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Out of many, dominance by a few? Market power in the Jamaican banking sector

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Abstract

This paper presents an empirical assessment of the degree of competition within the Jamaican banking sector during the period 1998 to 2007. The popular *H*-statistic by Panzar and Rosse is utilised to estimate market power among the sample of banks. Using usual statistical tests, we are unable to reject monopoly/perfect collusion for the banking market in Jamaica. This contrasts with earlier findings using alternative estimators. Therefore, the use of a dynamic reformulation of the model with a dynamic estimator highlights some collusive behaviour among banks.

Keywords: Competition, banking, Rosse-Panzar *H*-statistic, Dynamic panel estimation, Jamaica

JEL Codes: G21, G28

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1. Introduction

The level of competition in the banking sector of any economy has a major impact on consumer welfare and economic growth through its influence on bank performance and the stability of the financial sector. Undoubtedly, this partly explains the plethora of academic articles in recent years that have examined competition in banking from various perspectives and for different geographical regions. Changes in the competitive structure of the banking industry may occur in response to local or global stimuli such as financial liberalisation, deregulation, technological advancements, crises, internationalisation or harmonisation. Therefore, it is an invaluable exercise that is better able to provide an assessment of measures of competition for regulation and policy formulation at the micro and macro levels.

The liberalisation of the Jamaican economy in the early 1990s, the experience of financial crises in the mid- to late-1990s, the enhancement of information technologies and the imminent establishment of the CARICOM Single Market and Economy (CSME) are expected to have contributed or will contribute to changes in the financial sector. These structural and other changes experienced and expected, carry cogent implications for competition and, ultimately, stability of the banking and financial sector and the wider economy. Of course, the impact of the wave of instability resulting from the global financial crisis beginning around 2007 cannot be ignored as this will undoubtedly impact the metamorphosis already taking place within Jamaica's banking and financial sector.

The purpose of this paper is to undertake an empirical assessment of the degree of market power within the Jamaican banking sector during the period 1998 to 2007. Among the most widely used methods to assess degrees of competition in banking is the model popularised by Rosse and Panzar (1977) and Panzar and Rosse (1987) (P-R model). The P-R model assesses the degree of market power on the basis of a reduced form equation that explains revenue in terms of factor input prices and other explanatory variables. However,

this model, which has been widely used in the literature, has been challenged by a new strand appearing in the literature on two main grounds. The first basis of the challenge is that it is mis-specified. For example, Bikker *et al*. (2006) argue that the revenue equation is mis-specified since it is effectively reduced to a 'price equation if the logarithm of relative income is taken as the dependent variable' as is the case in much of the extant literature. This, they note, has important far-reaching implications for the *H*- statistic and its interpretation. They further argue that similar misspecification occurs with the use of covariates that reflect scale (such as the natural logarithm of total assets) and that the use of such a scaling variable renders the equation 'indistinguishable from a price equation.' The second point of challenge is that the model equation of Panzar and Rosse is static and presumes equilibrium or instantaneous adjustment to equilibrium at each point in time when the data are observed. For example, Goddard and Wilson (2009) note that the reality is not in line with this presumption as adjustment towards equilibrium is often not instantaneous and markets are therefore not necessarily in equilibrium and recommend a dynamic estimation model.

Accordingly, for our empirical assessment of market power within the Jamaican banking sector we seek to assess market power using nine alternative specifications of the empirical models. The objectives of this are three-fold. First, it affords testing for equilibrium within the Jamaican banking sector over the period and therefore an appropriate interpretation of the results. Second, it affords robust comparison of the degree of competitiveness among Jamaican banks between 1998 and 2007. Third, comparison with the findings of other studies allows for informed policy making. The data set consists of an unbalanced panel of eleven banks: five merchant banks and six commercial banks. The findings are indicative of low levels of competition maintained by a few banks restricting competition, but the data is unable to pin down the exact competitive structure which mostly lies between monopolistic competition and monopoly (or conjectural variations of oligopoly).

The next section outlines the background to Jamaica's banking sector. Section 3 reviews the literature and the methodology on bank competitiveness. Section 4 discusses the model strategy and data. Section 5 presents the results and Section 6 some concluding remarks.

2. The Jamaican Banking Sector 1998 to 2007

Jamaica's network of banks is fairly well-developed and diversified consisting of the Bank of Jamaica (BoJ – the Central Bank), commercial banks, merchant banks, non-banking financial firms and development banks. In Jamaica's liberalised financial environment, banks operate within a relatively small market and therefore expect tough competition. Despite an expansion in the number of merchant banks in the early 1990s, the 'traditional' commercial banks dominate both in terms of their geographical presence through branches across the island and also by share of total banking assets (see Table 1).

Prior to 1998, in the height of the financial crisis, Jamaica's banking sector changed with the exit of several banks. The crisis resulted in a transformation of the sector, significantly reducing the number and types of banks with resulting changes in ownership. The structural changes that took place within Jamaica's banking sector over the period 1998 to 2007 included a number of mergers and eventual consolidations in 1999, acquisitions by foreign stakeholders in 2001, transfer of assets and liabilities to other entities and licences surrendered in 2002 and 2003, further mergers in 2004 and more licences surrendered in 2007. At the end of 2007, 6 of the 10 banks operating had majority foreign ownership. The relative number of mergers, consolidations and acquisitions that occurred during the 1990s and in the new century suggests an increase in concentration and worsening of competition. In general our findings confirm this.

Table 1: Share of Total Banking Assets by Category of Banks[¥]

	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998
Commercial	458,860.40	400,700.40	351,428.50	327,034.70	301,483.90	250,320.20	220,345.30	207,801.10	184,336.80	147,750.80
% of total	92	91	89	88	92	85	95	98	98	96
Merchant	41,394.60	40,346.70	41,330.30	46,698.80	26,645.20	43,169.00	12,014.20	4,192.40	3,830.10	6,685.70
% of total	8	9	11	12	8	15	5	2	2	4
Local	66,823.40	61,927.90	58,103.30	60,012.20	34,706.90	46,402.40	125,803.00	117,973.90	108,580.00	83,875.40
% of total	13	14	15	16	11	16	54	56	58	54
Foreign	433,431.60	379,119.20	334,655.50	313,721.30	293,422.20	247,086.80	106,556.50	94,019.60	79,586.90	70,561.10
% of total	87	86	85	84	89	84	46	44	42	46
Top 3	382,849.60	334,218.90	298,767.20	281,789.70	263,692.20	221,463.20	193,012.40	185,158.10	166,697.70	133,055.50
% of total	77	76	76	75	80	75	83	87	89	86
Lower 3	96,254.70	85,045.00	71,974.60	72,136.30	51,604.90	46,768.30	24,349.00	17,045.50	13,881.40	14,163.80
% of total	19	19	18	19	16	16	10	8	7	9

Source: Authors' calculations

[¥]Assets measured in millions of Jamaica Dollars

3. Measuring market power in Banks

As noted above, we utilize the popular model of Panzar and Rosse with adjustments recommended by Bikker *et al*. (2006) and Goddard and Wilson (2009). Earlier studies on bank competition may be classified into one of the two schools of the structural and the non-structural approaches. Many early studies on market power within banking took the form of structure-conduct-performance (SCP) analysis or the efficient-structure hypothesis (ESH).[1] The Panzar-Rosse (P-R) model is from a new school – the New Empirical Industrial Organisation (NEIO) models that were developed to address the shortcomings of the early approaches.[2] NEIO models measure the impact of monopoly and oligopoly power by estimating the deviation between marginal cost and competitive pricing without explicitly using the market structure indicator. The Rosse-Panzar reduced-form revenue model and the Bresnahan-Lau mark-up model are two important methods in this strand of literature. Both approaches are derived from profit-maximizing equilibrium conditions. However, Shaffer (2004) notes that the Rosse-Panzar model is preferable as it is robust even in small empirical samples and works well with firm-specific data on revenues and factor prices without requiring information about equilibrium output prices and quantities for the industry.

The model by Rosse and Panzar (1977) and Panzar and Rosse (1982, 1987) as well as the extension to banking by Nathan and Neave (1989) and Perrakis (1991) assumes that firms can enter or leave rapidly any market without losing their capital, and that potential competitors possess the same cost functions as firms that already serve in the market. The test of the model is based on the properties of a reduced form log-linear revenue equation for a panel data set of banks of the following type:

[1] See, for example, Bikker (2004) for an overview of these approaches.
[2] See, for example, Berger (1995), Berger *et al.*(1997) and Paul (1999) for discussion of the shortcomings.

$$\ln R_{it} = a_0 + \sum_{j=1}^{J} a_j \ln w_{jit} + \sum_{k=1}^{K} b_k \ln X_{kit} + \sum_{n=1}^{N} g_n \ln Z_{nt} + e_{it}$$

(1)

where R = the revenue of bank i at time t,

w = the J[th] input price for each bank,

X = K bank-specific variables that affect the banks' revenue and cost functions,

Z = N macro variables that affect the banking market as a whole, and

e is a stochastic term.

The stylized bank-specific variables which have been used by researchers in these equations are a measure the riskiness of the bank's overall portfolio, a proxy for size and the extent of diversification effect, and the ratio of the number of branches of each bank to the total number of branches of the whole banking system (viewed as a traditional way of maintaining market share by providing consumers with close-quarter access to financial services, and mitigating, to some extent, price competition).[3]

The H-statistic is calculated from the reduced form revenue equation and measures the sum of elasticities of total revenue of the banks with respect to the banks' input prices. In the context of equation (1), $H = \sum_{j=1}^{J} a_j$. Rosse and Panzar (1977) and Panzar and Rosse (1982, 1987) outline certain conditions from which inferences may be drawn about the structure of the market. Table 2 summarises these theoretical underpinnings of the main theory for measuring competitive condition and contestability in the banking market, when using a revenue equation and when using a price equation. However, the specification approach characteristic in the extant

[3] See, for example, Northcott (2004). Notably, branching has cost implications, so there is a trade-off between maintaining market share and increasing cost of branch maintenance.

literature on banking competition involves the 'rescaling' of the dependent variable through division by total assets or inclusion as a control variable. Bikker *et al*. (2006) suggest that this inadvertent misspecification of the revenue equation as a price equation 'leads to wrong inference about the market structure and the degree of competitiveness through a strong bias of *H* towards one'.

Table 2: Alternative theories and interpretations of the Panzar-Rosse *H*-statistic

Competitive conditions	**Revenue Equation**	**Price Equation**
H=0	Monopoly or conjectural variations short-run oligopoly (increase in input prices will increase marginal costs, reduce equilibrium output and subsequently reduce total firm revenue)	-
***H* = 1**	Perfect competition or natural monopoly in a perfectly contestable market or sales maximising firm subject to a break even constraint (any increase in input prices increases both marginal and average costs without altering the optimal output of any individual firm)	Perfect competition or natural monopoly in a perfectly contestable market or sales maximising firm subject to a break even constraint
0 < *H* < 1	Monopolistic competition	Monopoly or conjectural variations short-run oligopoly
H > 1	-	Monopolistic competition

An important feature of a correctly identified *H*-statistic using an estimated revenue equation is the long-run market equilibrium assumption. This suggests that competitive capital markets will equalise risk-adjusted rates of return across banks such that, in equilibrium, rates of returns should be uncorrelated with input prices. To test for equilibrium, equation (1) is calculated replacing the dependent variable total revenue in with return on assets, p , as shown in equation (2):

$$\ln p_{it} = a'_0 + \sum_{j=1}^{J} a'_j \ln w_{jit} + \sum_{k=1}^{K} b'_k \ln X_{kit} + \sum_{n=1}^{N} g'_n \ln Z_{nt} + u_{it} \quad (2)$$

Here, $E = \sum_{j=1}^{J} a'_j = 0$ indicates long-run equilibrium; and E < 0, indicates disequilibrium.

Much of the extant literature utilise the 'mis-specified' equation discussed above and reflects an *H*-statistic with a bias towards one, suggesting a prevalence of monopolistic competition in many markets.[4] Unfortunately, there remains is a paucity of research on critical banking issues for Jamaica. The single known study of competition among Jamaican banks also applies the 'misspecification' noted above. Duncan and Langrin (2004) examined competition in the commercial banking market over the thirteen-year period 1989 to 2002 using quarterly panel data. Using total interest revenue to total assets as the dependent variable, their results indicate declining competition in the banking market in the presence of monopolistic competition.

4. Measuring bank competitiveness in Jamaica: data and model strategy

Due to the lack of detailed information on factor prices, much is imputed from accounting information for measuring levels of competition in banking. We utilise annual audited unconsolidated financial data and, because we favour a more homogenous sample, focus on Jamaican commercial and merchant banks only, between 1998 and 2007.[5] Data were obtained from publicly available resources, including Bankscope, financial statements and Annual Reports, the website of the respective banks, the website of the Central Bank, and media reports.[6] Notably, all the banks now use International Financial Reporting Standards (IFRS) to report financial information.[7] Data was not consistently available for all banks; in a few

[4] Bikker and Haaf (2002) find monopolistic competition the prevailing market structure in 100 of 101 countries. See also Al-Muharrami *et al.* (2006) for a summary of results from other studies.
[5] Unconsolidated means data relating to the bank entity only, excluding other group companies.
[6] Bankscope database, maintained by Bureau Van Dijk, provides financial and other data for over 29,000 banks worldwide.
[7] IFRS were adopted in Jamaica for financial year-end reporting on or after July 2002. Some financial statements have therefore been reported using the local accounting standards (Local GAAP) previously in use for a part of the sample period. Daley (2004) and Daley (2002) discuss the likely impact of the change.

instances a number of working assumptions had to be made to fill gaps in the data.[8] In the final analysis we therefore used an unbalanced panel of 11 banks. In the case of mergers, the banks are treated as two separate entities until the point of merger; thereafter, only one bank is reported.[9]

The sample used in this study is comprised of a small number of banks that constitute the majority of the population and market and asset share, over ten years. The sample period 1998 to 2007 spans a period of continuing structural change resulting from crisis in the Jamaican banking sector during the early to mid-1990s. Any operational and profit variances occurring would significantly influence overall revenue and profitability levels. While the macroeconomic environment has not been identified as a cause of failure during the Jamaican banking crisis, it was acknowledged that a weak macroeconomic environment could render marginal banks infeasible (see, for example, Daley, 2007). For this reason, the final equations (3) and (5) include a time series variable, either real GDP growth rate (*RGDP*) or, alternatively, a full set of individual year dummy variables.[10]

In response to the challenge noted above, we focus at the outset on identifying any departure from the critical *P-R* assumption of long-run equilibrium in the banking market. Using an empirical test for equilibrium described in (2) above, we compute the dependent variable as $\ln(1+ROA)$ as shown in equation (3), since our sample includes small negative values.[11]

$$\ln(1+ROA)_{it} = \alpha_0 + \alpha_1 \ln PL_{it} + \alpha_2 \ln PK_{it} + \alpha_3 \ln PF_{it} + \beta_1 \ln KASS_{it} + \beta_2 \ln DLNS_{it} + \beta_3 \ln NLASS_{it} + \beta_4 \ln SIZE_{it} + \beta_5 \ln Br_{it} + \beta_6 OWN_{it} + \beta_7 PER_{it} + \gamma_1 RGDP_t + u_{it} \quad (3)$$

[8] These assumptions are 'conditioning' factors that should be taken into account when interpreting the results, but are not pervasive.
[9] There is an assumption that the merged banks assume similar strategy with respect to its competitive stance and business mix (see, for example, Kishan and Opiela (2000); Hempell (2002).
[10] Coccorese (2004) recognises the role of macroeconomic indicators in assessing bank competition in Italy.
[11] See also Claessens and Laeven (2004) for use of the log of the adjusted ROA as a dependent variable.

where *i* denotes banks *i*=1,…N; and *t* denotes time *t*=1,…T. The variables are defined as follows:

ROA	return on assets measured by profits after tax divided by total assets
PL	personnel expenses to number of employees (unit price of labour)
PK	capital expenses to fixed assets (unit price of capital)
PF	ratio of interest expenses to total customer deposits (unit price of funds)
KASS	ratio of capital to assets, measuring funding risk (leverage)
DLNS	ratio of deposits to loans, measuring business risk
NLASS	ratio of net loans to assets, measuring portfolio risk
SIZE	total bank assets
Br	ratio of bank branches to total bank branches per year

OWN is a dummy variable taking a value of 0 or 1 local or foreign ownership, respectively and PER is a dummy variable taking the value 0 for the period 1998 to 2000 and 1 thereafter. The model assumes a one-way error component as described by:

$$u_{it} = \eta_i + \nu_{it} \tag{4}$$

where η_i is the bank-specific effect and ν_{it} is an IID random error. The banking market is deemed to be in equilibrium if $E = \alpha_1' + \alpha_2' + \alpha_3' = 0$. Five specifications of Equation (3) are tested on the data from our unbalanced panel using the fixed effects estimator to allow for heterogeneity across the sample of banks. Table 3 summarises the various models constructed. Model 1 is the full equation shown in (3); model 2 includes lags of the factor prices; model 3 introduces individual year dummies to replace the variables PER and RGDP; model 4 is a combination of models 2 and 3; and model 5 is equation (3) excluding the regressor ln *SIZE*.

Since all specifications of the FE profit equation reject $H_0 : E = 0$ (see below), suggesting disequilibrium in the banking market, how then should we model the revenue equation as an inference to market power? Goddard and Wilson (2009) suggest that the answer to that question is the dynamic revenue equation that includes

the lagged dependent variable as a regressor. Following their example, we re-specify the full dynamic revenue condition as:[12]

$$\begin{aligned}\Delta \ln R_{it} &= a_0 + a_1 \Delta \ln PL_{it} + a_2 \Delta \ln PK_{it} + a_3 \Delta \ln PF_{it} + b_1 \Delta \ln R_{it-1} + b_2 \Delta \ln KASS_{it} \\ &+ b_3 \Delta \ln DLNS_{it} + b_4 \Delta \ln NLASS_{it} + b_5 \Delta \ln Br_{it} + b_6 \Delta OWN_{it} + b_7 \Delta PER_{it} \\ &+ g_1 \Delta RGDP_t + e_{it}\end{aligned} \quad (5)$$

$$e_{it} = m_i + v_{it} \quad (6)$$

where R = total bank revenue, measured by total income (*TI*) or interest income (*II*), all other variables are as defined above, m_i denotes the unobservable bank-specific effect and v_{it} denotes a random term which is assumed to be IID. The long-run (dynamic) *H*-statistic is given by $H = (a_1 + a_2 + a_3)/(1 - b_1)$. Four specifications of Equation (5) are tested on the data from our unbalanced panel using the generalized method of moments (GMM) dynamic panel estimator as proposed by Arellano and Bond (1991).[13] Table 4 summarises the various models constructed. Model 1 is the full equation shown in the (5). Model 2 introduces individual year dummies to replace the variables *PER* and *RGDP*. As a robustness test, we re-estimate models 1 and 2 with interest income instead of total income as the dependent variable in models 3 and 4. All models are estimated using the one-step GMM estimator as well as the robust one-step GMM estimator.[14]

5. Empirical results and analysis

As a first step we assess whether the banking market is deemed to be in equilibrium. To do this, we compare the *E*-statistics obtained from the five variants of

[12] The re-specified equation addresses the mis-specifications noted by Bikker *et al*. (2006) and concurred by Goddard and Wilson (2009). These are mis-specifications regarding the 'scaling' of the dependent variable (dividing by total assets) or the inclusion of a 'scaled' covariate, ln*SIZE*, that lead to flawed conclusions in the interpretation of the *H*-statistic.

[13] We opt for GMM since the use of a 'static' estimator such as FE may lead to bias in the estimates (see, for example, Goddard and Wilson, 2009).

[14] Arellano and Bond (1991) note that the one-step estimator is only valid for IID errors while the robust one-step estimator is also valid for general heteroskedasticity over individual[s] [banks] over time.

the P-R profit equation (3) outlined in Table 3. Table 3 summarises the results obtained by applying FE estimation to the various model specifications. We also report the E-statistic estimates, along with Wald *F*-statistics and probabilities for the null hypothesis, $H_0 : E = 0$ over the period 1998 to 2007. For parsimony, the final models have been determined by strict variable deletion on statistical grounds.

We apply the Wald *F*-test applied to the models and consistently reject the null hypothesis of long-run equilibrium at a 99% significance level. Table 3 shows that the sum of the input price elasticities of the factors, are significantly different from zero for all specifications. Based on the fixed effects specification, the Jamaican banking market is shown to be in long-run disequilibrium from 1998 to 2007. A possible explanation of the inability to identify equilibrium in the Jamaican banking sector over the 10-year period is the dynamic changes that have taken place in the sector since the crisis.[15]

To assess the degree of competition in the Jamaican banking sector, we then examine the value of the Rosse-Panzar *H*-statistic and apply usual statistical framework to test hypotheses as set out in Table 2.[16] Table 4 reports the estimated values of *H* for each of the four model specifications based on equation (5) with results for the one-step estimator as well as the robust one-step estimator.

We focus initially on columns 2 to 5 in table 4 which describe the estimates for total income as the dependent variable. From these columns we observe that of the three input prices, the unit price of funds (*PF*) is always significant at conventional levels of significance, suggesting that the cost of funds is an important contributor to total income. Furthermore, the large positive coefficient suggests that it

[15] We recognise that equilibrium may not hold for the entire period but that it may do for sub-periods as the consistent rejection of H_0:E = 0 may only suggest the presence of defined structural break(s) with different periods of 'equilibrium.' The small sample constrained our ability to test this hypothesis.

[16] We apply the Wald *F*-test to these hypotheses: H_0:H=0; H_0:0<H<1; H_0:H=1. See Table 2 for explanations.

was the main contributor to *H*. The unit price of fixed capital, *PK*, was never statistically significant in any of the robust estimates and the small coefficient of the unit price of labour varied in sign. The strong positive coefficient on *Br* shows significant market share effects on total income. This highlights that the positive effects of maintaining market share outweigh the costs of maintaining additional branches and therefore implies that a greater number of branches should lead to a net overall increase in total income. It also suggests that the Jamaican banking sector is not over-branched and could possibly benefit from an expansion. The variable *DLNS*, which is a proxy for business mix appears important to total income based on its occurrence and significance for all estimates except for the robust estimates of models 1 and 4. The significant positive coefficients on this variable are in line with expectations since the provision of additional deposits makes available more funding for lending and the provision of more loans would, *ceteris paribus*, lead to an increase in revenue. The significant negative coefficient of *OWN* on total revenue suggests that foreign ownership is inversely related to income generating capability. This finding contrasts with expectations and anecdotal evidence that foreign-owned banks in Jamaica are more profitable. Of course, it could be that foreign-owned banks actually earn less income than locally-owned banks but they are also more efficient at cost management and therefore achieve higher net profits. The coefficient on *PER* in column suggests that the post-crisis period has had the expected positive effect on total income.

Columns 2 to 5 of table 4 also show that the estimated *H*-statistics fall between 0.25 and 0.40.We firmly reject $H=1$ or the perfectly competitive banking market for Jamaica over the sample period using the one-step results for both models (at 10% level of significance). However, $H=0$ cannot be rejected using the one-step or robust

one-step in Model 1 and the robust one-step in Model 2. Therefore, based on the GMM estimator using total income as the dependent variable, the Rosse-Panzar *H*-statistic for the one-step model suggests that the Jamaican banking market as a whole was characterised by monopolistic competition between 1998 and 2007, while the robust one-step model failed to provide a clear indication (in the statistical sense) of the competitive structure of the banking market. However, the point estimates of the *H*-statistic suggest a very low level of competitiveness. The main results using total revenue as the dependent variable is that the indications as to the structure of the Jamaican banking sector over the period 1998 to 2007 are mixed. The low *H*-statistics suggest that the Jamaican banking sector was increasingly controlled by one or a few dominant banks over the period.

From columns 6 to 9 in table 4 we observe the results for the estimates using interest revenue as the dependent variable. We focus on a number of striking differences. First, the coefficient of the risk proxy, *NLASS*, shows strong and positive influence on interest income indicating that greater risk is associated with greater net return. Second, the coefficient on the lagged dependent variable was significant for all specifications and estimators and the effect on interest income generating capacity was more robust than on total income. Third, bank-specific variables such as *Br* and *OWN* are not statistically significant suggesting that the market share and ownership benefits apparent on total income do not follow through to net income.

Estimated *H*-statistic for the interest income equations range from 0.14 to 0.27. While $H=0$ cannot be rejected in any of the models at conventional significance levels, we also cannot reject $H=1$. Testing for the boundary values of *H*, the results support the findings that monopoly or perfect collusion cannot be rejected. A grid search for the boundary values of the *H*-statistic was conducted by searching over the

range [-1, 1], the results of which are shown in table 4. The process involved testing for the limits for which the value of *H* can be rejected at the 90% or higher level of confidence. At best, the results for model 3 and 4 and the robust one-step results for models 1 and 2 indicate perfect competition and at worst, monopoly or collusive behaviour. In this paper, we concur with the views of Bikker and Haaf (2002) and interpret *H* as a continuous measure of the level of competition with higher values indicating stronger competition than lower values. We note the low values of *H* in columns 6 to 9 of table 4 as the best unbiased estimates. Using this principle we can infer low competition and an inference to cartelisation despite the 'indeterminate' nature of the significance tests. The low *H*-statistics are supported by the inability to reject $H=0$ at the conventional 5% level of significance in any of the equations. There is therefore sound basis for the inference that a few banks restrict competition and consequently weaken the influence of other banks.

In general, our broad conclusion is inconsistent with the findings of Duncan and Langrin (2004) who reported the Jamaican banking market as reflecting monopolistic competition over the period 1989 to 2002. However, the cartelisation/collusion conclusion is consistent with the findings of the Herfindahl-Hirschman Index (HHI) of their study which suggested that there was a decline in competition among Jamaican banks after the crisis. Furthermore, although the Panzar-Rosse *H*-statistic 'rejected monopoly/perfect collusion in favour of monopolistic competition for the entire sample period,' Duncan and Langrin (2004) note that '… there was a steady decline in competition throughout the specified sample period'. While we may try to attribute the different inferences from the *H*-statistic to the variation of sample periods (both in terms of the frequency of the data and the actual years covered) and sample size, a more pointed explanation remains.

Notably, the P-R model estimated by Duncan and Langrin (2004) is the 'mis-specified' equation discussed earlier. The equation estimated is in fact a price equation as noted by Bikker *et al*. (2006) and therefore $0<H<1$ should be interpreted as monopoly or conjectural variations short-run oligopoly instead of monopolistic competition (see table 2).

Evidently, competition in Jamaican banking has weakened over the full sample period 1998 to 2007 whether or not non-interest income is included in the assessment of bank performance along with core business (interest income). Despite the overall low *H*-statistics for the models with total income as well as those with interest income, we note that the models with total income showed slightly higher statistics. The implication of this is that, although alteration of the product-mix of banking services did not have a significant effect on overall market power within Jamaica's banking sector, the non-interest income segment showed slightly less reduction in competitiveness.[17] The lack of competitiveness in the interest income segment of bank earnings has seen Jamaican banks making a strategic decision to develop this area of business and to seek to 'corner' the market along with one or two other major players. However, Llewellyn (2005) notes that the 'bundling' of bank services in Britain may have resulted in opposite movements in competitiveness within each segment.

6. Concluding remarks

In this paper we have examined the structure of the Jamaican bank sector and sought to draw inferences about market power. The Panzar-Rosse *E*-statistics of various fixed effects models suggested that the Jamaican banking market was characterised by disequilibrium over the period 1998 to 2007. In other words, there was some

[17] de Young and Roland (2001) in an empirical study of US banks argue that the trend to off-balance sheet activity increases bank earnings volatility because of high competitive rivalry in these markets.

correlation between rates of return on banking assets and the prices of factor inputs. This finding necessitated the use of a dynamic estimator to be applied to a dynamic revenue equation for market power inferences. In this paper we have applied the Arellano and Bond (1991) GMM estimator to the dynamic Panzar-Rosse revenue equation.

We have presented a number of GMM models for estimating market power within the Jamaican banking sector during the period 1998 to 2007. Regression results and goodness of fit are satisfactory. *E* and *H*-statistics appear robust and hardly affected by specialisation choice. In general, the findings of the robust one-step estimator are consistent with those of the one-step estimator. Evidently, these models could also be useful to a variety of policy decisions relating to banks.

The period 1998 to 2007 spans the end of a period of crisis within Jamaica's banking sector to the post-crisis phase and embraces various structural, reporting and legislative changes. Our results suggest that over this period, Jamaica's banking market may have been characterized by cartelisation where a few banks have continued to exercise dominance in the market. While the low level of competition with the Jamaican banking sector may have secured premium profits for dominant players, the impact on customer welfare cannot be ignored. With the current trends and challenges in global markets, it is apposite that current policy decisions focus on levels of competition within Jamaica's banking sector. The literature would benefit from any future work that analyses a longer period of data in which case it may be possible to arrive at more conclusive results.

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Table 3: P-R profit models: Specifications and results

	Model 1	Model 2	Model 3	Model 4	Model 5
	Eqn. 3	Eqn. (3) + lagged factor prices	Eqn. (3) + year dummies - RGDP, PER	Eqn. 3 + lagged factor prices + year dummies – PER, RGDP	Eqn. (3) - lnSIZE
FE RESULTS					
Intercept	0.239	0.239	0.065	0.037	0.036
	(8.20)***	(8.20)***	(3.15)***	(1.38)	(1.20)
lnPL	0.04	0.04	0.063	0.056	0.026
	(5.37)***	(5.37)***	(6.18)***	(5.18)***	(2.83)***
lnPF	0.014	0.014	0.008	0.006	0.007
	(2.86)***	(2.86)***	(1.56)	(1.13)	(1.21)
lnPK	-0.000	-0.000	0.003	0.003	-0.002
	(-0.16)	(-0.16)	(0.97)	(0.79)	(-0.59)
lnKASS	0.025	0.025	0.036	0.035	0.03
	(5.46)***	(5.46)***	(8.12)***	(7.95)***	(6.17)***
lnSIZE	-0.015	-0.015	-	-	-
	(-5.42)***	(-5.42)***	-	-	-
lnBr	-	-	-	-0.010	-0.022
	-	-	-	(-1.65)*	(-3.87)***
PER	-	-	-	-	-0.009
	-	-	-	-	(-1.54)
N_{obs}	90	90	90	90	90
N_{bank}	11	11	11	11	11
$\hat{E}^F$	0.05	0.05	0.07	0.06	0.03
$F(H_0:E=0)$	F(1,74)=26.49***	F(1,74)=26.49***	F(1,66)=34.2***	F(1,65)=22.3***	F(1,73)=6.16**
Market Condition	Disequilibrium	Disequilibrium	Disequilibrium	Disequilibrium	Disequilibrium
F-statistic	18.11***	18.11***	9.20***	8.96***	12.47***
$F(H_0: h_i = 0)$	F(10,74)=6.17***	F(10,74)=6.17***	F(10,66)=7.40***	F(10,65)=6.83***	F(10,73)=5.46***

Notes:
***, **, * Significant at 1%, 5%, 10%
RGDP, PER, SIZE as defined above
N_{obs} is the number of bank-year observations used
N_{bank} is the number of banks for which data are available
$\hat{E}^F$ is the estimated E-statistic using the fixed effects (FE) estimator
$F(H_0:E=0)$ is the F test of null hypothesis $H_0:E=0$
$F(H_0: h_i = 0)$ is the F test of null hypothesis that the fixed effects are zero
Time dummies included in models 3 and 4

Table 4 P-R Dynamic revenue models: Specifications and results

Equation	**Model 1: Eqn.(5): R = Total Income (TI)**		**Model 2:Eqn. (5):R = TI + year dummies - RGDP, PER**		**Model 3: Eqn. (5): R=Interest Income (II)**		**Model 4:Eqn. (5): R=II + year dummies -RGDP, PER**	
Variable (first difference)	**One-step**	**Robust One-step**	**One-step**	**Robust One-step**	**One-step**	**Robust One-step**	**One-step**	**Robust One-step**
Intercept	0.175	0.117	0.150	0.150	0.078	0.078	0.088	0.088
	(6.82)***	(1.73)*	(5.9)***	(2.77)***	(1.73)*	(1.40)	(1.98)*	(1.62)
lnR_{t-1}	0.195	0.266	0.160	0.160	0.652	0.652	0.579	0.579
	(2.08)**	(1.44)	(1.79)*	(1.12)	(5.84)***	(3.44)***	(5.33)***	(3.58)***
lnPL	-0.102	-0.026	0.152	0.152	0.208	0.208	0.137	0.137
	(-0.56)	(-0.07)	(0.08)	(0.06)	(0.69)	(0.55)	(0.46)	(0.37)
lnPF	0.5222	0.537	0.527	0.527	0.348	0.348	0.332	0.332
	(7.97)***	(7.19)***	(7.60)***	(5.75)***	(2.58)**	(3.33)***	(2.33)**	(3.73)***
lnPK	-0.170	-0.190	-0.141	-0.141	-0.29	-0.29	-0.330	-0.330
	(-1.84)*	(-1.45)	(-1.53)	(-1.41)	(-1.86)*	(-1.06)	(-2.16)**	(-1.52)
lnNLASS	-	-	-	-	0.513	0.513	0.444	0.444
	-	-	-	-	(2.06)**	(1.93)*	(1.79)*	(1.43)
lnDLNS	0.199	-	0.142	0.142	0.572	0.572	0.492	0.492
	(3.56)***	-	(2.17)**	(2.02)**	(2.71)***	(2.32)**	(2.28)**	(1.39)
lnBr	0.258	0.252	0.420	0.420	-	-	-	-
	(2.16)**	(4.94)***	(3.51)***	(6.37)***	-	-	-	-
OWN	-0.343	-0.772	-0.608	-0.607	-	-	-	-
	(-1.80)*	(-3.83)***	(-2.54)**	(-3.56)***	-	-	-	-
PER	-	0.362	-	-	-	-	-	-
	-	(2.51)***	-	-	-	-	-	-
N_{obs}	68	68	68	68	68	68	68	68
N_{bank}	10	10	10	10	10	10	10	10
***H*-value**	0.25	0.32	0.40	0.40	0.27	0.27	0.14	0.14
F test H=0	1.35	0.66	3.41*	1.90	0.55	0.24	0.15	0.07
F test H=1	5.91**	0.54	3.62*	1.07	0.04	0.03	0.49	0.37
Sargan	0.073	-	0.059	-	0.267	-	0.071	-
AR(2)	0.401	0.256	0.448	0.243	0.772	0.796	0.553	0.549
Grid search	H=-0.2 (F=3.56)* H=0.8 (F=3.13)*	H=-0.4 (F=3.40)* H=1 (F=0.54)	H=-.1 F=4.95)** H=1 (F=3.62)*	H=-0.1 (F=3.04)* H=1 (F=1.07)	H=-0.9 (F=2.88)* H=1 (F=0.04)	H=-1 (F=0.87) H=1 (F=0.03)	H=-1 (F=2.71) H=1 (F=0.49)	H=-1 (F=0.84) H=1 (F=0.37)
Market condition	MColl-MComp	MColl-PC	MColl-MComp	MColl-PC	MColl-PC	MColl-PC	MColl-PC	MColl-PC

Notes: Time dummies included in models 2 and 4

***, **, * Significant at 1%, 5%, and 10%, respectively; t-values in parenthesis

N_{obs} is the number of bank-year observations; N_{bank} is the number of banks.

H-value is the estimated Rosse-Panzar *H*-statistic

Sargan is the p-value for the Sargan test for the validity of the over-identifying restrictions for the GMM estimates

AR(2) is the p-value for the test for 2nd order autocorrelation for the GMM first-difference estimate residuals

MColl = Monopoly-Collusive behaviour; MComp = monopolistic competition; PC = perfect competition