	.12	**.18***	-.03	.13	.11	**.73***	-.12	**-.28***	1	3.21

Notes: Correlation coefficients of variables are significant at the 5% level or better. See Table 1 for variable definitions.

The results obtained from the traditional panel data models, i.e., the pooled-OLS, fixed-effects and random effects models are shown in Table 5. According to the results obtained from F-test, Breusch–Pagan's Lagrange multiplier (LM) test and Hausman specification test reported at the bottom of Table 5, fixed effects (FEs) estimator is preferred over random effect (REs) estimator and our model specified in Equation (1) is interpreted by using fixed effect (FEs) estimator. In Table 5 we report the coefficients of the explanatory variables and the corresponding t-statistics. We check the econometric properties of our specification in advance and report heteroskedasticity and autocorrelation consistent t-statistics on account of the existence of heteroscedasticity and autocorrelation.

According to the findings of empirical estimation of Eq. (1), bank capital (EQTA) has a positive impact on the rate of the NPLs in Turkish banks. In other words, higher capital ratio is related to higher rate of NPLs. We do not find evidence supporting Berger and DeYoung (1997)'s "moral hazard argument" that banks with thinner capital engage in more risky lending, resulting in an increase in the NPL ratio. This finding can attribute to the influence of regulatory pressure on the minimum level of Turkish banks' capital. The positive relationship between the EQTA and the NPLs rate is similar to previous banking studies (e.g., Ghosh 2015, Curak et al. 2013 and Godlewski, 2004). This result, however, is different from the findings of Abdioglu and Aytekin (2016), Ashraf et al. (2016), Bardhan and Mukherjee (2016) and Marki et al. (2014).

Regarding the relationship between ROA as a measure of bank profitability and the level of the NPLs ratio, it is negative and statistically significant at the 5% level. The negative sign of the ROA variable in the regression Equation (1) can be explained by the risk-taking behavior of banks' management. That is, banks with higher profitability ratios have less incentive to engage in more risky lending than the optimal level, which in turn results in lower non-performing loans rate. In case of Turkish banks, this finding supporting "bad management argument" that there is a negative association between past profitability and the NPLs are consistent with prior empirical results of Bardhan and Mukherjee (2016) for Indian banking system, Yagcilar and Demir (2015) for Turkish banking sector, Ghosh (2015) for the US banking sector, Baselga-Pascualet al. (2015) for European banking sector, Curak et al. (2013) for Southeastern European banking systems, Marki et al. (2014) for Eurozone's banking systems, Louzis et al. (2012) for Greek banking sector, Dimitrios et al. (2016) for euro-area banking system, Messai and Jouini (2013) for Italy, Greece and Spain and Boudriga et al. (2010) for commercial banks from 12 MENA countries.

The loan loss provisions ratio (PLLTA), which reflects asset quality and credit risk of deposit banks and defined as provisions for loan losses over total assets, has a positive and significant influence on the NPLs rate at the 10% level. The possible explanation for this result is that banks with poor credit quality could increase risk level of loan portfolio in their balance sheets. This estimation confirms the results obtained from prior banking studies (e.g., Boudriga et al., 2009; Chaibi and Ftiti, 2015; Ghosh, 2015; Messai and Jouini, 2013; among others).

Concerning the association between revenue diversification (NII) and nonperforming loans ratio, it is negative and significant at the 10% level. This means that a higher revenue diversification rate significantly contributes

to lower the NPLs ratio. The negative impact of bank revenue diversification on the NPLs rate of banks allows us to accept Hu, Yang and Yung-Ho (2004)'s "diversification hypothesis" that less diversified banks have to rise the riskiness of their loan portfolio to generate profit, leading to an increase in the rate of NPLs. In terms of sign of this variable, the estimation result obtained is similar to the findings of Ghosh (2015) and Hu, Yang and Yung-Ho (2004), but different from the studies of Louzis et al. (2012) and Chaibi and Ftiti (2015).

Table 5: Results of Panel Data Analysis

	Pooled OLS		REs		FEs	
Explanatory variables	Coefficient	t-Stat	Coefficient	z-Stat	Coefficient	t-Stat
BS	-.0011	-0.39	.0028	1.22	.0092	1.45
EQTA	.06987	0.67	**.2229***	1.85	**.2607***	1.94
ROA	-.2251	-0.63	**-.5372****	-2.19	**-.5259****	-2.24
LTA	-.0269	-0.76	.0088	.53	.0237	0.68
PLLTA	**1.3155*****	3.00	**.7207****	2.49	**.7769***	1.85
NII	.3006	0.75	-.1273	-0.63	**-.2508***	-1.98
CRISIS	.0005	0.07	**.0083***	1.72	**.014****	2.17
INF	.0526	0.58	.0373	.47	.04465	.56
GDP	**-.1452*****	-3.12	**-.1404*****	-3.56	**-.1326*****	-3.48
UNEMP	.1989	1.52	.1514	1.50	.0859	.85
Constant	.0239	0.62	-.0296	-1.14	-.0994	-1.30
Results of diagnostic test						
F-test					11.54(.0000)	
Breusch-Pagan LM test			67.79(.0000)			
Hausman test					13.87(0.0312)	
Autocorrelation					14.414(.0013)	
Heteroscedasticity					51.02(.0001)	
Adj. R^2	0.3277		0.2735		0.5420	
F-statistics	13.50(.0000)				9.41(.0000)	
Wald chi-squared			94.34(.0000)			
Observations	114		114		114	
Banks in sample	19		19		19	

Notes: This table reports the determinants of the NPLs of Turkish banks over the period 2006-2012 using the traditional panel data estimators. Dependent variable is the ratio of non-performing loans to total loans. See Table 1 for definitions of the independent variables. The values in parentheses are probability values. All bank-specific indicators are lagged by one year to cope with endogeneity issue in our model specified in Eq. (1) and ***, **, and * indicate significance levels at 10, 5, and 1%, respectively.

When the analysis results are evaluated with regard macroeconomic indicators, we can say that economic growth (GDP) is the most essential factor in determining the NPLs rate of deposit banks in Turkey. According to the results, a 1% percent rise in economic growth lowers the NPL ratio approximately by 0.13%. The negative sign of this variable supports the findings of Kasman and Kasman (2015), Baselga-Pascualet al. (2015), Chaibi and Ftiti (2015); Makri et al. (2014); Nkusu, 2011; Castro (2013); Curak et al. (2013); among others. Finally, our results also reveal that NPLs ratio of deposit banks in Turkish banking system increases during the global economic crisis period. In other words, the crisis period covering the years 2008-2010 leads to a higher rate of non-performing loans. This finding is also in accordance with recent banking studies such as Us (2016), Kasman and Kasman (2015) and Castro (2013). Despite the fact that the effects of bank size (BS), loans-to-assets ratio (LTA), inflation rate (INF) and unemployment rate (UNEMP) on non-performing loans ratio are positive, the coefficients of these variables are statistically insignificant, implying that these variables have no effect on non-performing loans ratio of deposit banks operating in Turkey during the sampling period.

6. CONCLUSION

The influence of bank-specific and macroeconomic factors on non-performing loan (loans under follow-up) is a widely explored research object for researchers, regulatory authorities and policy makers in the wake of the

latest global economic crisis. This paper investigates the factors affecting non-performing loans ratio of 20 deposit banks in Turkish banking sector covering the period from 2006 to 2012 using traditional panel data analysis such as pooled ordinary least square, random effects and fixed effects estimates.

Our main results indicate that: (i) solvency ratio has a positive impact on the NPLs ratio; (ii) profitability measured by net income-to-total assets has a negative impact on the NPLs ratio; (iii) loan loss provisions has a positive impact on the NPLs ratio; (vi) revenue diversification measured by non-interest income-to-total assets has a negative impact on the NPLs ratio; (v) economic growth rate has a negative impact on the NPLs ratio; (vi) NPLs ratio increases during latest global economic crisis period.

There are lots of empirical studies focuses their attention on the NPLs matter because of the fact that the rise of non-performing loans (NPLs) is a remarkable characteristic of financial crises. The determining the rise of NPLs percentage in the banking systems is a vital issue in order to maintain financial/loans stability for the banks. The last global financial turmoil has re-emphasized the importance of the banking system problems in most advanced economies as well as emerging market economies. Banking system has some structural weakness such as NPLs, hazardous banking applications, moral hazard, bad loans, bad management, skimping in the last decades. These problems can weaken the banking system and cause payment difficulties. NPLs, impaired bank assets and their macroeconomic effects are the heart of financial stability problems. Hence, the solution of these problems is required for sustainable macroeconomics view, rapid economic activity, high economic performance, the creation of new jobs, and healthy financial stability. Otherwise, potential risks in banking system may occur a fall in the economic growth, increases of unemployment, high prices in the economy and banking crisis in the end.

For future research, various macroeconomic and bank specific variables and different estimators could be employed to explore the association between these variables and non-performing loans of banks. First, the effect of these factors on NPLs can be analyzed in deeper form for deposit banks in Turkey. Second, it may be worth expanding on the study of credit risk by using different kind of econometrics methods for Turkey. The results could be debated in terms of the findings of prior banking studies and related hypotheses.

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EFFECT OF FIRM'S EXPORT-ORIENTATION ON BACKWARD SPILLOVERS OF FOREIGN DIRECT INVESTMENT IN TURKISH MANUFACTURING INDUSTRY *

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ABSTRACT

This study examines the direct and indirect or spillover effects (horizontal and vertical) of FDI with special emphasis on the backward spillover effects. My main purpose is to examine whether the effect of backward spillovers generated by export oriented foreign owned firms is larger on productivity of domestic firms than backward spillover effect generated by domestic oriented foreign owned firms by using firm-level data for the years 2003-2011. With this purpose, value added and total factor productivity equations with two different measures of backward spillover effects for Turkish manufacturing industry firms are estimated by using the panel data method. My empirical results are consistent with the existence of positive horizontal and vertical spillovers of FDI. My estimation results also show that the backward spillover generated by export oriented foreign owned firms is larger than the backward spillover generated by domestic oriented foreign owned firms.

Keywords : Foreign direct investment, spillover effects, backward spillovers, firm exports
JEL Classification : F21, F23

1. INTRODUCTION

It is argued that there are many potential benefits of FDI and plays a vital role in economic growth. Firstly, FDI increases productivity of domestic firms through the importing of high-tech products and transfer of new technology. De Mello (1997: 9). Moreover, FDI advances technology, management capacity and know-how therefore provides a high level of effectiveness and productivity to the host country. Colen et al. (2008: 13). FDI also can create horizontal and vertical spillovers that increase productivity of domestic firms. Foreign owned firms transfer new technologies and organizational methods to their affiliated firms, also with joint ventures and strategic alliances, importing of capital goods and technology licenses provide positive spillovers to host country directly or indirectly. Blomstrom and Kokko (1998: 3).

FDI spillovers can be formed in the firms that integrated vertically with foreign owned firms (inter-industry) or firms which are in direct competition with them (intra-industry). Intra-industry spillovers or horizontal spillovers occur when foreign owned firms enter into a sector and improve performance and competitiveness of firms in the same sector. The inter-industry or vertical spillovers occur when firms can benefit from the presence of foreign owned firms through forward and backward linkages. This, include firms providing services for FDI firms (Backward Spillover) and also the firms which are provided by FDI firms (Forward Spillover). Stancik (2007: 2).

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2. LITERATURE REVIEW

According to Javorcik (2004), export status of the firm is one of the determinant of the extent of the backward spillover effect generated by foreign owned firms. Javorcik (2004) stated that export oriented foreign owned firms is expected to cause backward spillover more than domestic oriented foreign owned firms since foreign owned firms would have imposed more quality requirements to their domestic suppliers. Although domestic oriented foreign owned firms tend to use domestic resources more than export oriented foreign owned firms, export oriented foreign owned firms use more variety or better quality resources and it can lead to more learning of domestic suppliers and thus it can lead to increased productivity. Therefore, it is expected that exporting firms are associated with the backward spillovers.

Although the productivity effects of horizontal and vertical spillovers have been widely studied, the result of these studies is ambiguous. Some studies found positive evidence of horizontal and vertical spillovers; Reganati and Sica (2005) for Italy, Ayyagari and Kosova (2008) for Czech Republic, Beugelsdijk et al. (2008) for developed countries, Iyer and Stevens (2009) for New Zealand. By contrast, some studies found negative spillover effects; Stancik (2007) for Czech Republic, Mishra (2011) for India. There are also studies pointing out both negative and positive spillover effects; Xu and Sheng (2012)-positive forward spillover and negative backward spillover for China, Liang (2008)-positive forward spillovers and negative horizontal and backward spillovers. Similarly, Schoors and Van der Tol (2002) and Javorcik (2004) find that the productivity of firms in the manufacturing sector was associated with backward spillovers but no evidence of forward and horizontal spillovers respectively, Hungary and Lithuania.

There are limited number of studies investigating the spillover effects of FDI at firm level in Turkey due to the difficulties in obtaining firm-level data. Taymaz and Yılmaz (2008), found that foreign affiliated firms are more productive than domestic firms for the period 1990-1996. According to Köymen and Sayek (2010), human capital plays a significant role in the transmission of horizontal spillovers, but it does not have any role in the transmission of backward and forward spillovers during the period 1990-2001.

To that end value added and total factor productivity equations for Turkish manufacturing firms for the years 2003-2011 are estimated using the panel data analysis. In the third part of the study, direct and indirect effect of FDI on productivity of domestic firms will be examined. Estimation results are presented in the fourth part of the study. Section five concludes.

3. DATA AND METHODOLOGY

In order to determine whether backward spillover effect generated by export oriented foreign owned firms is larger than backward spillover effect generated by domestic oriented foreign owned firms in the Turkish manufacturing industry, Cobb-Douglas production function Equation (1) and Total Factor Productivity (TFP) Equation (2) are estimated.

$\ln\text{Value Added}_{ijt} = \beta_0 + \beta_1 \ln\text{Labour}_{ijt} + \beta_2 \ln\text{Capital Stock}_{ijt} + \beta_3 \text{Foreign Capital Share}_{ijt} + \beta_4 \text{Horizontal Spillover}_{jt} + \beta_5 \text{Backward Spillover (Export-Oriented)}_{jt} + \beta_6 \text{Backward Spillover (Domestic-Market-Oriented)}_{jt} + \beta_7 \text{Forward Spillover}_{jt} + \text{Year} + \varepsilon_{ijt}$ (1)

$\ln\text{TFP}_{ijt} = \beta_0 + \beta_1 \text{Foreign Capital Share}_{ijt} + \beta_2 \text{Horizontal Spillover}_{jt} + \beta_3 \text{Backward Spillover (Export-Oriented)}_{jt} + \beta_4 \text{Backward Spillover (Domestic-Market-Oriented)}_{jt} + \beta_5 \text{Forward Spillover}_{jt} + \text{Year} + \varepsilon_{ijt}$ (2)

Where i, j and t denote firm, industry and year respectively. $lnValue\ Added_{ijt}$ and $lnTFP_{ijt}$ show the natural logarithm of real value added and total factor productivity respectively. The $Value\ Added_{ijt}$ variable is calculated based on the equation

$$Value\ Added_{ijt} = (Output_{ijt} - Raw\ materials_{ijt} - Electricity_{ijt} - Fuel_{ijt}).$$

Output, Raw materials, Electricity and Fuel variables are deflated by the Domestic Producer Price Index (2003=100) compiled by the Turkish Statistical Institute (TurkStat). $lnLabour_{ijt}$ indicates the natural logarithm of labour that I calculated as the sum of paid employees and unpaid family members who work with business owner and partners. $lnCapital\ Stock_{ijt}$ indicates the natural logarithm of capital stock. Data for the capital

stock is not available in the database of TurkStat. Therefore, capital stock series of firms are generated based on the building and structure, machinery and equipment, transportation equipment, computer and programming expenses of firms by using the Perpetual Inventory Method following the Berlemann and Wesselhöft (2012). Total Investment Deflator (2003=100), obtained from the Ministry of Development, was used to deflate the capital stock series. $Foreign\ Capital\ Share_{ijt}$ indicates the share of foreign capital in total capital of a firm. $Horizontal\ Spillover_{jt}$, $Backward\ Spillover_{jt}$ and $Forward\ Spillover_{jt}$ represent the proxy variables for measuring horizontal and vertical productivity spillovers arising from the foreign presence in upstream and downstream sectors.

Proxy variables for Horizontal, Backward and Forward Spillovers variables are calculated at sectoral level based on 2-digit NACE Rev. 2 classification. As a proxy for the horizontal spillover resulting from the foreign presence in the same sector $Horizontal\ Spillover_{jt}$variable is calculated by using equation (3) following Javorcik (2004). In equation (3), horizontal spillover is defined as foreign equity participation averaged over all firms in the sector, weighted by each firm's share in sectoral output. In the other words, it is defined as the average participation of foreign capital of sector j's all firms.

$$Horizontal\ Spillover_{jt} = \frac{\sum_{i\ for\ all\ i\epsilon j} Foreign\ Capital\ Share_{it} \times Output_{it}}{\sum_{i\ for\ all\ i\epsilon j} Output_{it}} \quad (3)$$

$Output_{it}$ indicates the real output of the firm. The output variable was deflated by Domestic Producer Price Index (2003=100) of TurkStat.

$Backward\ Spillover_{jt}$ is a proxy for the foreign presence in the industries that are being supplied by sector j. This variable is designed to measure the potential link between domestic suppliers and multinational customers. In order to measure the backward spillover equation (4) is used following Javorcik (2004).

$$Backward\ Spillover\ (Export - Oriented)_{jt} =$$

$$\sum_{\text{k if k}\neq\text{j}} \alpha_{\text{jk}} \times [\sum_{\text{i for all i}\epsilon\text{k}} \text{Export} - \text{Oriented}_{\text{it}} \times \text{Foreign Capital Share}_{\text{it}} \times \text{Output}_{\text{it}}] / \sum_{\text{i for all i}\epsilon\text{k}} \text{Output}_{\text{it}} \quad (4)$$

α_{jk} indicates the ratio of inputs purchased by sector k from sector j. [1]

$Export\ Oriented_{ijt}$ is a dummy variable that identifies export oriented firms. If firm i is exporting at least 20% of its output that variable takes the value 1, otherwise zero. [2] The $Export\ Oriented_{ijt}$ variable is a time-dependent dummy variable.

In addition, backward spillover generated by firms that focused on domestic market (Backward Spillover (Domestic-Market-Oriented)) is calculated similarly.

$$Backward\ Spillover\ (Domestic - Market - Oriented)_{jt} =$$

$$\sum_{\text{k if k}\neq\text{j}} \alpha_{\text{jk}} \times [\sum_{\text{i for all i}\epsilon\text{k}} \text{Domestic} - \text{Market} - \text{Oriented}_{\text{it}} \times \text{Foreign Capital Share}_{\text{it}} \times \text{Output}_{\text{it}}] / \sum_{\text{i for all i}\epsilon\text{k}} \text{Output}_{\text{it}} \quad (5)$$

In order to determine the value of domestic orientation of firms I have created the Domestic-Market-Oriented$_{it}$ variable. If firm i is exporting less than 20% of its output that variable takes the value 1, otherwise zero.

$Forward\ Spillover_{jt}$ represents the weighted share of foreign capital from all sectors that supply sector j. For measuring the forward spillover equation (6) is used following Stancik (2007). This variable measures the spillover resulting from the presence of foreign firms in the upstream sector.

$$Forward\ Spillover_{jt} = \sum_{\text{k}\ if\ \text{k}\neq\text{j}} \alpha_{\text{kj}}\ Horizontal\ Spillover_{kt} \quad (6)$$

[1] The coefficients were calculated by using the year 2002 Input-Output matrix (classified as NACE 2-digit level) produced by TurkStat. The latest Input-Output table available is for the year 2002 (with 2-digit NACE Rev. 1.1 industrial classification). So as a first step, NACE Rev. 1.1 and NACE Rev. 2 Transformation matrix was constructed by using Annual Business Statistics 2009 data and then 2002 Input-Output table was transformed to NACE Rev. 2 CPA 2008 classification.

[2] The frequency distribution of share of export of a firm in its total output shows that the number of firms which exports approximately 20% of the output is the most commonly observed. Thus, 20% is chosen as the lower limit for the export orientation variable.

α_{kj} indicates the ratio of inputs purchased by sector j from sector k.

Griliches and Mairesse (1995) points out the endogeneity of input selection problem in the estimation of production function. According to Griliches and Mairesse (1995), the inputs must be considered endogenous since they are chosen by based on firm productivity, which is observed by the producer but not by the econometrician. OLS method can lead to biased estimates of coefficients if labour and other inputs are assumed to be exogenous variables. Therefore, in order to avoid the simultaneity and selection bias problems created by the OLS method, TFP is estimated by using non-parametric estimation procedure suggested by Levinsohn and Petrin (2003) and semi-parametric estimation method of Olley and Pakes (1996). [3] Consistent estimates of input coefficients obtained by using Levinsohn and Petrin (2003) and Olley and Pakes (1996) methods for every 2-digit NACE Rev. 2 sector, are used to calculate the total factor productivity. The estimation results of Levinsohn-Petrin and Olley-Pakes coefficients are given in Appendix 1. [4]

The data used in this study was collected from Annual Industry and Service Statistics and Annual Trade Statistics provided by TurkStat. Annual Industry and Service Statistics database constitutes an unbalanced panel for firms with labor force of more than 10 and covering the period of 2003-2011. Annual Industry and Service Statistics contains 417,797 firms and 815,646 observations, Annual Trade Statistics contains 238,736 firms and 15,912,781 observations. My study includes the manufacturing industry sectors under the classification NACE Rev. 2. [5]

To avoid any possible deviated results, the database was cleared of missing observations and abnormal values. Abnormal observations were discarded based on the cleaning procedure proposed by Hall and Mairesse (1995). I excluded observations displaying extraordinary jumps and drops over one year. The firms with less than 20 employees were also excluded from the sample. Finally, I excluded firms in NACE sectors numbered 12 and 19 since they include a small number of firms. After merging and cleaning procedures, a database of 22 sectors consisting of 39,806 firms and 159,007 observations was constructed. Finally, ε_{ijt} indicates the error term and $Year$ indicates dummy variable generated for controlling the time-specific effects. Summary statistics of the variables used in the estimations of the study are presented in Appendix 2.

In order to take into account unobservable heterogeneity among firms that is potentially correlated with the dependent variables the fixed effects specification of the panel data was used. Hausman test results also indicate that a fixed effects specification should be employed. According to Aitken and Harrison (1999) and Keller (2004), controlling for unobserved factors (fixed effects) is necessary in order to avoid deviations resulting from endogeneity created by the presence of FDI. According to Hale and Long (2007), the increase in domestic firms' productivity in an industry may correspond to an increase in the presence of FDI in that industry. Therefore, ignoring unobserved factors can lead to a biased regression or simultaneity bias. So, time dummy variables are added in equations to control industry level unobserved heterogeneity. In addition, the standard error should be corrected for clustering because spillover variables are calculated at the sector level but the rest of the variables in the data set are at the firm level. According to Moulton (1990), when aggregate market and public policy variables are used to explain the economic behavior of the micro units, standard errors of the estimated coefficients of total variables can be downward biased so this may lead to the overstated significance of coefficients. Therefore, if the cluster error problem is not solved it may cause a serious downward deviation in the estimated standard error and it can lead to misleading results in the

[3] TFP estimation results obtained by Olley and Pakes (1996) method are used for robustness check of the benchmark equations.

[4] All of the equations are estimated by using the Stata 13.1 software.

[5] Those sectors are; 10. Manufacture of food products, 11. Manufacture of beverages, 12. Manufacture of tobacco products, 13. Manufacture of textiles, 14. Manufacture of wearing apparel, 15. Manufacture of leather and related products, 16. Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials, 17. Manufacture of paper and paper products, 18. Printing and reproduction of recorded media, 19. Manufacture of coke and refined petroleum products, 20. Manufacture of chemicals and chemical products, 21. Manufacture of basic pharmaceutical products and pharmaceutical preparations, 22. Manufacture of rubber and plastic products, 23. Manufacture of other non-metallic mineral products, 24. Manufacture of basic metals, 25. Manufacture of fabricated metal products, except machinery and equipment, 26. Manufacture of computer, electronic and optical products, 27. Manufacture of electrical equipment, 28. Manufacture of machinery and equipment n.e.c., 29. Manufacture of motor vehicles, trailers and semi-trailers, 30. Manufacture of other transport equipment, 31. Manufacture of furniture, 32. Other manufacturing, 33. Repair and installation of machinery and equipment.

statistical significance of total variables. Moulton (1990: 334). Thus, it is necessary to improve intra-group correlation in the standard errors of observations in the same sector in a particular year. For this purpose, one of the most common approaches in the literature, the general cluster-robust approach, that is used by Aitken and Harrison (1999), Javorcik (2004) and Haskel et al. (2002) is also adopted in this study.

4. FINDINGS AND DISCUSSIONS

The estimation results of the equations for value added (Equation (1)) and for total factor productivity (Equation (2)) are presented in Appendix 3.

According to Appendix 3, coefficients of all variables are in accordance with theoretical expectations. The coefficients of Labour and Capital Stock are positive and statistically significant. A 1% increase in the firm's labour increases the value added of the firm by 0.7755%, a 1% increase in the capital stock increases the value added of a firm by 0.0590%. [6] The direct effects of FDI, which is represented by the Foreign Capital Share variable, have a positive and significant effect. A one unit increase in the Foreign Capital Share increases the productivity of domestic firms by 0.09% in Equation (1) and 0.02% in Equation (2). This result shows that the direct effect of foreign direct investment contributes to increase productivity of firms. This positive effect might arise because FDI increases the accumulation of capital in the manufacturing industry of Turkey, allowing the use of new intermediate goods and technology in accordance with theoretical expectations. In other words, positive coefficient shows that FDI increases production of firms directly through increasing of capital in Turkish manufacturing industry. In the case of indirect effects of foreign direct investment (spillover effects), Horizontal Spillover variable is positive and statistically significant in both of the equations. According to this result, one unit increase in foreign presence in a specific sector increases the productivity of firms by 0.11% in Equation (1) and 0.22% in Equation (2). The positive coefficients of horizontal spillover show that competitive effects, know-how and technology spillovers generated by the presence of FDI happen in the Turkish manufacturing industry. When vertical spillover components are issue, the coefficients of Forward Spillover are positive and significant in both of the equations. One unit increase in foreign presence in a sector increases the productivity of firms by 0.24% in Equation (1) and 0.80% in Equation (2). This result shows that the performance of domestic firms which is provided by the foreign owned firms affected positively by presence of foreign owned firms in the Turkish manufacturing industry. The coefficients of Backward Spillover (Export-Oriented) are positive and significant in both of the equations. One unit increase in Backward Spillover (Export-Oriented) increases the productivity of firms by 0.38% in Equation (1) and 0.30% in Equation (2). Coefficient of Backward Spillover (Domestic-Market-Oriented) is statistically significant in Equation (2). According to this, one unit increase in Backward Spillover (Domestic-Market-Oriented) increases the productivity of firms by 0.06%. The results of vertical spillovers show that domestic firms which are not in the foreign owned firms sectors but they have a direct business relationship with foreign owned firms can benefit from presence of foreign owned firms. These results include firms providing goods and services for foreign owned firms (Backward Spillover) and also the firms which are provided by foreign owned firms (Forward Spillover). According to Javorcik (2004), both of Backward Spillover (Export-Oriented) and Backward Spillover (Domestic-Market-Oriented) are significant but in Turkey contrariwise to Lithuania, coefficient of Backward Spillover (Export-Oriented) is larger.

To ensure the robustness of my findings to the measurement of alternative methods for calculating TFP, that variable is also estimated using the Olley and Pakes (1996) method. The last column of Appendix 3 shows the estimation results when the TFP obtained by using the method of Olley and Pakes (1996) is used as the dependent variable. As with the results obtained using the Levinsohn and Petrin (2003) method, the sign of the coefficients of all variables are as theoretically expected and the coefficient of Backward Spillover (Export-Oriented) is larger than Backward Spillover (Domestic-Market-Oriented).

I also checked whether my results are sensitive to alternative methods of measuring the spillover variables. With this aim, the Horizontal Spillover variable that measures foreign presence in the same sector (equation 3) is recalculated as foreign capital share is used as a dummy variable (if the firm i is foreign-owned, its value is 1,

[6] As with the results obtained by Konings (2001), Driffield et al. (2002), Reganati and Sica (2005), Stancik (2007), Blalock and Gertler (2008), Kolasa (2008) and Mishra (2011), the coefficient of labour is greater than the coefficient of capital in my study.

otherwise, its value is zero), following Kolasa (2008). Accordingly, the Backward Spillover and Forward Spillover variables were recalculated using the above mentioned dummy variable and then all of equations were re-estimated using those new spillover variables. The estimation results for both value added as well as total factor productivity equations are not significantly different from the results presented in Appendix 3.

5. CONCLUSION

This study examines the effect of horizontal spillover and vertical spillover generated by FDI on productivity of firms in the Turkish manufacturing industry by using the firm-level data. The effect of backward spillover was investigated into two groups; the effect of backward spillover generated by export oriented foreign owned firms and the effect of backward spillover generated by domestic oriented foreign owned firms. With that aim, value added and total factor productivity equations were estimated for the Turkish manufacturing industry firms by using panel data analysis for the period 2003-2011. My estimation results indicate that direct productivity increasing effect of FDI and the horizontal and vertical spillover effects of FDI increases the productivity of firms in the Turkish manufacturing industry. Estimation results of the effect of backward spillover generated by export oriented foreign owned firms and domestic oriented foreign owned firms are positive and significant for both of value added and total factor productivity equations. In addition, backward spillover generated by export oriented foreign owned firms is larger than the backward spillover generated by domestic oriented firms. My results are robust to the use of alternative measures of TFP and productivity spillovers variables.

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Appendix 1: Estimation Results of the Production Function

	Levinsohn-Petrin Method		Olley-Pakes Method	
NACE	lnLabour	lnCapital Stock	lnLabour	lnCapital Stock
10	0.6643396	0.3690162	0.9001304	0.3854903
11	0.6562387	0.1099754	1.10636	0.1710952
13	0.6065918	0.2619154	0.8402271	0.2768331
14	0.602835	0.0995597	0.8503689	0.3518474
15	0.6373821	0.288632	0.8547244	0.4227617
16	0.7780355	0.3809461	1.15912	0.2335914
17	0.6661604	0.1572146	1.142118	0.1617897
18	0.7894822	0.3499856	1.096053	0.4295174
20	0.6225729	0.1543822	0.8818092	0.2962203
21	0.7576247	0.3980981	0.8711153	0.0138103
22	0.6966312	0.1336371	0.9625531	0.3032417
23	0.7031888	0.4635353	0.8754299	0.505786
24	0.7932771	0.1068973	0.9885009	0.2419338
25	0.6613395	0.2718319	0.8659006	0.2689197
26	0.5632432	0.7115465	0.871297	0.6925946
27	0.7866029	0.0900711	1.008095	0.1294716
28	0.6496103	0.3584798	1.006742	0.1874356
29	0.7662098	0.3986395	1.005509	0.4400386
30	0.604252	0.1904869	0.8345395	0.4138524
31	0.6847619	0.3759167	0.9875932	0.187478
32	0.7517591	0.4653771	0.8706252	0.4506237
33	0.6713068	0.750807	0.82576	0.5897504

Appendix 2: Summary Statistics for the Variables

	Statistical Summary for the Variables Used in Main Models			Summary for the Variables Used for the Robustness Check		
	Obs. No	Mean	Std. Error	Obs. No	Mean	Std. Error
lnValue Added	151,601	13.88	1.41			
lnTFP_LP	137,470	1.93	0.43			
lnTFP_OP				137,588	1.66	0.42
lnLabour	155,347	4.01	0.86			
lnCapital Stock	143,384	14.60	1.90			
Foreign Capital Share	159,007	2.67	14.82			
Horizontal Spillover	159,007	11.41	10.98	159,007	0.18	0.16
Backward Spillover (Export-Oriented)	159,007	172.26	247.67	159,007	2.34	3.25
Backward Spillover (Domestic-Market-Oriented)	159,007	390.91	641.83	159,007	6.68	12.52
Forward Spillover	159,007	564.34	1370.25	159,007	9.04	21.45

Appendix 3: Export, Spillovers and Productivity; Fixed Effects Model

	Equation (1)	Equation (2)	Equation (2) Olley-Pakes Method
Labour	0.7755*** (0.0099)		
Capital Stock	0.0590*** (0.0058)		
Foreign Capital Share	0.0009** (0.0004)	0.0002* (0.0001)	0.0002*** (0.0001)
Horizontal Spillover	0.0011* (0.0006)	0.0022*** (0.0006)	0.0013** (0.0006)
Backward Spillover (Export-Oriented)	0.0038*** (0.0011)	0.0030*** (0.0004)	0.0027*** (0.0004)
Backward Spillover (Domestic-Market-Oriented)	0.0015 (0.0048)	0.0006*** (0.0002)	0.0009*** (0.0002)
Forward Spillover	0.0024* (0.0013)	0.0080** (0.0036)	0.0028*** (0.0004)
Year Dummy	Evet	Evet	Evet
Constant	9.8226*** (0.0870)	1.8924*** (0.0075)	1.6719*** (0.0071)
Number of Observations	138,192	137,470	137,588
Number of Groups	32,409	32,254	32,355
R^2: Within	0.1937	0.0450	0.0260
R^2: Between	0.6075	0.0110	0.0330
R^2: Overall	0.6162	0.0230	0.0440
F-Statistic	759.91	20.88	22.31
Prob > F	0.0000	0.0000	0.0000
Chi^2-Statistic	2202.98	2063.15	2197.01
Prob > Chi^2	0.0000	0.0000	0.0000

Note: Robust standard errors are in parentheses; these errors have been corrected for clustering in each year and sector; '*' '**', '***' indicate significant value at 10%, 5% and 1% level of significance respectively.

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THE RELATIONSHIP BETWEEN EXCHANGE RATE AND INFLATION: THE CASE OF WESTERN BALKANS COUNTRIES

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ABSTRACT

The paper investigates empirically the relationships between exchange rates and inflation in Western Balkan countries. The literature on the transition countries has recently focused on exchange rate as a shock absorber and downplayed its costs to macroeconomic stabilization. However, the decision to apply a different exchange rate regime depends on the costs and benefits in giving up an exchange rate instrument. With this in mind, the objective of this study is to determine whether fixed exchange rates play a significant role in inflationary performance or whether flexible exchange rates perform as a better shock-absorbing instrument in the Western Balkans. The result reveals that an exchange rate is still the main source of inflationary pressures in Western Balkan countries. Thus policy makers must weigh the relative costs and benefits associated with introducing a flexible exchange rate in small open economies because such regime is likely to incur more costs than benefits.

Keywords: Transition economies, Western Ballkan Countries, exchange rate, inflation

JEL Classification: E44, F33, P21

1. INTRODUCTION

The paper investigates empirically the relationship between exchange rates and inflation in Western Balkan Countries (Albania, Serbia, and Macedonia). Based on the generally accepted macroeconomic theory, many authors **(**Calvo and Reinhart, 2002; Edwards, 2006) argue that transition countries should apply either fixed exchange rates currency boards or peg their currencies to that of their main trading partners. The main reason for applying rigid exchange rate is that countries in transition show signs of “fear to float" (Edwards, 2006). On the other hand, the empirical evidence that provides argument that exchange rate reacts adversely to real shock by stabilizing the economy, makes a strong case for more accommodative exchange rate as a shock absorber (Blanchard, 2010; Adler and Tovar, 2012). Based on the empirical evidence for transition countries, particularly in the Western Balkan region, exchange rate has often played a fundamental role in macroeconomic stabilization. Looking at the data, it can be seen that from 1996 to the 2014, the rate of inflation has been in single digit in Western Balkan countries. Since, Western Balkan countries in particular, have faced many systemic changes (such as the liberalization of the capital account, becoming members of the World Trade Organization, and gaining candidacy status for joining the European Union) as well as the latest financial crisis (2008), the issue of exchange rate regime has become more pronounced in terms of using the exchange rate as a shock absorber. The empirical evidence for flexible exchange rate is mixed in terms of the role of exchange rate as a shock-absorbing instrument. A very small shock-absorbing role is found for the

flexible exchange rate for Austria, the Netherlands, France, Italy, Spain and the United Kingdom (see Canzoneri et al., 1996).

A similar conclusion was reached by Thomas (1997) and Funke (2000) in the case of the United Kingdom and Sweden. Artis and Ehrman (2006) who investigated the symmetric and asymmetric shocks for Denmark, Sweden, Canada and the United Kingdom also arrived at a similar conclusion. On the other hand, the study by Coricelli et al. (2005) found no shock-absorbing role of exchange rates in the Check Republic, Hungary, Poland and Slovenia. The analysis by Borghijs and Kuijs (2004) for Central European countries found exchange rates to be less helpful propagator of monetary and financial shocks compared to serving a useful absorber of the real shocks. Recently the study by Shevchuk (2014) made the same conclusion. On the other hand, Stażka-Gawrisyak (2009) and Dabrowski and Wróblewska (2014) who investigated the exchange rate as a shock-absorber of the adverse effects of the asymmetric real shocks in Poland claimed that the exchange rate has responded as a shock-absorber to real shocks. However, Edwards (2006) who investigated the relationship between exchange rate and inflation in emerging countries and transition countries did not find any evidence of the exchange rate acting as a shock absorber. Recently, Tsangaridis (2012) showed that emerging countries that peg their currencies during the financial crisis were not worse than those that floated. However "peggers" were far worse during the period of recovery 2010-2011. The same result was found by Blanchard (2010) who claims that the fixed exchange rate has a limited effect on output, and growth declined during the crisis. Adler and Tovar (2012) in another recent study showed that exchange rate flexibility can mitigate the impact of the adverse effect of financial shocks, particularly to the emerging economies that are greatly financially integrated.

To summarize, the question of the optimal monetary regime for small open economies is still unanswered. Economists have not been able to determine whether these countries should use floating or fixed exchange rates. Thus the solution of simply shifting the exchange rate from a fixed exchange rate to a more flexible one, so that it could serve as a shock absorber could easily disturb macroeconomic stability without any real short-term economic benefits. To the best of our knowledge, there are no studies that have investigated the role of exchange rate as a shock-absorbing instrument in the Western Balkans. Hence, we address the issue of whether a fixed exchange rate is more effective than a more flexible exchange rate in serving as a shock absorber in the Western Balkans. Therefore, our efforts in this paper are focused on identifying the effect that exchange rate regimes have on inflation in the Western Balkans. The reminder of the paper is organized as a follows: Section II covers the methodology and data; section III covers the results, and section IV covers the conclusions.

2. DATA AND METHODOLOGY

In order to examine the relationship between inflation and exchange rate, we apply panel methods data such as Fixed and Random Effects Model and 'Hausman-Taylor instrumental variables IV' model. With these methods we are able to evaluate the effect of exchange rate changes on inflation in Western Balkan countries from 1996-2014. We used quarterly data covering the 15- year period (1996: Q1 to 2014: Q4) and report the results in 'Poodel OLS', 'Fixed Effects' 'Random Effects' and 'Hausman-Taylor IV' model. Because some of the variables can be considered to be endogenous, they are problematic as exchange rates are considered to be determinants of exchange rates themselves. As a consequence the endogenous independent variables will lead to bias regression coefficient accompanying with this variable (Baltagi, 2009). In order to deal with the problem of endogenity, we use instrumental variables. The Hausman-Taylor instrumental variables IV is considered to be a more appropriate model than the random and fixed effect models. The dependent variable is the consumer price index (CPI) while it at the same time serves as an independent variable of the 'first lagged' term of the CPI (inflation), as well as the exchange rate in logarithm form (lnexchange), and the short-term interest rates (lending interest rate).

The specification of the Hausman-Taylor model is shown through the following equation:

$$y_{it}=c+ \beta_1(y_{it-1}) + \beta_2 log(EXCH_{it})+ \beta_3 (LIRr_{it})+u_{it} \quad (1)$$

where:
y_{it}- index of consumption prices CPI
c – a constant
y_{it-1}-represents ''First Lag''* of CPI
LnEXCHit – logarithm form of exchange rate
Lend_IRr$_{it}$ – interest rate of short term loans (lending interes rate)
u_{it}- exogenous disturbances

3. FINDINGS AND DISCUSSIONS

Table 1 reports the coefficients of the regression results and all the coefficients are statistically significant. As seen from that Table 1, the results of the regression coefficient of exchange rate is 1.792951 (s.e. 1.103001) and statistically significant. This shows that an increase by 1% in the exchange rate will have a positive effect on price level by 1.79%, while keeping constant the other variables. This shows furthermore that the flexible exchange rate is a potential source of the inflation in Western Balkans countries. This result is consistent with previous studies, for example Kuijs (2002), Ganev et al., (2002), Coricelli at al., (2005), Bailliu and Fujii (2005), Fetai (2013). The result shows that the flexible exchange rate is the main source of the inflationary pressures in Western Balkans countries. Hence, the policy makers in these countries must take into consideration the relative costs and benefits that come with introducing a flexible exchange rate as shock absorber. Based on the results of this study, a flexible exchange regime is more likely to incur more costs than benefits.

Table 1: The Impact of Exchange Rate on Inflation

	OLS	**Fixed effects**	**Random effects**	**Hausman Taylor IV**
Variablat	**CPI**	**CPI**	**CPI**	**CPI**
cpiL1	0.8588193**	0.8353863**	0.8588193**	0.8515707**
	(-0.0311345)	(-0.0345063)	(0,0311345)	(-0.0329302)
Log Exchange	1.116882*	2.128529*	1.116882*	1.792951*
	(-0.864495)	(-1.121202)	(-0.864495)	(-1.103001)
Lend_IR	-0.2048432**	-0.2078634*	-0.2048432*	-0.2092824*
	(-0.0443571)	(-0.0448472)	(-0.0443571)	(-0.044994)
Constant	-7.115912*	-11.27087*	-7.115912*	-11.17423*
	(-4.098568)	(-5.221626)	(-4.098568)	(-6.341948)
Observations	191	191	191	191
R-squared	0.8825	0.8815	-	-
F	468.04	298.19	.	.
Chi2	.	.	1404.11	1134.08

Note: (*) statistically significant at 5% level, (**) statistically significant at 10% level

We include L_IR (Lending short term interest rate on loans) as a control variable in this study. The result shows that in the lending scenario, an increase in the interest rate by 1% will have modest and opposite effect on inflation, i.e., it will reduce inflation by 0.2%. This result is also consistent with economic theory as well as previous studies which concluded that there is a negative relationship between inflation and interest rate. To summarize, the exchange rate has a significant effect on inflation, therefore any decision to change current monetary strategy i.e., applying fixed or flexible exchange rate must also take into consideration the associated costs and benefits. Our study has shown that in the case of applying the flexible exchange rate, the associated costs seem to outweigh the benefits. The study suggests that, since Western Balkan countries have to join EU- the exchange rate seems to be the main source of inflation, hence a wise strategy will be to stabilize the

exchange rate which in turn would lead to lowering inflation and help to fulfill conditions to enter in the EMU (European Monetary Union).

4. CONCLUSION

Exchange rates have played a significant role in maintaining price stability in the Western Balkans. Since Western Balkans countries are faced with systemic changes (such as the liberalization of the capital account, becoming a members of the World Trade Organization, and gaining candidacy status for joining the European Union) as well as the latest financial crisis (2008), the question of exchange rate regime becomes more pronounced in terms of using the exchange rate as a shock absorber. Recently, the literature on transition countries has focused on the exchange rate as a shock absorber, but seems to have downplayed the costs with regard to macroeconomic stabilization. We have attempted to address question of whether the fixed exchange rate plays a significant role on the inflation performance or whether the flexible exchange rate should be applied to serve as a shock absorber in the Western Balkans. The main finding of the study is that changes in the exchange rate will have a strong effect on inflation in Western Balkan countries. The result also reveals that the exchange rate is still the main source of inflationary pressures in Western Balkans countries, therefore policy makers in region must weigh seriously the relative costs and benefits associated with introducing a flexible exchange rate regime before making a decision. The results of this study are consistent with the findings of previous studies that held that the stability of the exchange rate plays a significant role in maintaining price stability in transition economies. Furthermore, since Western Balkan countries have to join EU- and exchange rate is the main source of inflation- stabilization of the exchange rate would lower inflationary pressure and help to fulfill some of the criteria to enter the EMU (European Monetary Union).

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GARDEN OF MENTORING: REVISITING MENTORING IN ENTREPRENEURIAL SENSE

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ABSTRACT

For many years, mentoring has been used as the influential career development tool in organizations. From a wider perspective, mentoring is perceived as a way of people development by helping individuals to achieve something meaningful in their lives. However, due to proliferation of entrepreneurial initiatives, now it is not only scrutinized from an intra-organizational perspective, but also it is considered a tool for self-employed development. Therefore, new area for cultivation in the garden of mentoring has emerged: *Entrepreneurial Mentoring*. Although, its multi-faceted development effect for new ventures is accepted, mentoring is not highly discussed topic in entrepreneurship literature to the best of our knowledge (St-Jean and Mathieu, 2015, St-Jean and Audet,2009). Hence, this conceptual study mainly deals with definitional issues, roots of mentoring and how mentoring evolves from career development towards entrepreneurial development perspective. The concern is offering some insights about multiple roles of mentoring, especially for new-start ventures as a supportive mechanism in their entrepreneurial journey.

Keywords: Mentoring, entrepreneurial mentoring, entrepreneurship, new-start ventures, career development.
JEL Classification: L26, M13, M12

1. INTRODUCTION

In general sense *mentoring* is a tool contributing to adult development and career growth (Kram, 1985). In entrepreneurship literature, it is also used as a process of matching a new-start entrepreneurs (Sullivan, 2000) with an experienced person who have either started a new venture or worked as a professional in several initiatives/companies, provides advice and assistance to avoid costly and fatal mistakes in entrepreneurial ventures (St-Jean and Mathieu, 2015; St-Jean and Audet, 2009; Sullivian, 2000). As a practice, mentoring allows new-start entrepreneurs or mentee/protégé to make informed choices and persevere when faced with difficulties. They are also skilled at resolving personal and professional dilemmas by provoking self-questioning (St-Jean and Mathieu,2015). Despite their important functions in entrepreneurial process, their multi-faceted development effect for new-start entrepreneurs or mentee/protégé is not highly discussed topic in the entrepreneurship literature to the best of our knowledge (St-Jean and Mathieu, 2015; St-Jean and Audet,2009). However, mentoring programs provided under both several private and public initiatives are increasingly on the agenda of fostering entrepreneurship. As key strategic partners, universities, governments, and other industry participants have initiated several programs in which mentoring programs with different characteristics provided to new-start entrepreneurs (Easley and Wang, 2014). Proliferation of pre-incubation, incubation, acceleration programs, government sponsored Small and Medium Sized (SMEs) entrepreneurship education agendas and other private education efforts show that entrepreneurial efforts are supported to some degree under some structured initiatives around the world which feature mentorship components (Bruneel, Ratinho, Clarysse and Groen, 2012; Eesley and Wang, 2014). Therefore, ultimate aim of this conceptual study is to explore the garden of mentoring and to find out entrepreneurial mentoring as a way of developing entrepreneurship. Firstly, roots and evolution of mentoring has been briefly discussed. Mentoring is further elaborated with definitions drawn from mainstream mentoring literature. Then, mentoring construct has been expanded to entrepreneurship literature. Lastly, the importance of mentoring for new-start ventures as a supportive mechanism has been brought forward for future studies.

2. REVIEW OF MENTORING LITERATURE

2.1. Garden of Mentoring: Brief Discussion about Definitional Issues, Roots, and Evolution of Mentoring

As stated garden metaphor in Kram and Ragin's (2007) *Handbook of Mentoring*, we do have more topics to be discussed in mentoring literature, more areas are waiting to be cultivated. It has been almost 30 years, scholars have been dealing with mentoring. Since then, these efforts have spread around several disciplines. Scholarly research has provided us to delve into the construct of mentoring in terms of definitional issues, relationship dynamics in organizational settings and outside of organizations, types of mentoring programs provided, mentoring relationship arisen naturally other than organized programs so on so forth. Although there has been a great deal of research in this field, it is argued that mentoring literature is still very young, seems to be a child in primary school. Thus, from several aspects this field needs to be developed (Ragins and Kram,2007; Wanberg et al 2003).

In general sense, mentoring is defined as an approach for people development by helping to achieve something important in the life (Kay and Hinds, 2009). This achievement could be about both an educational and professional life or any other spheres of life. In all segments for development, people need training and getting instructions given by more experienced people (Kay and Hinds, 2009). As stated by Kay and Hinds' mentoring schemes, this could be in the form of formal periods of training, preparation for vocational or professional qualifications, introduction of new employees into new jobs, helping members of staff for medium and long term development aspirations, preparing senior members to the next level posts, developing processes for staff of some higher educational institutions, developing gifted pupils, those with particular learning needs and helping those individuals to develop required skills in social activities (Kay and Hinds, 2009). It is about helping people to make their own choices, thus it is not dictating what to do or how to do (Kay and Hinds,2009:5). It is a form of practice that makes people questioning what, how, why, when and with whom they are doing, therefore allow people to make informed choices and persevere when faced with difficulties (St-Jean and Mathieu, 2015). As the important training and development tool for upward progression, mentoring is not a new concept (Hunt and Micheal,1983). This ancient archetype (Ragins and Kram, 2007) dates to Homer's Odyssey in that Ulysses entrusts his son Telemachus to his good friend called *Mentor* before leaving for the siege of Troy. For ten years, this mythical wise and faithful advisor *Mentor* was to be responsible for Telemachus' education and the development of his identity in the adult world. He acted faithfully as teacher, adviser, friend, and surrogate father to Telemachus. The goddess Athena spoke to Telemachus through Mentor, with the result that he acquired divine qualities and became the incarnation of wisdom. This also explains ancient Greek tradition of pairing young male citizens with older males to provide each boy to learn and emulate values of the Mentor. Likely, in ancient times young boys were traditionally apprenticed to a master who own a shop or business to learn details of trade (Bishop, 2012; Hunt and Micheal,1983; Murray, 2001; St-Jean and Audet, 2009). His master goes with him along this learning journey until the new master would take over the business at the old one's retirement or death. From ancient times to industrial societies, this master-apprentice relationship was transformed a new form of structured relationship between employer-employee (Murray, 2001). Therefore, this archetype offers insights into mentoring relationship exceeding time, gender, and culture. While it is explained through myths, it is a very real and social relationship for years, even it has been reshaped in several contexts (Ragins and Kram, 2007). As in ancient times, today in the technology driven twenty-first century, people need mentoring to have skills for mastering more complex issues and tasks in every working environment (Murray, 2001)

Levinson's seminal work of *The Seasons of a Man's Life* has been used for the basis of scholarly interest in role of mentoring in human development. In that study providing chronology of the lives of 40 men transitions in their lives, mentor is described as a ***guide, teacher, counsellor,*** and ***developer of skills*** facilitating the realization of their dreams. Levinson is said to go on to discuss the influential role of a mentor by stating that not having a mentor or having a poor mentor is the equivalent of poor parenting in childhood (Levinson, 1978 cited in Eby, Rhodes and Allen, 2007; Ragins and Kram,2007). Kram's work of *Mentoring at Work* conducted in 1985 is another ground-breaking study which delineates the key aspects of mentoring relationship including functions, phases, and complexities (Eby et al 2007; Ragins and Kram,2007). This study delineates the key aspects of mentoring relationship including functions, phases, and complexities (Eby et al 2007; Ragins and Kram,2007). Based on stated scholarly efforts, there are several definitions made in the literature considering mentoring. Principally, it has been defined as "*the relationship between an older, more experienced mentor and*

a younger, less experienced protégé for the purpose of helping and developing the protégé's career" (Ragins and Kram, 2007). Illustrative definitions considering mentor, mentoring and mentorship from the literature are also shown in the Table 1 below.

Table 1: Illustrative Definitions on "Mentor, Mentoring, Mentorship" in the Literature

AUTHOR (S)	DEFINITION
David Marshall Hunt and Carol Michael	Mentorship is an important training and development tool for upward professional progression in organizations. Mentorship is the development process in many occupations: master-apprentice; physician-intern; and teacher and student (1983: 475).
Kathy E. Kram and Lynn A. Isabella	Mentors provide young adults with career enhancing functions such as sponsorship, coaching, facilitating exposure and visibility, and offering challenging work or protection, all of which help the younger person to establish role in the organization, learn the ropes and prepare for advancement (1985:111).
Raymond A. Noe	The mentor is usually a senior, experienced employee who serves as a role model, provides support, direction, and feedback to the younger employee regarding career plans and interpersonal development, and increases the visibility of the protégé to decision-makers in the organization who may influence career opportunities (1988:148).
Ellen A. Fagenson	In general, mentoring is considered to be a development relationship that enhances both an individual growth and advancement (1989: 309 cited Kram,1985).
Belle Rose Ragins and John L. Cotton	A mentor can generally be defined as a high-ranking, influential member of your organization who has advanced experience and knowledge and who is committed to providing upward mobility and support to your career." (1993:101).
William T. Whitely and Pol Coetsier	Mentoring is a particular kind of interpersonal relationship that can influence career progress and personal well-being (1993:421).
Terri A. Scandura and Chester A. Schriesheim	Supervisory mentoring is a transformational activity involving a mutual commitment by mentor and protégé to the latter's long-term development , as a personal , extra-organizational investment in the protégé by the mentor, and as the changing of the protégé by the mentor, accomplished by the sharing of values, knowledge, experience and so-forth (1994:1589 cited from Hunt and Micheal,1983 and Kram, 1985).
Ellen J. Mullen	A mentoring relationship is a one to one relationship between a more experienced member (mentor) and a less experienced member (protégé) of the organization or profession. The relationship is developed to promote the professional and personal growth of the protégé through coaching, support and guidance. Through individualized attention, the mentor transfers needed information, feedback and encouragement to the protégé as well as providing emotional support and putting in a good word when possible (1994:259).
Daniel B. Turban and Thomas W. Dougherty	Mentoring is a set of role activities, including coaching, support, and sponsorship that upper level managers provide to protégés (1994:688).

Benneth J. Tepper	Mentoring relationships facilitate junior colleagues' (protégés) professional development and career progress (1995:1191).
Stacy, E. McManus and Joyce E.A Russell	Mentoring is a developmental relationship typically occurring between senior and junior individuals in organizations (1997:145 (cited Kram's 1985 work).
Lillian T. Eby	Mentoring is one mechanism by which individuals may be able to develop skills and competencies that will help them adapt to organizational changes in the workplace. Mentoring is typically defined as a relationship between a senior organizational member (the mentor) and a junior member of the organization (the protégé´) that is designed to help the protégé advance within the organization (1997: 126 cited Kram, 1985).
Tammy D. Allen and Mark L. Poteet	Mentoring reflects a relationship between two individuals, usually a senior and junior employee, whereby senior employee takes the junior employee "under his or her wing" to teach the junior employee about his or her job, introduce the junior employee to contacts, orient the employee to the industry and organization and address social and personal issues that may arise on the job (1999:59 cited Kram's 1985 work).
Angela M. Young and Pamela L. Perrewe	Mentoring has been thought of as a relationship between a very experienced senior person and a novice (2000:613).
Margo Murray	Mentoring is a deliberate pairing of a more skilled or more experienced person with a less skilled or less experienced one, with the mutually agreed goal of having the less skilled person grow and develop specific competencies (2001 from preface).
Steven J. Armstrong, Christoper W. Allinson and John Hayes	Mentoring process is defined as a developmental, caring, sharing, helping relationship where one person invests time, know-how and effort in increasing and improving another person's growth, knowledge and skills (2002:1112 cited Shea,1995)
Burleson, MacGeorge, Knapp and Daly	Mentoring is a dyadic "communication relationship" consisting of verbal and nonverbal behaviours intended to offer or ask for help (2002 cited from Memon et al 2015:2).
Ensher, Grant-Vallone and Marelich	Traditionally, a mentor has been defined as someone senior in age and experience, and who provides guidance and upward mobility to his or her protégés. A mentor can be defined as an individual with greater or equal career experience than his or her protégé and who can provide vocational, psychosocial, or role-modelling support (2002:1407 cited Hunt and Michael, 1983; Ragins, 1989).
W. Brad Johnson	Mentoring is a personal relationship in which a more experienced (usually older) faculty member or professional acts as a guide, role model, teacher, and sponsor of a less experienced (usually younger) graduate student or junior professional. A mentor provides the protégé with knowledge, advice, challenge, counsel, and support in the protégé 's pursuit of becoming a full member of a particular profession (2002:88 cited Clark et al., 2000; Johnson, Koch, Fallow, and Huwe, 2000).
Val Singh, Divindra Bains and Susan Vinnicombe	Mentors are those individuals with advanced experience and knowledge who are committed to providing upward support and mobility to their protégé's careers' (2002:391).

Lea Waters,Marita McCabe, Dennis Kiellerup and Steven Kiellerup	Mentoring has been described as a one-to-one relationship between an experienced person (a mentor) and a less experienced person (protégé) that provides a variety of developmental functions (2002:108 cited Mullen,1998).
Florence Stone	Mentorship is a process by which a wise and helpful guide or adviser uses experience to show a person how to avoid mistakes he or she made earlier in his career or otherwise help advance the individual's career (2004 cited from Steel et al 2014:7).
Nikos Bozionelos	Mentoring is defined as a developmental relationship that involves organizational members of unequal status or, less frequently, peers (2004:25 cited Kram's 1985 work).
Barry Bozeman and Marry K. Feeney	Mentoring is a process for the reciprocal, informal transmission of knowledge, social capital, and psycho-social support perceived by the recipient as relevant to work, career, or professional development; mentoring entails informal communication, usually face to face and over a sustained period of time, between a person who is perceived to have greater relevant knowledge, wisdom, or experience (the mentor), to a person who is perceived to have less (the protégé) (2008:5).
David Kay and Roger Hinds	Mentoring is an approach to people development that is independent of and takes place outside of any line management relationship (2009:3).
Jamshed Memon, Zaidi Abd Rozan, Mueen Uddin and Asadullah Shah	Similarly, in modern times, the term mentor has come to denote a person with certain qualities, or who is in a position of authority that watch benevolently over a younger person who benefits from counsel and support from the mentor. The original meaning of the word mentor refers to a father figure who sponsors, guides and develops a younger person (2013:733)

** These definitions are retrieved from articles from peer-reviewed journals that are accessible as of the date of writing. This framework is based on the work of Bozeman and Feeney (2007) and new definitions are also added.

To sum up mentoring relationship is a kind of interaction between mentor and mentee/protégé, both sides are coming with their own experiences, thoughts, knowledge, interests, different backgrounds, and different development needs etc., thus every mentorship has unique nature. Idiosyncratic interaction patterns define and shape such relationship. Mentoring is a learning partnership, because nearly all of them involve acquisition of knowledge in some sense. It is a process in which its structure could be reshaped on different phases with different needs, so mentoring relationship is dynamic and change over the period. Mentoring is mutual relationship, yet there is an asymmetry. Although mentor could benefit from giving mentorship, the focus of this relationship is to satisfy specific or general development needs of the mentee/protégé (Eby et al 2007:10).

2.2. Entrepreneurial Mentoring: Revisiting Mentoring in Entrepreneurship Context

Although, mentoring is rapidly gaining in popularity as a customized way to assist and support new start ventures, most of the scientific literature on the subject of mentoring concentrates on highly placed individuals providing high level of knowledge and sharing experience for those need in their career development (St Jean and Audet, 2009). This indicates an intra-organizational point of view where the mentor and mentee(protégé) work for same organization (Bishop,2012; St Jean and Audet,2009). Even it is stated long ago in 1985 by Kram's work that mentoring must be examined in a variety of contexts (St-Jean and Mathieu,2015), there are few exemptions explaining mentoring for self-employed (Weijman, Sijde and Bentham,2008). Then the attention has turned on it as a supportive mechanism for new business ventures/start-ups as well. Therefore, it is recognized that its role is changing (Sullivan,2000) in accordance with conditions in that environment, expectations from mentees(protégés), characteristics of both sides, types of relationship (e.g. formal/informal), policies and regulations adopted so on so forth. At this point, Waters et al tried to close the gap in the literature with the study focusing on the role of mentoring in new business start-ups. This effort represents the

beginning of the focus that has shifted from existing organizations to emerging ones (Waters et al 2002; Wooten, Timmerman and Folger,1999). This is because of an understanding of non-traditional career paths for employees have emerged, life-long commitment for a job, for a company, for an owner are all becoming minor issues in working life (Waters et al 2002). Together with this differentiation working life has passed, functions and character of mentoring relationship have also changed in several ways. For example, experience was regarded as a function of vertical ranks and illustrated power in the organization, but in a new business context mentor's business and technical experience create the basis for career-related function. In some instances, mentoring relationships likely occur under formal programs which are structured for new ventures that potentially influences the opportunity to develop close relations at the beginning (Waters et al 2002). As a hybrid version of mentoring (Edwards,2016), it has been reframed in entrepreneurship context and defined as "*a support relationship between an experienced entrepreneur- mentor and a novice entrepreneur (mentee- the protégé) to foster the latter's personal development*." (Memon et al 2013; St Jean and Audet,2009).

Although scholarly efforts exploring mentoring in entrepreneurial sense are few in number, it is possible to find studies approaching mentoring from an entrepreneurial sense. For example, Sullivan (2000)'s study on entrepreneurial learning and mentoring emphasizes added value of mentorship for long term benefits of entrepreneurs. At the same time, as a learning mechanism entrepreneurs are assumed to learn from previous experiences of their mentors and modify their future by exemplifying critical incidents they come across along the way (Sullivan, 2000). Another study conducted by Weijman, Sijde and Benthem (2008) to reveal perceptions of mentors and mentees (protégés) under different development programs for knowledge intensive start-ups across Europe, overall mentoring process and its short/long term outcomes. This study also operationalized and discussed several variables as frequency/intensity of the contact, trust and benefits as short term outputs, depth of the relationship in the long term, career related and psychosocial support. Kaffka and Krueger (2012) are among those scholars empirically investigated the effect of intensive mentoring and feedback on co-evolution of cognitive development of entrepreneurs and their venture. They categorized entrepreneurs in three groups. Their findings indicate that entrepreneurs appreciate mentoring and panel feedback that help them to mainly in terms of reflecting on the business idea, setting up networks in order to find investors or collaborative partners for business idea development. Opportunity recognition is another area of interest in entrepreneurial mentoring research, Ozgen and Baron investigated effects of mentors, industry networks, and professional forums as social sources of information for opportunity recognition. They extended previous research findings by showing the fact that reliance on mentors can facilitate opportunity recognition by entrepreneurs, suggest that nascent entrepreneurs, like individuals in many other career paths, can benefit greatly from having a mentor. Mentor role before founding a new venture has also been discussed by St-Jean, Janssen, Baronet and Nafa (2016) who defined mentors as knowledge brokers making necessary information available to entrepreneurs and supporting emergence of new businesses in the ecosystem. Another striking example of scholarly interest in combining entrepreneurship and mentoring, St Jean and his colleagues' findings showing mentoring that increases novice entrepreneur's confidence, in turn increase the mentee's (protégé) entrepreneurial self-efficacy (St Jean and Mathieu, 2015). Furthermore, in his previous study, St Jean identified number of factors affecting the quality of mentor-mentee (protégé) relationship and level of satisfaction with this interaction (St Jean,2009). These studies are name of few exploring mentorship processes and integrating them into entrepreneurship literature. These illustrative examples indicate that, in entrepreneurial journey, mentor has an important role from the beginning with an idea towards the conceptualization and commercialization of that idea (Memon, Rozan, Uddin, Shah and Dzurllkanian, 2013). As a significant evidence of such effect, mentoring programs around the world are proliferating due to low rates of start-up survival. Hence, mentoring as an intervention tool is suggested to be an option to change inevitable end for start-ups (Memon et al 2013).

3. Mainstream vs Entrepreneurial Perspective of Mentoring

The first and second part of the study tries to discuss the nature of mentoring both from career development and entrepreneurship development perspective. This part deliberates overlapping and divergent characteristics of both perspectives and makes a conceptual contribution to the mentoring field. By doing this, the study also responds to the concerns in literature that mentoring should be elaborated in different contexts. Revealing significant characteristics of mentoring in both perspectives could contribute to the ever-evolving field and

open new areas for quantitative and qualitative researches. This exploratory and conceptual study tries to show underlying features of mentoring, more deliberately compare two perspectives, and understand the evolving nature of mentoring under today's business life. Since, outstanding improvements in business life have changed the nature of static career paths and entrepreneurship has emerged as an alternative career option for individuals.

In this context, new framework has been developed for displaying changing nature of mentoring in entrepreneurial sense. Table 2. as figured below demonstrates several dimensions for both perspectives including definitions, underlying arguments, main foci, outstanding characteristics, areas for development, type and form of the relationship, relationship dynamics and functions. These mentioned dimensions have been drawn from the definitions and re-framed in accordance with main components of such definitions in the study.

Mentoring has been defined in a similar vein in both perspectives, experience for helping and development has been highlighted while explaining mentoring. On the other hand, foci have been changed from intra-organizational career perspective to inter-organizational considering self-employed. This also reflects on underlying arguments of both perspectives. From mainstream point of view, mentoring is regarded as training and development tool for upward progression on the vertical line of hierarchy. Considering entrepreneurship, there is no hierarchy even, structure of the organization has not determined yet. Therefore, asymmetry in the relationship does not come from organizational hierarchy, but also from lack of experience and knowledge in entrepreneurial mentoring. New ventures start their journey mostly with unstructured efforts, as the time passes, they start to operate business functions and formalize their ideas in a meaningful manner. Besides all these, outstanding characteristic of the relationship is the same for both understanding. Relationship is based on constructive feedbacks and guiding less experienced ones, not dictating them to show what to do and how to do. Questioning makes them to find their own ways. From a career perspective, development could be attained in educational, professional or any other sphere of life. Yet, entrepreneurial mentoring places an importance on developing entrepreneurial skills, more specifically on how to survive in business life. Lastly, mentors serve career, psycho-social and role modelling functions. Although, these functions are not in the scope of the study, possible versions of them should be explored in entrepreneurial sense. Since, there are different development needs of entrepreneurs, so the mentoring functions would be for them. They are not employees any more, they are owner and still need for development as well but specifically in different fields (see also St Jean and Audet, 2009; St-Jean,2011; St-Jean and Mathieu,2015 for entrepreneurial mentoring functions).

Table 2: Mainstream and Entrepreneurial Perspective of Mentoring

Perspective	Mainstream (career) development perspective	Entrepreneurial Development Perspective
Definition	*the relationship between an older, more experienced mentor and a younger, less experienced protégé for the purpose of helping and developing the protégé's career.*	*support relationship between an experienced entrepreneur- mentor and a novice entrepreneur (mentee- the protégé) to foster the latter's personal development.*
Focus	*Intra-organizational career*	*Intra-organizational career view is supplemented with inter-organizational one particularly considering the self-employed.*
Underlying Argument	Training and development tool for upward progression (on vertical hierarchy). Including both professional and personal growth.	Entrepreneurial development tool. No vertical hierarchy at all, human resources are limited, relations are newly formed.
Outstanding characteristics	Constructive, not dictating.	Constructive, not dictating.
Areas for development	Educational, professional, and other spheres of life.	Mainly entrepreneurial skills: "*How to operate in business life.*"
Type	• Formal periods of training, • Helping members of staff for medium and long term development aspirations, • preparing senior members to the next level posts, • developing processes for staff of some higher educational institutions, • developing gifted pupils, those with particular learning needs and helping those individuals to develop required skills in social activities.	Both formal and informal under structured or unstructured initiatives.
Sides of the relationship	**Mentor**: High ranking, influential member of the organization. **Mentee**: Less skilled and less experienced member of the organization/junior -novice colleagues.	**Mentor**: veteran professional, mostly prior entrepreneurial experience. **Mentee**: Founder of new venture, novice or nascent entrepreneur.
Relationship dynamics	Unequal status or, less frequently, peers.	Inequality does not come from organizational hierarchy, but from experience.
Functions	Career enhancing, psychosocial or role modelling.	Career enhancing, psychosocial or role modelling functions and others needed to be re-defined.

4. CONCLUSION

For years, both researchers and practitioners have been dealing with new ventures and their related processes due to their potential contribution to the economic growth by generating an overall dynamism with innovations, increased variety, stimulated competition to countries in general sense (Fritsch, 2008 cited in Kösters and Obschonka, 2010; Lorrain & Laferté, 2006). It is such a phenomenon that gains and losses could not be known before business ideas realized in the economy. High uncertainty comes with those ideas without knowing the expected payoff (Scott, Shu and Lubynsky, 2015). Although there is an uncertainty and fuzzy outcomes, entrepreneurs are considered active players with their fundamental role in the development of a healthy and vibrant economy. Since, entrepreneurs and their start-ups could be both source of gross job creation by opening up new vacancies for developing business or growing more rapidly than mature/sustained businesses (Haltiwanger, Jarmin and Miranda, 2013). Despite this potential, survival rates within the first five years of new ventures are not promising. Assuming start-ups are fundamental mechanisms in the economy, the presence of them is critical and they need support (Clarysse and Yusubova, 2014). Entrepreneurial mentoring would be considered as a supporting framework for new ventures. It seems that same concerns arise from the discussions of career and entrepreneurship literatures. However, it is likely that roles and functions of mentoring mechanism gain some new meanings for entrepreneurs, because entrepreneurial needs are different from those in typical organizational context. Process is more dynamic and demanding for new ventures, there is need to be flexible and adapt swiftly to new conditions. That's why small touch but firm interventions could create new learning opportunities for entrepreneurs.

This study has operationalized firstly mentoring from a career development perspective and given some definitions regarding mentoring. As it is seen from the definitions, experience sharing is standing characteristic for mentoring relationship. As though this could create a relationship asymmetry, there is a mutual interaction between mentor and mentee/ protégé. It is worth to mention that such relationship could contribute both sides, what possible contributions would be, what kind of latent and expressed needs of both sides, which of them is satisfied, what are the motivations behind receiving and giving mentorship are all research questions waiting to be answered. Furthermore, revealing mentoring functions and roles in entrepreneurial sense would be a promising research avenue with its practical implications. Pairing mentor(s) and entrepreneurial mentee(s) and exploring their relationship dynamics is another topic for further research.

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THE VIABILITY OF RESIDENTIAL GRID-CONNECTED SOLAR PHOTOVOLTAIC SYSTEMS IN THE STATE OF INDIANA

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ABSTRACT

While the use of green energy has gained popular support and efforts have been made to market it, few studies have investigated the economic advantages and the savings that could be gained by implementing green solutions for energy challenges. This study aims to measure the financial viability of installing and using a residential grid-connected photovoltaic (PV) system in the State of Indiana while predicting its performance in eighteen geographical locations within the state over the system's expected lifetime. A systematic approach of six steps was used to collect and analyze the data. The analysis has been condcutded using engineering economic methods including payback period, net present value (NPV) and internal rate of return (IRR). It has been found that installing a PV system for a single family residence in the State of Indiana will not pay for itself within 25 years assuming the average cost of a system. The government incentive programs are not enough to offset the cost of installing the system against the cost of the electricity that would not be purchased from the utility company.

Keywords: Net present value, internal rate of return, payback period, residential solar PV system, renewable energy, State of Indiana.
JEL Classification: O22, Q28, Q42

1. INTRODUCTION

Different types of renewable energy are increasingly being used throughout the world to meet the growing demand for energy. Tremendous efforts have been invested in the United States to improve residents' awareness of the use of such resources as wind, solar, and biomass energy. In recognition of this fact, the U.S. government, in general, and the state of Indiana, in specific, has offered a number of incentive programs that help reduce the costs of installing renewable systems to make these systems more affordable for the residents (Nemet, 2009; Diamond, 2009).

Among the solar systems available, photovoltaic (PV) systems would allow households to produce their own electricity with little noise or air pollution (Tsoutsos, Frantzeskaki & Gekas, 2005; Turney & Fthenakis, 2011). In order for a PV system to become a practical solution for Indiana residents, it must be perceived as attractive financial investments for its owners. The lack of knowledge regarding the economic assessment of installing and using a residential grid-connected PV system has resulted in a low number of homeowners installing the systems in the state. In order to address this knowledge gap, this study aims to measure the financial viability of installing and using a residential grid-connected PV system in the State of Indiana while predicting its performance in different geographical locations within the state over the system's expected lifetime. The study has taken time value of money, system maintenance (e.g. convertor replacement every 10 years), and future electricity price increases into consideration.

2. DATA AND METHODOLOGY

This section describes the goals, questions, assumptions, tools, procedures and methodology of this research work.

2.1. Goals and Objectives

This research aims, first, to determine the suitable and standard size of a residential PV system for average Indiana households. Second, to estimate the energy generation of a standard PV system and determine areas with high solar potential. Third, to gain understanding of the economic benefits of using a standard PV system. Also, it aims to identify the factors that should be considered when determining the economic payoff of installing and using a PV system in terms of electricity rate, system performance, and incentives. The fifth goal of this research is to use US Department of Energy recommendations and methodologies to develop a model for building a standard PV system. Evaluating the current policies toward installing a standard residential PV system in the state of Indiana is the sixth goal of this reserach. Finally, this reaerch aims to determine the areas suitable for installing a commercial PV system in the State of Indiana.

By achieving the goals and objectives that are mentioned above, the following questions can be answered: What is the precise size of a PV system suitable for a typical single family home in Indiana?; How much does a standard PV system cost?; Does the government subsidy programs i.e. federal tax credit make the system financially attractive investment to Indiana homeowners?; and what is the payback period and the internal rate of return for a standard PV system?

2.2. Statement of Purpose

This study aims to measure the financial viability for a residential grid-connected PV system in the State of Indiana. In order to evaluate the financial feasibility of typical residential grid-connected PV systems in the State of Indiana, data regarding the counties of Indiana State should be collected, evaluated, and analyzed through mathematical models and formulas. In addition, information about prices and the size of a typical system should be collected from the professionals and representatives who work in the PV industry via online quotes.

2.3. Assumptions

This study is conducted based on the following eleven assumptions: 1) the PV system is assumed to be integrated within the utility grid, eliminating the need for investing in batteries or an electrical storage system; 2) the data obtained using the PV Watt application, a performance calculator for on-grid PV systems, is assumed to be an accurate predictor; 3) the analysis period for this study is 25 years because the warranty that is provided by the PV professionals in Indiana is 25 years (Energysage, 2016) , so it assumed that is a reasonable lifetime (Lagorse, Paire & Miraoui, 2009; Branker, Pathak & Pearce, 2011); 4) the market interest rate will remain steady at 3% (Indiana Department of Revenue, 2012); 5) it is assumed that the net metering program is available in all the areas and for all the residents of Indiana; 6) it is assumed that PV energy production degradation is equal to 3% per year based on the literature (Energy Efficiency & Renewable Energy, 2008; El–Bassiouny & Mohamed, 2012; Jha, 2010); 7) it is assumed that the end of life decommissioning cost is equal to end of life salvage price; 8) it is assumed that the average electricity cost will increase in a constant pattern over the lifetime of the system at an annual rate of 1.052 % based on the literature (U.S. Energy Information Administration, 2012; Edison Electric Institute, 2006; Indiana Utility Regulatory Commission, 2012; Americas Power, 2012); 9) it is assumed that the selected counties, which are the counties with the highest population in each geographical area, are typical of that area of the state of Indiana; 10) it is assumed that tilt is equal to latitude and azimuth is equal to true south to avoid shading; 11) and it is also assumed that a typical single family in the state of Indiana consumes 11000 kWh / year (Energy Efficiency and Renewable Energy Clearinghouse, 2012).

2.4. Statement of Limitations

One limitation of this study is that changes may occur over time that may make the results time sensitive.

2.5. Research Tools

The study utilized the following methods, tools, and applications:

1. PV Watts application: The PV Watt is a computer simulation application developed by the U.S Department of Energy to predict the energy production and cost savings of grid-connected photovoltaic (PV) energy systems throughout the world (Safaei, Freire, & Antunes, 2013; Dobos, 2014).
2. Google Earth: Google Earth is an application that provides geographical information regarding locations. Microsoft Excel: Microsoft Excel is a software package used to produce spreadsheets and graphs and perform mathematical functions and calculations.
3. Online quoting: Via their websites, PV system providers were requested to provide online quotes of the size, necessary components and their costs, maintenance expenses, and lifetime of a standard single family residential PV system.
4. Zip Code finder: The Zip Code Finder is a general web application offered by many websites to identify the zip code of a specific area for the counties in the State of Indiana.

2.6. Research Design Methodology and Procedures

This study has employed a systematic approach to collect data via reviewing the relevant literature, requesting information about the system's cost from PV professionals, collecting data about the Indiana cities location, using a computer simulation program called PV Watt Calculator to estimate a standard system's performance, and then evaluating and analyzing the collected data using engineering economic methods, including breakeven, cash flow analyses, net present value, and internal rate of return, to determine the economic features of the system. The following explanation for each step:

Step One: Reviewing relevant literature

Reviewing the literature was important to identify electricity usage of a typical house and the average electricity rates increase in the State of Indiana. This study only considers the real increase in electricity prices during the period of 2005-2011 without considering the impact of the new EPA regulations. Table 1 shows the average electric rates in the State of Indiana between 2005 and 2011. Also, from the table, it can be found that the average increase in electricity rates is 1.052%. This rate is used in this study to measure the impact of future increase in electricity prices on the economic performance for the standard PV system.

Table 1: The Average Electric Rates in the State of Indiana, 2005-2011

Year	Price (Cents/KWh)	The increase
2005	7.5	
2006	8.22	1.096%
2007	8.26	1.01%
2008	8.87	1.074%
2009	9.5	1.07%
2010	9.56	1.01%
2011	10.06	1.05%
The average increase		1.052 %

Source: U.S. Energy Information Administration, 2012.

The Energy Efficiency and Renewable Energy Clearinghouse (2012) estimates the average yearly energy consumption for a typical home according to the 23 appliances described in Table 2.

Table 2: The Average Energy Consumption for a Typical Home

Appliance	Time in use	kWh / year
Air Conditioner (one ton)	4 hrs / day, 180 days/ yr	2278
Clock radio	24 hours / day	44

Clothes washer (does not include hot water)	2 hours / Week	31
Coffee maker	30 minute / day	128
Dehumidifier	12 hours / day	700
Dishwasher (does not include hot water)	1 hour / day	532
Electric blanket	8 hrs / day,120days / yr	175
Fan (furnace)	12 hrs / day,120 days / yr	432
Fan (whole house)	4hrs / day, 120 days / yr	270
Fan (window)	4 hrs / day,180days / yr	144
Hair dryer	15 minutes / day	100
Heater (portable)	6 hours / day,120 days / yr	1240
Iron	1 hour/week	52
Microwave oven	2 hours/week	89
Radio (stereo)	2 hours / day	73
Range (with self-cleaning)	2 hours/ day	775
Refrigerator (frost free 16 cubic feet)	24 hours / day	642
Television	4 hours / day	292
Toaster	1 hour / day	73
Vacuum cleaner	1 hour / week	38
VCR	4 hours / day	30
Water bed (no cover)	12 hrs / day,180 days / yr	620
Water heater (40 gallon)	2 hrs / day	2190
	Total	10948

Source: Energy Efficiency and Renewable Energy Clearinghouse, 2012

Step Two: Identifying the standard system's size and specification

Data regarding the costs of installing a standard system was collected by requesting online quotes from PV professionals via their websites. The names and the websites of PV manufacturers, distributers, dealers, and repair specialists were identified using the key phrase "Solar System" and the location of "Indiana" to search the electronic version of the Yellow Book. The results were then filtered by selecting the following three categories:

1. Solar Energy Equipment and Systems–Dealers;
2. Solar Energy Equipment and Systems–Service and Repair; and
3. Solar Energy Equipment and Systems–Manufacturers and Distributors.

The online quotes provided data regarding required components and their costs, size, maintenance costs, and expected lifetime, necessary to address the following questions:

A. Components and costs:
   1. What are the major components of a grid-connected PV system?
   2. What is the cost of each component and its installation, and on what basis is the cost determined?
B. Performance:
   1. How the electrical performance of PV modules and arrays is typically rated?
   2. How should a PV array be oriented for maximum energy production?
C. Size
   1. What is the surface area that is required for installing a PV array?
D. Maintenance
   1. What is the estimated annual maintenance cost of a standard PV system?
E. Lifetime
   1. What is the expected lifetime of a standard PV system?

Step Three: Selecting the cities and locations

The third step in the research methodology was identifying the cities and counties of Indiana. According to the State of Indiana website (IN.gov, 12; IN.gov, 13), the counties are grouped into the six geographical regions of North, East, West, Central, South Central, and South. The counties within each group were sorted based on the population and then the county with the highest population within each group was selected to represent the geographical region, as it is most representative of the greatest number of Indiana residents in that region. By using this procedure, it may be easier to target the most populous locations where the findings can be made known to the greatest number of residents, which will facilitate the study goal of increasing awareness of PV systems among the greatest number of Indiana residents possible.

Step Four: Finding the potential solar power based on the location

The next step was identifying the zip codes and the cities within each of the selected counties (regions of the state) using the Zip Code Finder application. Identification of the zip codes for each city was used to collect precise geographical data, including solar power potential, that affect the amount of electricity that can be generated via a standard PV system located in a particular area. More than one location within each of the six selected counties with different latitudes and longitudes were used (see later, Table 6). The reason for selecting more than one location is to have a more accurate results that show the generated energy at multiple locations in the county. Google Earth application was used to determine the solar azimuth and solar altitude, two parameters necessary to identify the exact locations for each zip code to determine the solar power potential for each area. More details can be found in Al-Odeh (2013).

Step Five: Estimating the system's performance

The fifth step was entering the geographical parameters (solar azimuth and solar altitude) and the system specifications (which gathered from PV professionals) into the PV Watt application to calculate the amount of energy that can be produced using a standard PV system. The application will show the cost of electricity for a particular area in terms of rate per kilowatt hour. If the area is not covered by any utility provider, it will show the rate for the nearest utility service area.

Step Six: Conducting the economic assessment

Once the technical requirements of the standard PV system have been stated, the economic analysis, which was the final step in the research methodology, carried out. The economic assessment included both costs and benefits of the system. The economic assessment was conducted by using Excel spreadsheets for calculation of the financial parameters, including cash flows, project balance (PB), net present value (NPV), and internal rate of return (IRR).

The PB starts with negative values in this case as it is an investment project in a PV system. The project balance (PB) for the year 0 is equal to the cash flow (CF) for year 0, and it is equal to initial cost and the installation costs (Al-Odeh, Stergioulas, & Badar, 2012). For the remaining years, PB can be calculated by multiplying PB of the previous year (t-1) by (1 + interest rate i) and adding CF of that year (t) (Newnan, Eschenbach, & Lavelle, 2011; Rosen & Dincer, 2003; Dasgupta & Stiglitz, 1974).

$$PB_t = [PB_{t-1} * (1+i)] + CF_t \quad (1)$$

If PB reaches 'zero' at a particular time while changing from negative to positive values, this time is referred to as discounted payback period (DPP). If PB remains negative till the end of the analysis period (i.e., n = 25 years) meaning the project is not justified economically (Newnan, Eschenbach, & Lavelle, 2011).

Project balance (PB) helps to determine the discounted payback period (DPP). PB vs time (year) can be plotted to determine the discounted payback period (DPP). The DPP over 25 years has been calculated along with the internal rate of return (IRR) and the net present value (NPV) or present worth (PW). IRR is the interest rate (i*) at which the project benefits are equivalent to the project costs or the present worth (PW) of the project is zero. IRR (i.e., i*) can be obtained by solving Equation 2 for i*.

$$NPV(i^*)=PW(i^*)=0=PW(i^*)_{benefit}-PW(i^*)_{cost}=\sum_{t=0}^{n}CF_t(1+i^*)^{-t} \quad (2)$$

NPV or net PW or PW represents an equivalent amount of the project cash flows at t = 0 (i.e., present time) at interest rate (i) (Newnan, Eschenbach, & Lavelle, 2011; Khan, & Iqbal, 2005). NPV can also be computed from a range of cash flows (from period 1 to *n*) using the NPV function in the Microsoft Excel as given below (Newnan, Eschenbach, & Lavelle, 2011).

NPV:=NPV(rate, values) (3)

If any cash flow occurs at *n* = 0, it is added algebraically to the value obtained from Equation 3 in the excel NPV function. If NPV is less zero, the project is concluded to be not justified (Kim, Y. H., Philippatos, & Chung, 1986; De Reyck, Degraeve & Vandenborre, 2008).

IRR can also be computed from a range of cash flows (from period 0 to n) using the IRR function in the Microsoft Excel as given below (Newnan, Eschenbach, & Lavelle, 2011). If IRR is less than market interest rate or MARR, the project is concluded to be not justified.

IRR:=IRR(values, [guess]) (4)

Thus, DPP, values of PB at n = 25, and NPV and IRR for n = 25 were used to evaluate the economic feasibility of installing a grid-connected PV. The total system's cost (which was collected from PV professionals) and the projected cash flows (which were based on analysis of system costs, expected energy production, electricity rate, maintenance expenses, expected lifetime, and interest rate) were the two most important factors for conducting this analysis. Figure 1 shows the process that was used to make the economic assessment for the standard PV system.

Figure 1: The Process of Making the Economic Assessment for the Standard PV System

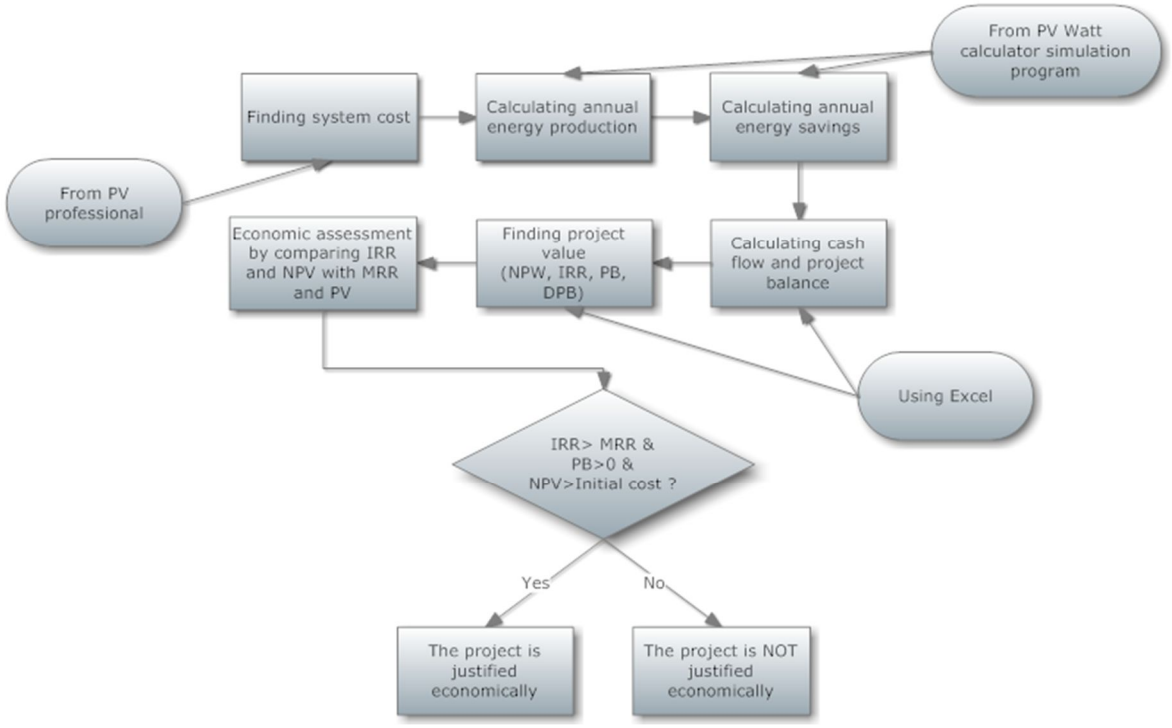
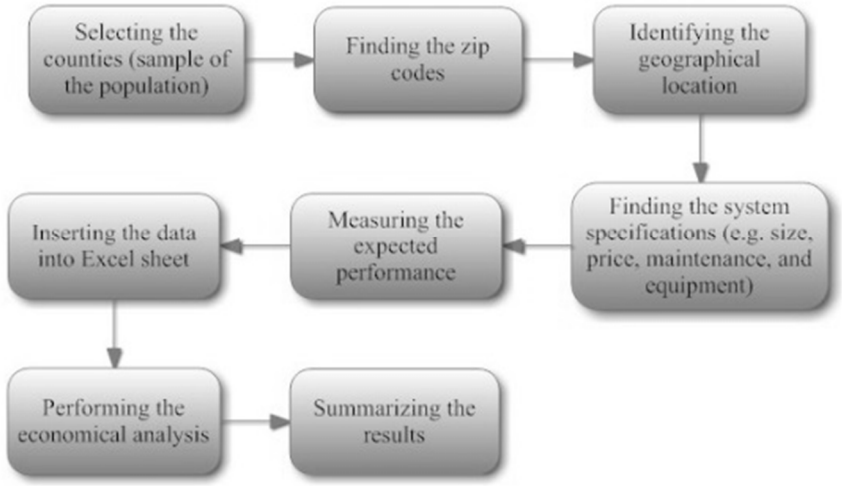


Figure 2: Research Methodology



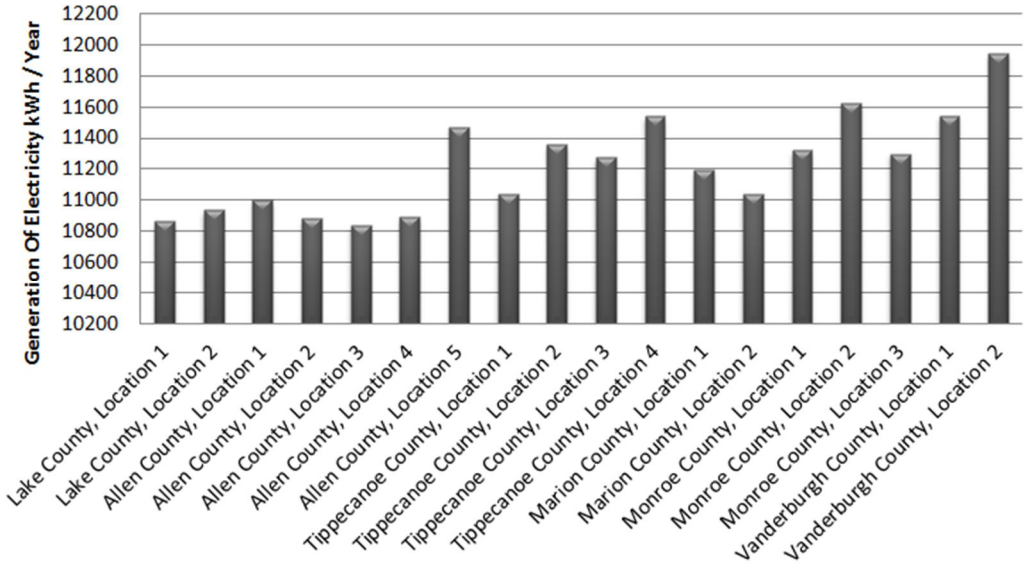
3. FINDINGS AND DISCUSSIONS

This section describes the research finding details including: system and cost specification, system efficiency, and the economic analysis in each Indiana location studied.

3.1. The Selected Locations and the Amount of Electricity Generation

After identifying the locations, potential solar power and the system performance were calculated. Figure 3 summarizes the electricity that could be generated by a standard PV system in all of the selected locations.

Figure 3: Electricity Generation by a Standard PV System in the Selected Locations



3.2. The System Specification

PV professionals in the State of Indiana estimated a standard size of a PV system suitable for an average single family home in Indiana, to be 9.36 KW. The system consists of 36 panels of 260 W each and enables a

household to generate 11,000 kWh per year. The system is enough to supply a typical house in Indiana with the needs of electricity. Installing this system could eliminate the need for buying electricity by up to 100% because it generates all the electricity needed, and excess electricity could be sold back to the electric utility to offset power needed at night.

Table 3: System Specifications

PV System Specifications	
DC Rating	9.36 kW
DC to AC Derate Factor	0.77
AC Rating	7.21 kW
Array Tilt	32.0°
Array Azimuth	180.0°
Array Type	Fixed Tilt
Weight per Panel	46.7 lbs
Panel Width	39.41
Panel Length	65.94
Total Panels	36

Source: Interviewing several industrial professionals in a focus group session

3.3. The Cost Specifications

The cost of a standard PV system varies from one manufacturer to another and depends on the system's configuration (e.g., roof or ground mounted, accessories…). The data regarding the system component and the rates have been collected via the process of requesting online quotes. Quotes were obtained from 13 of the 23 providers with online quotes capability. The rates for the system components are summarized in Table 4.

Table 4: The Rates for the Solar System Parts

Provider	Solar Panels Price ($ per W)	Inverter	Racking, Mounting, Wires, and Accessories
1	$1.59	$2,543.21	$140.72
2	$1.89	$2,646.15	$55.12
3	$2.13	$2,785.19	$57.23
4	$2.43	$2,841.03	$64.46
5	$2.28	$2,895.00	$75.55
6	$2.53	$2,842.53	$65.61
7	$2.63	$2,449.77	$76.73
8	$2.80	$2,510.45	$87.83
9	$2.75	$2,527.69	$90.91
10	$3.13	$2,357.90	$99.03
11	$3.43	$2,391.50	$100.09
12	$3.89	$1,789.50	$91.10
13	$4.45	$3,089.50	$124.14
Average	$2.76	$2589.96	$86.81
Total	$25869.60 (for 9.36 KW)	$2,589.96	$781.28 (for 9 racks)
Total Cost	$ 29,240.84		

Source: Interviewing several industrial professionals in a focus group session

The cost of the PV panels ranges from $1.59 to $4.45 per Watt. The average cost for installing a 9.36 kW system is $ 2.76 per Watt. From the online quotes, the researcher found that the PV manufacturers in the State of Indiana provide a warranty of 25 years for the panels and 10 years for the inverter. The price of the inverter ranges from $ 1,789.5 to $ 3,089.5. The average price for an inverter is $ 2,589.96. The maximum cost for a

standard PV system is $44,882.22 (4.45*9360+3089.5+140.72). The minimum cost is $16,727.02 (1.59*9360+1789.5+55.12). The average cost for a standard PV system is $ 29,240.84 ($25,869.60 +$2,589.96 +$781.28). The average price was used in this study to calculate expected cash flows of the system. The system price includes 36 panels to generate kWh per year, one inverter, nine rack systems, accessories (e.g., wires, connectors, breakers, and switches…), and installation. There is no maintenance required for the system but it is suggested that a household buy a new inverter every 10 years.

Homeowners in the State of Indiana are eligible to receive a 30 percent federal tax credit for the installation of solar technologies (Solangi, Islam, Saidur, Rahim & Fayaz, 2011; Wiser, Bolinger & Barbose, 2007). The federal tax credit is Residential Renewable Energy Tax Credit and if a taxpayer owes less than the tax credit, the excess credit generally may be carried forward to next tax year. This tax credit reduced the average net cost for a standard system to $20,468.588 ($ 29,240.84 – $8,772.252). Other parameters that should be considered in the analysis process are the market interest rate 3% (according to Indiana Department of Revenue), production degradation is equal to 3% per year starting from the second year (Energy Efficiency & Renewable Energy, 2008; El–Bassiouny & Mohamed, 2012; Jha, 2010) and the yearly increase in the cost of electricity 1.052 % (U.S. Energy Information Administration, 2012; Edison Electric Institute, 2006; Indiana Utility Regulatory Commission, 2012; Americas Power, 2012).

3.4. The System Efficiency

The efficiency of the system is called the DC to AC derate factor. According to U.S. Department of Energy (2012), the efficiency of the system (derate factor) is considered to be 77% (PV module nameplate DC rating= 0.95 * Inverter and transformer=0.92 * Mismatch =0.98* Diodes and connections =0.995* DC wiring =0.98* AC wiring =0.99 * Soiling = 0.95* System availability =0.98* Shading = 1.00 * Age =1.00). In order to consider degradation factor, the system performance (electricity production) is reduced by 3% per year starting from the second year.

3.5. Summary of the Analysis Parameters

The analysis depends on the following parameters:

1- The average net cost of a standard system = total cost - federal taxes credit (30% of the total cost).
The average net cost of a standard system = $ 29,240.84 – ($ 29,240.84* 30%) = $ 29,240.84 – $8,772.252 = $20,468.588
2- Geographical location of an area (depends on solar azimuth and solar altitude).
3- Electricity cost (varies from area to other).
4- Sales Tax= 7%.
5- The market interest according to Indiana Department of Revenue rate =3%.
6- The yearly increase in rates of electricity =1.052%.
7- Degradation factor = 3% starting from the second year (U.S. Department of Energy, 2012).
8- Yearly Maintenance = 0.
9- Salvage value = Decommissioning cost.
10-Array Tilt =32° (U.S. Department of Energy, 2012).
11-Array Azimuth =180° (U.S. Department of Energy, 2012).
12-Panels lifetime =25 years (According to the PV professionals in Indiana) (Energysage, 2016).
13-Inverter lifetime = 10 years (According to the PV professionals in Indiana) (Energysage, 2016).

3.6. Description of Conducting the Engineering Economy Assessment

The specifications mentioned above were used to economically evaluate the viability of the system. The calculation of the annual cost or savings from the PV system depends on how much electricity was generated per month or per year. Electricity generated from the system was computed based on the available solar potential of the counties of Indiana.

The interest rate is equal to 3%, which calculated according to Indiana Department of Revenue. The electricity rates were computed according to the rates that are provided by the utility company that serves the area. The

electricity cost is considered to increase 1.052% every year. Savings were computed by multiplying the electricity cost with the amount of electricity generated. It has been considered that the system efficiency is 77%, which is the derate factor. Starting from the second year, degradation factor was considered to be equal to 3% per year. Cash flows and project balances for a standard system over an analysis period of 25 years are presented for each of the selected counties (regions of the state).

The cash flow at the end of the first year is the saving due to electricity generation multiplied by the state sales tax of 7%. The cash flows for the remaining years have been computed by multiplying the cash flow for the previous year by 1.052 (to account for the 1.052% yearly increase in electricity cost) and by 0.97 (to account for a 3 % yearly decrease in system efficiency or to count degradation factor). A household is advised to replace the inverter every 10 years. Therefore, assuming the inverter average cost remains the same during the system lifetime; $2,589.96 was added to the project balance at the 10^{th} and 20^{st} year. An analysis period for this work has been calculated to be 25 years because the warranty for the system is 25 years. Project balance amounts were calculated using Equation (1), IRR was computed using the IRR spreadsheet function in Equation 4, and NPV was computed using the NPV function in the Microsoft Excel in Equation 3. If any cash flow occurs at n = 0, it is added algebraically to the value obtained from Equation 3 in the excel NPV function.

3.7. Conducting the Analysis

This section explains the process for calculating the engineering economy parameters only for the first location in the Lake County, Indiana. The system in this location can generate 10864 kWh in the first year. This value is multiplied by the cost of electricity 11.6 ¢/kWh ($1260/year), and then multiplied by the 7 % state tax. Therefore, a household in this location could save $1,348.21(=1260 *1.07) in the first year. The project at the end of year 25 has -$8,632.74 as a balance. According to these numbers, the NPV is equal to $15,869.46, which is less than the initial cost for the system ($20,468.59), the IRR is 0.491%, which is less than MARR (3%), and the project balance is negative. Therefore, it can be concluded that installing a standard PV system in that area is not justified economically. Table 5 is a sample to show the cash flow and project balance calculation for the first location in the Lake County, Indiana.

Table 5: Cash Flows and Project Balances for a Standard System at the First Location in the Lake County, Indiana

Year	Cash Flow	Project Balance	Year	Cash Flow	Project Balance
0	-$20,468.59	-$20,468.59	13	$1,060.61	-$13,524.68
1	$1,348.21	-$19,693.99	14	$1,039.62	-$12,859.62
2	$1,321.52	-$18,923.64	15	$1,019.04	-$12,195.79
3	$1,295.36	-$18,157.13	16	$998.87	-$11,532.84
4	$1,269.72	-$17,394.03	17	$979.09	-$10,870.36
5	$1,244.58	-$16,633.93	18	$959.71	-$10,207.96
6	$1,219.95	-$15,876.40	19	$940.71	-$9,545.27
7	$1,195.80	-$15,121.02	20	-$1,667.87	-$11,549.53
8	$1,172.13	-$14,367.36	21	$903.84	-$10,965.06
9	$1,148.92	-$13,614.99	22	$885.95	-$10,381.49
10	-$1,463.78	-$15,531.14	23	$868.41	-$9,798.47
11	$1,103.89	-$14,860.07	24	$851.22	-$9,215.67
12	$1,082.03	-$14,191.38	25	$834.37	-$8,632.74

The same technique was used in all 18 locations to calculate the cash flow, project balance, NPV, and IRR. Table 6 summarizes the result of the economic analysis for all the selected counties in the State of Indiana.

Table 6: Summary of the Study Results

County	Electricity rate	Generation of Elec./ Year	Project Balance by end of year 25	NPV	IRR
Lake County, location 1	11.60	10864 kWh	-$8,632.74	$15,869.46	0.491%
Lake County, location 2	11.50	10935 kWh	-$8,746.96	$15,816.50	0.460%
Allen County, Location 1	7.30	10999 kWh	-$23,677.31	$8,893.37	-4.427%
Allen County, Location 2	10.20	10880 kWh	-$13,642.66	$13,546.39	-0.944%
Allen County, Location 3	9.90	10842 kWh	-$14,869.06	$12,977.71	-1.319%
Allen County, Location 4	9.70	10890 kWh	-$15,429.92	$12,717.64	-1.494%
Allen County, Location 5	10.00	11472 kWh	-$12,481.77	$14,084.69	-0.598%
Tippecanoe County, Location 1	11.00	11043 kWh	-$10,290.32	$15,100.85	0.032%
Tippecanoe County, Location 2	10.70	11358 kWh	-$9,928.59	$15,268.58	0.133%
Tippecanoe County, Location 3	11.30	11277 kWh	-$8,140.01	$16,097.93	0.625%
Tippecanoe County, Location 4	10.90	11539 kWh	-$8,642.62	$15,864.88	0.488%
Marion County, Location 1	10.20	11194 kWh	-$12,372.82	$14,135.20	-0.566%
Marion County, Location 2	9.70	11035 kWh	-$14,884.85	$12,970.39	-1.324%
Monroe County, Location 1	10.40	11319 kWh	-$11,437.39	$14,568.96	-0.295%
Monroe County, Location 2	11.50	11626 kWh	-$6,026.24	$17,078.08	1.186%
Monroe County, Location 3	10.90	11297 kWh	-$9,501.03	$15,466.84	0.252%
Vanderburgh County, Location 1	10.90	11543 kWh	-$8,818.05	$15,783.53	0.440%
Vanderburgh County, Location 2	10.00	11942 kWh	-$10,649.42	$14,934.34	-0.070%

4. CONCLUSION

This study is intended to provide useful information to Indiana residents and homeowners considering the installation of a standard PV system as a means of reducing the cost of electricity. This study contributes to developing energy policies in the state of Indiana, by providing an independent analysis of the economic feasibility of using the grid-connected PV systems. The results of the study may help Indiana decision makers to evaluate the real needs and the applicable situations for using the residential PV system and may assist in the development of strategies and financial incentives that could make the PV system financially attractive.

This study found that the standard PV system does not produce a positive project balance and does not pay for itself within the life time of the system (25 years). The cost of solar PV is higher than the market valuation of the power it produces; thus, solar PV did not compete on the cost basis with the traditional competitive energy sources. Reducing the capital cost will make the standard PV system economically viable in Indiana. It is recommended that the policy makers in the State of Indiana may need to review the renewable energy incentive programs and make these programs more effective.

Even though the system does not seem to be economically viable in Indiana, environmental benefits could be gained from installing the system. For example, previous studies compared PV solar generation versus coal-fueled generation; they estimated that, on an average, producing 1000 kWh of electricity with solar power reduces emissions by nearly 8 pounds of sulfur dioxide, 5 pounds of nitrogen oxides, and more than 1400 pounds of carbon dioxide (Ibrahimov, 2013). Therefore, installing a standard PV system will enable its owner to reduce emissions by nearly 88 (11*8) pounds of sulfur dioxide, 55 (11*5) pounds of nitrogen oxides, and more than 15400 (11*1400) pounds of carbon dioxide. This study may help the resident of Indiana understand the inter-relationship between energy, economy, and environment. By installing a standard PV system, residents of Indiana might be able to make their state a healthier place that is more suitable to raise their kids in healthy environments. In addition, energy efficiency and healthy environment are important factors that attract other people to live in the State of Indiana. The government should create educational programs that help in improving the residents' awareness regarding the environmental benefits of installing the standard PV system. Improving the Indiana residents' awareness will support the U. S. Department of Energy's efforts in reducing energy shortages and reducing America's dependence on foreign oil. Indiana residents should know that energy efficiency is beneficial for themselves, beneficial for their cities, and beneficial for the nation and the world even without immediate financial benefit. The following are recommendations for future research:

1- The researcher recommends developing a future study to investigate the viability of one-axis and two axis PV grid-connected system and compare the result with the result of this study in order to develop a comprehensive picture for the viability of different types of PV systems.
2- Comparison study might be conducted to look at financial difference between the use of residential PV systems and residential wind turbines.

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