

## Determining bank effects on economic growth: An artificial neural network analysis

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### ABSTRACT

This study characterized the influence of the banking industry's influence on the growth of the economy. A neural network using the Multilayer Perception was used to define functions of Universal Bank, Cooperative Bank, and Thrift Bank as predictors of Gross Domestic Product growth. Using data series from 2003-2013, it was found that Universal banks have been growing tremendously taking huge shares of growth compared to the other two bank types. Meantime, the Gross Domestic Product was found to be steadily growing over the same period with a significant spike in 2004. In addition, neural network presents the contribution of the bank types on Gross Domestic Product, and found that the assets and capital of rural banks positively affect the Gross Domestic Product growth. As such, the sensitivity analysis of the Artificial Neural Network indicates Rural banks asset as the most important predictor of all the chosen variables followed by Universal bank capital. However, the capital of Thrift banks was found to show least contribution on the growth of the Gross Domestic Product.

**Keywords:** Analysis, Banking, Economy, Poverty.

### INTRODUCTION

Small and developing countries largely benefit from capital markets with little contribution of bank and stock market into the growth of the economy (Tennant & Tracey, 2014). Long term economic dynamics, however, also relates to banks' role in the economy (Nasir, Ali & Khokar, 2014; Levine, 1998; 1999). Edison et al., (2002) employed sophisticated econometric tools to determine the effects of financial structure on economic growth. As the economy shifted from large-company dependence to smaller but many firms (Carree & Thurik, 1998), transformation processes improved and technological advances pushes hard development dynamics which ultimately impacts on overall employment

(Folster, 2000; Carlsson, 1999). In all these dynamics, banks and banking institutions have significant roles to play.

Sussman & Zeira (1995) reveal the interplay of financial intermediation generally referred to as Financial Development Conjecture (FDC) into economic development. They describe that cost of banking, a specific unit element in the FDC, negatively relates to real economic growth. On the micro level, business-government relationships continue to intensify; banks fill the gaps of providing investment earnings and tax revenues (Sylla, Legler & Wallis, 1987). Among them, banks provided healthy competition that heightened accretions of holdings (Schwartz, 1987). The competition among banks stem from their activities lending to the wide and varied segments of the business community: artisans, farmers and women. Lending to clients usually is characterized by losses as capital is shifted to low quality firms that do not maximize profit (Sharpe, 1990). As firms spend money for operation and expansion, the economic agents benefit from the activity. The rent-shifting changes the interest rates and the payback period thus increasing scope and breadth of economic benefits (Degryse & Van Cayseele, 2000). Stiglitz & Weiss (1981) introduced the concept of temporary disequilibrium that points on the stickiness of credit that affects rationing opportunities. The rationing of credit, borrowing and repayment depends on financial system and eventually on economic growth.

The Philippine Banking System has been characterized by a common pattern of frailty when faced with shocks (Gochoco-Bautista, 1999; Unite & Sullivan, 2001). Using stochastic frontier analysis, Manlagnit (2011) confirmed inefficiencies in domestic banks, and further underpinning the asset quality to have effects on the quality of the banks, in particular, and in the whole banking system, in general. The Philippine banking structure can be made efficient through entries of foreign banks as interest rates will reduce. Entry of foreign banks will lead to better competition within this service industry) which will improve the reputation and soundness of the financial system (Milo, 2001).

Moreover, Kwan (2003) pointed out that key determinants of banking performance, and by extension, in the performance of financial markets in Asian countries are hugely affected by quality of loans, liquidity, capitalization, output mix and even operating costs of the banks. Ownership of the bank also show influence on the performance of the bank (Laeven, 1999). All these are important considerations in the operation of the bank because Karim (2001) confidently forecasted that increased competitive pressures will ease off less

efficient banks while at the same time reinforcing competitive advantage of the efficient ones.

Koetter & Wedow (2010) contended that the size of financial system, characterized at some point by banks, causes the systematic differences of economic growth differentials. On this note, this study shall be conducted in order to determine the bank factors that directly influence economic growth which shall be described in the latter section of the paper as Gross Domestic Product (GDP) and the banks total assets using the artificial neural network (ANN). This study used the artificial neural network (ANN) in portraying the relationship of GDP and the bank total assets of various types of banks and eventually determines effects of bank types on the growth of the economy.

## METHODS

### *Artificial Neural Network*

The Artificial Neural Network (ANN) employs the general network architecture of the Multilayer Perceptron (MLP) that defines the function of predictors (in this study referred to as input variables) to minimize the prediction error of target variables (output variable).

The network architecture follows a feed forward topology as described by the connections in the network flow forward from the input layer to the output layer without any feedback loops. The MLP network allows a second hidden layer. Note that the second hidden layer is a function of first hidden layer and that each response is a function of the second hidden layer.

### *Neural Network Analysis Architecture*

The study applied custom architecture selection in defining the optimal neural network model of the influence of the type of banks to the GDP. The model employs identify that has the form  $\gamma(c) = c$ . It takes real-valued arguments and returns them unchanged. The automatic architecture selection activates the function for units in the output layer for the scale-dependent variables apply.

The re-scaling of the dependent variables follows the “standardized” control where the variables were subtracted with the mean and divided by the standard deviation,  $(x - \text{mean})/s$ .

The hyperbolic tangent function uses the activation function that target values

$$\text{between } -1 \text{ and } +1 \text{ represented as } h'(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}}$$

$$h'(x) = \frac{1 - e^{-2x}}{1 + e^{-2x}}$$

with a first derivative

$$h'(x) = [1 + h(x)][1 - h(x)]$$

#### *The Delta Rule*

The delta learning rule was used for the supervised networks. The mappings of the input patterns are linearly dependent and can be solved through single layer (Fletcher, 2002).

The training tab is used to specify how the network should be trained to achieve optimum algorithm. The study employed “batch” option. The batch training option updates the synaptic weights only after passing all training data records. This means that this option uses information from all records in the training data set. It is a commonly preferred option because it minimizes the total error directly and is useful for smaller data set. As a requirement of the batch training option, the optimization algorithm follows the scaled conjugate gradient.

#### *Steps in designing an Algorithm of the Neural Network*

1. Train the artificial neural network with  $H = H^0$  hidden nodes
  2. Establish the training session.
    - a. Perform decomposition of the nodes to eliminate notes with minimal contribution to the neural network. Then test the hypothesis of the likelihood ratio statistic given as
- $L_1 = \left( \frac{SSE_R - SSE_F}{df_R - df_F} \right) / \left( \frac{SSE_F}{df_F} \right)$ , note that value of  $L_1 < F_{\alpha; df_F - df_R; f_R}$
- b. The batch option was used in this study which provides the optimum minimization of error.

- c. Choose the scaled conjugate gradient for optimization algorithm.
3. Experiment. Train the artificial neural network with  $H - \Delta H^*$  nodes.
  - a. Choose description output, diagram and synaptic weights to produce parameter estimates.
  4. Analysis

*Sources of Data*

The data were extracted from the official government agencies like Bangko Sentral ng Pilipinas (BSP) and National Statistical Coordination Board (NSCB) of the Philippine Statistics Authority (PSA). The Central Bank data can be accessed using the URL <http://www.bsp.gov.ph/statistics/overview.asp>. The growth of the economy was accessed from the NSCB website using the URL <http://www.nscb.gov.ph/stattables/>.

## RESULTS

The total asset of banks in the Philippines is presented in Figure 1. The Universal banks have siphoned assets of the banking sector, making it significantly leading the industry compared to the other type like thrift and rural banks. Meantime, rural banks staggers in earning sizable asset compared to the other two types. Berger & Udell (1995) illustrated the growth of the universal banks and their roles in credit rationing. They found that the bigger banks, mostly universal banks, reduce allowable credit to be loaned by small businesses. While they are limiting loan amounts to banks, the universal banks experiences a degree of monopoly for big loans in the financial industry. Thus, over time, interest returns accrue bigger net benefit to universal banks and leaving relatively marginalized value for the other types of banks like thrift and cooperative banks.

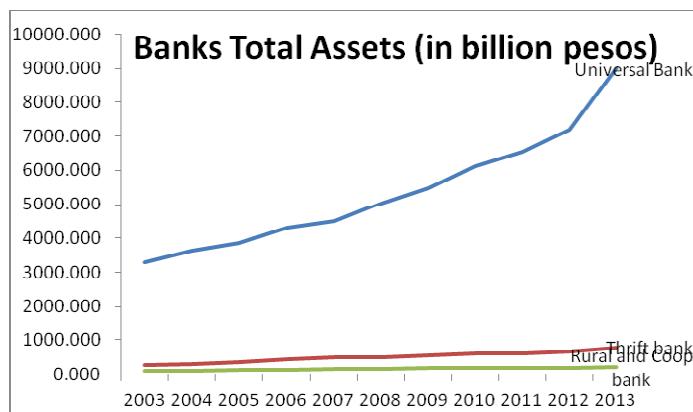


Figure 1. Bank assets of Universal, Thrift and Rural & Coop banks, 2003-2013

The banks performance in terms of capital accounts also reveal the same condition: Universal banks have been reaping huge while Thrift and Rural & Coop banks are lagging far off behind. Rural and Coop dipped lower than Thrift bank. As a result of massive and effective use of funds of universal banks, their capital returns also increases. The performance of the cooperative banks seems to reiterate the very nature of its existence: cooperative ownership. Frankel (1971) noted at the onset the very problem of the cooperative banks in Europe which is oriented on its institutional setup which is to accumulate capital in perpetuity which is also defining ownership rights and profit disbursement issues.

If these twin concerns are not addressed, the fate of the cooperative banks might be merged with larger banks as what happened to a thousand banks in Germany in 1990's (Lang & Welzel, 1999). Though rural or cooperative banks are finding hard in surviving the competitive environment of the banking market, their contribution towards addressing poverty in areas where they are located cannot be undermined, as an example, Burgess & Pande (2003) contested in affirmative that rural banks benefit the poor. Its benefits stem from the nature of its institution; cooperative banks are considered as stakeholder-value banks (Ayadi, Llewelyn, Schmidt, Arbak & de Greon, 2010), and that they continue to exists as long as members stick together and form a strong capital asset value.

On the other, disunited stakeholders of the cooperative banks will lead to a loose operation and poor capital accumulation which causes erosion of the competitive advantage of the banks forcing them either to close shop or to be merged (Lang & Welzel, 1990) usually with bigger banks like a universal bank. The bank mergers also have adverse and good impacts in the economy. It is a common expectation that a merged bank will offer different format of services to its clientele; and this is also true among rural banks, a reduced amount of loans available to the farmers might occur if rural banks are to be merged with company-owned banks.

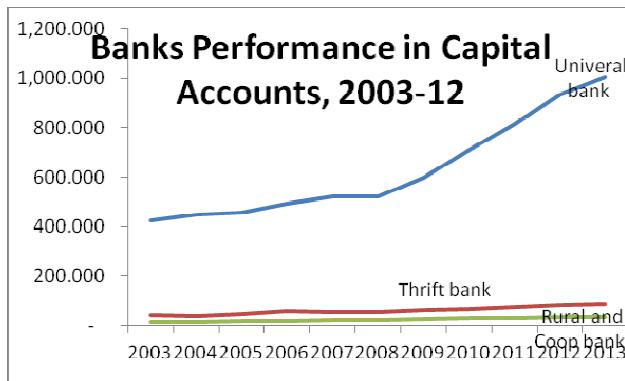


Figure 2. Banking performance in terms of capital accounts, 2003-2013

Keeton (1996) watered down this concern as such claim is half truth. Merged banks still serve the customers they target before merger with the larger banks, yet in a tenor that follows the policy of the bigger bank. Then, five year later, Berger, Bonime, Goldberg & White (2001) substantiated the claim that merger will lead to improved supply of credit in a relationship-dependent loan activities that is evident among rural and cooperative banks. The Philippine GDP has been observed to experience constant increase overtime with the observe spikes in 2003. It continuously grow but hit some snags in 2008 and 2009, however, it was able to surpass the economic turmoil of 2007 to 2009. The effective gains of the Philippine GDP have been observed as it continues to increase from 2004 and slowly increasing up to 2014. The good GDP performance is a result of the continuing struggle of the Philippine government against corruption. Under the Aquino administration, credit ratings improved.

The source of economic growth of the Philippines can be well-traced in its human capital, however, it was still widely discussed that education development is found to lacking (Santiago, 2005).

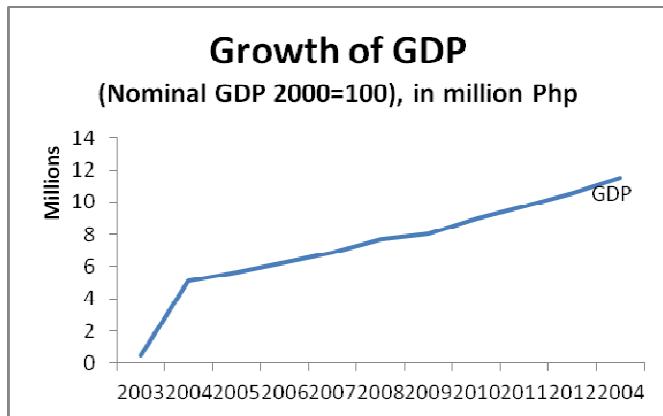


Figure 3. Philippine Growth of Gross Domestic Product, 2003-13

#### *Results of Artificial Neural Network*

The network performance displays results that are used as basis for determining the model as “good”. It includes model summary. The model summary contains the results by partition and overall, the error, the relative error or percentage of prediction that is incorrect, the stopping rule.

Table 1 Network Information of the ANN Model for GDP growth

Components	Architecture functions	Variables and number
Input Layer	Covariates	1 Universal Asset
		2 Thrift Asset
		3 Rural Asset
		4 Universal Capital
		5 Thrift Capital
		6 Rural Capital

	Number of Units <sup>a</sup>	6
	Rescaling Method for Covariates	Standardized
Hidden Layer(s)	Number of Hidden Layers	1
	Number of Units in Hidden Layer 1 <sup>a</sup>	4
	Activation Function	Hyperbolic tangent
Output Layer	Dependent Variables	1
	Number of Units	1
	Rescaling Method for Scale Dependents	Standardized
	Activation Function	Identity
	Error Function	Sum of Squares
a. Excluding the bias unit		

The network information reveals that there are 6 variables that are used in the study that are scale-dependents in measurement. The training test also yielded one hidden layer with 4 units in the layer in a hyperbolic tangent as activation function. The output layer uses standardize rescaling method, identity as activation function and produce sum of squares of errors as error function.

The schematic representation of the neural network is presented below. It should be noted that the lighter colored synapses suggest positive synaptic weights; the darker colored implies negative synaptic weights.

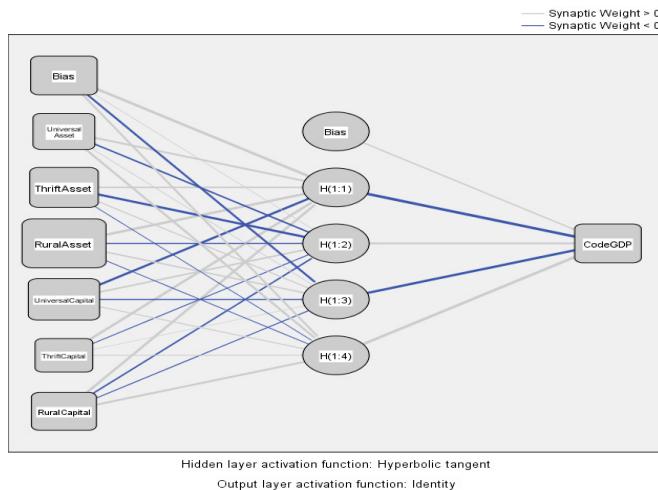


Figure 4. Diagrammatic representation of the neural network and the synaptic weights

Model summary reveals results that would qualify model to fit as good as indicated by a small SSE (0.018), relative error (0.006) for the training time.

Table 2 Model summary

Architecture	measure	Value
Training	Sum of Squares Error	0.018
	Relative Error	0.006
	Stopping Rule Used	1 consecutive step(s) with no decrease in error <sup>a</sup>
	Training Time	00:00.0
Testing	Sum of Squares Error	0.432
	Relative Error	3.014
Dependent Variable: CodeGDP		
a. Error computations are based on the testing sample.		

The parameter estimates are displayed in the proceeding table. It was found that universal bank capital contributes positive synaptic effect on the GDP through the hidden layer (H(1:2). GDP growth is also affected by assets and capital of universal bank; capital of thrift and rural banks through hidden layer H(1:4).

Table 3 Parameter estimates

Predictor		Predicted				Output Layer (GDP)	
		Hidden Layer 1					
		H(1:1)	H(1:2)	H(1:3)	H(1:4)		
Input Layer	(Bias)	1.41	0.01	-0.32	0.29		
	Universal Asset	0.40	-0.25	0.03	0.48		
	Thrift Asset	0.26	-0.58	0.17	-0.04		
	Rural Asset	1.00	-0.18	0.23	-0.09		
	Universal Capital	-0.52	0.29	-0.18	0.17		
	Thrift Capital	0.62	-0.13	0.01	0.10		
	Rural Capital	0.53	-0.22	-0.16	0.48		
Hidden Layer 1	(Bias)					0.20	
	H(1:1)					-1.72	
	H(1:2)					0.49	
	H(1:3)					-0.73	
	H(1:4)					1.65	

The de-specialization of banks, that is creation of many universal banks tend to cause a more efficient banking system because of superior monitoring capabilities of universal banks (Vander, 2002), which in effect stabilizes the financial market of an economy. Edwards & Ogilvie (1996) argued using the economic development of Germany that a bank-based financial system will support industrialization efforts of an economy, yet they emphasized that universal banks played the major role as a central component of the German economic development peculiarly characterized by mergers and acquisitions by universal banks of smaller but many cooperative banks (Krahnen & Schmidt, 2004).

The growth of universal banks also improves the performance of the firms in the economy, and undeniably, growth of the economy. The relationship between banks and the firms promotes improvements in investment to small firms upon proof of a firms governance performance (Krahnen & Elsas, 2004). Yet, the role of the universal banks in the global financial crisis of 2007 cannot be just given a marginal note. The universal banks lost huge capital in their investments in the subprime industries in the United States through their large, complex financial institutions (LCFIs) that secured underwriting in the nonprime homeowners market and even facilitated syndicated lending (Wilmarth, 2009). The very nature of the universal bank also opens up potential trouble to the economy because of the wide and massive coverage of its operations like selling insurance, underwriting securities and carried out transactions in behalf of others (Benston, 1994); all these are seen as the major culprits of the global financial crisis.

The proceeding figure is a plot of the predicted values against the observed values of GDP growth. To determine goodness of the model, plot should appear to follow a 45 degree line. Any other trend of the plot indicates that important variables are missing or the variables are related, thus collinear. Figure below displays plot that follows a 45-degree plot, thus, model is a good fit.

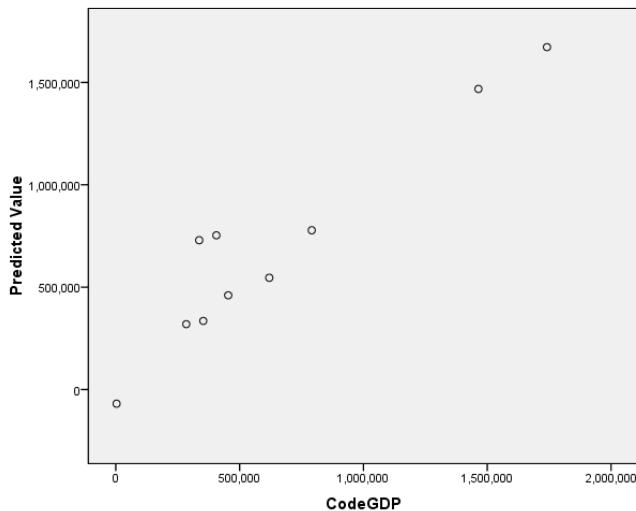


Fig 5. Scatter plot of GDP, actual and predicted values

The sensitivity analysis reveals the contribution of the variables on the GDP growth. Findings reveal that of the three chosen banks, the rural bank assets have the strongest impact on the growth of the GDP. The capital of the universal banks follows as the second strongest contributor to the GDP, then the thrift banks assets as the third most influential on the GDP dynamics. The universal bank asset is deemed as the least of the chosen variables that contributes to the growth of the GDP.

Philippines is hugely a developing country, it is described in the World Competitiveness Report that the Philippine competitiveness is described as factor-driven that competes on the factor endowments primarily unskilled labor and natural resources (Sala-I Martin, Blanke, Hanouz, Geiger & Mia, 2010). A manufacturing economy, like the Philippines, is faced with the debacle of low wages, high transportation cost, and high production cost. In effect, the competitiveness advantage of a manufacturing economy will erode unless exchange rate and monetary policy are reinforced in favor of the producing sector (Krugman & Venables, 1990); the differences in the factor endowments exacts the contrasts of growth paths over time (Engerman & Sokoloff, 2002) and that focus of advantage in international trade will strongly be affected by these endowments (Heller, 1976). In the microeconomic level the market of factors underscored the important linkage between trade and poverty (Hertel & Reimer (2002). The increase in the household income is seen as a result of the changes in the individual skills, a market that rewards improved productivity, selection of factors that have high rewards, and finally, the rise of entrepreneurial activities (Feldstein, 1999).

The forming of new firms is a result of increasing number of entrepreneurial individuals that contribute to the stronger growth of the GDP (Henderson, 2002). The new firms comprise the levels in what is described by Ploeg et al., (2000) as multi-level, multi-actor and multi-faceted process of rural development rooted in traditional sector. These new firms access loans from the smaller banks in a larger proportion and in fact, are found to experience no credit constraints in areas where small banks (Jayaratne & Wolken, 1999), usually rural banks are found. Thus, the role of the rural banks in the development of the Philippine economy is hereby confirmed. In addition, the universal banks also played significant role in the growth of the economy, they acted as the second level of sources of loans. The universal banks are sought out for bigger amount of loans, Berger et al (2005) further describe the function of the universal banks as they lend at greater distance, unwilling to provide funds

to firms with no financial records, and they do not alleviate credit constraints effectively. All these are only possible to big firms that require sizable capital.

Table 4 Sensitivity analysis of the contribution of variables to GDP

Predictors	Importance	Normalized Importance	Rank
Universal bank asset	0.112	36.50%	5
Thrift bank asset	0.171	55.80%	3
Rural bank asset	0.307	100.00%	1
Universal bank capital	0.195	63.50%	2
Thrift bank capital	0.075	24.50%	6
Rural bank capital	0.141	45.80%	4

## CONCLUSIONS

The assets trend of the chosen banks allow for a unique infrastructure that should be given a simultaneous support and regulations. The Universal Banks, found to have been reaping assets and capital, do not actively support the other players in the financing industry like the thrift and cooperative or rural banks. Instead, the growth of the Universal banks threatens the rural and cooperative banks. The latter banks are found to be of effective service to the growth of the domestic economy. The rural and cooperative banks influence on the economy is a description of the nature of the growth path that Philippines is taking; the country is taking a factor-support economic strategy where it is investing heavily on the small firms found in the periphery and are directly involving the households of the economy. On the other hand, there is the twin need of serving the growing sector of formal and large financial demand that is needed for efficiency infrastructure improvement found among advance economies.

## REFERENCES

- Booth, L., Aivazian, V., Demirguc-Kunt, A., & Maksimovic, V. (2001). Capital structures in developing countries. *The journal of finance*, 56(1), 87-130.
- Gochoco-Bautista, M. S. (1999). The past performance of the Philippine banking sector and challenges in the postcrisis period. *Asian Development Bank* (Ed.). *Rising to the challenge in Asia: A study of financial markets*, 10, 29-77.
- Manlagñit, M. C. V. (2011). Cost efficiency, determinants, and risk preferences in banking: A case of stochastic frontier analysis in the Philippines. *Journal of Asian Economics*, 22(1), 23-35.
- Frankel, F. R. (1971). *India's green revolution. Economic gains and political costs*. Princeton, NJ: Princeton University Press; London: Oxford University Press.
- Lang, G., & Welzel, P. (1999). Mergers among German cooperative banks: a panel-based stochastic frontier analysis. *Small business economics*, 13(4), 273-286.
- Burgess, R., & Pande, R. (2003). Do rural banks matter? Evidence from the Indian social banking experiment. Retrieved from [http://scholar.harvard.edu/files/rpande/files/can\\_rural\\_banks\\_reduce\\_poverty\\_evidence\\_from\\_the\\_indian\\_social\\_banking\\_experiment.pdf](http://scholar.harvard.edu/files/rpande/files/can_rural_banks_reduce_poverty_evidence_from_the_indian_social_banking_experiment.pdf)
- Ayadi, R., Llewellyn, D. T., Schmidt, R. H., Arbak, E., & Pieter De Groen, W. (2010). Investigating diversity in the banking sector in Europe: key developments, performance and role of cooperative banks. Brussels: Centre for European Policy Studies.
- Santiago, A. L. (2005). *Cross-border transactions in higher education: Philippine competitiveness* (No. DP 2005-27). Makati: Philippine Institute for Development Studies.

Vander Vennet, R. (2002). Cost and profit efficiency of financial conglomerates and universal banks in Europe. *Journal of Money, Credit, and Banking*, 34(1), 254-282.

Edwards, J., & Ogilvie, S. (1996). Universal banks and German industrialization: a reappraisal1. *The Economic History Review*, 49(3), 427-446.

Krahnen, J. P., & Schmidt, R. H. (2004). *The German financial system*. Oxford University Press.

Krahnen, J. P., & Elsas, R. (in press). Universal banks and relationships with firms. Oxford University Press.

Wilmarth, A. E. (2009). The dark side of universal banking: Financial conglomerates and the origins of the subprime financial crisis. *Connecticut Law Review*, 41(4), 963-1050.

Benston, G. J. (1994). Universal banking. *The Journal of Economic Perspectives*, 8(3), 121-143.

Sala-i-Martin, X., Blanke, J., Hanouz, M. D., Geiger, T., & Mia, I. (2010). The Global Competitiveness Index 2010–2011: Looking beyond the global economic crisis. *The global competitiveness report, 2011*, 14-80.

Krugman, P., & Venables, A. J. (1990). Integration and the competitiveness of peripheral industry. *Unity with diversity in the European Community*, 56-77.

Engerman, S. L., & Sokoloff, K. L. (2002). *Factor endowments, inequality, and paths of development among new world economies* (No. w9259). National Bureau of Economic Research.

Heller, P. S. (1976). Factor endowment change and comparative advantage: The case of Japan, 1956-1969. *The Review of Economics and Statistics*, 283-292.

Hertel, T., & Reimer, J. (2002). Predicting the poverty impacts of trade reform. *Journal of International Trade and Economic Development*, 14(4), 377-405.

Feldstein, M. (1999). Reducing poverty, not inequality. *Public Interest*, 137, 33-41.

Henderson, J. (2002). Building the rural economy with high-growth entrepreneurs. *Economic Review-Federal Reserve Bank of Kansas City*, 87(3), 45-75.

Jayaratne, J., & Wolken, J. (1999). How important are small banks to small business lending?: New evidence from a survey of small firms. *Journal of Banking & Finance*, 23(2), 427-458.

Berger, A. N., Miller, N. H., Petersen, M. A., Rajan, R. G., & Stein, J. C. (2005). Does function follow organizational form? Evidence from the lending practices of large and small banks. *Journal of Financial economics*, 76(2), 237-269.