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Patent Technological Field and Financial Performance of Malaysian Firms

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Patent Technological Field and Financial Performance of Malaysian Firms

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Abstract. The patent specification within the patent system consists of valuable information regarding the characteristics of an invention. This includes the patent's technological fields and citations. Statistics show that Malaysia's manufacturing industries constitute its largest exporting industries compared to other industries with the U.S. being Malaysia's largest trading partner since the 1990s. The objective of this study is to examine how far does the patent technology field given impact on the financial performance at the Malaysian firm level. By segregating the patent technology field into two categories, 1) Human Necessities and Performing Operations, and 2) Mechanicals and Electronics, this study measures the financial performance based on the patent application and renewal stocks from within the patent system. This study applied a panel dataset from 1994 to 2008 and the model is estimated using panel least square, fixed effects model, and random effects model. It is found that the mechanicals and electronics technological field demonstrate more statistically significant variables compared to the human necessities and performing operations field. This findings are not surprising as Malaysia's largest export in the manufacturing industries is the mechanicals/ electronics technology field.

Keywords: Patent technological field, patent system and firm financial performance

1. Introduction

There is an ongoing debate over whether the patenting system benefits only advanced economies when compared to emerging economies and, further, whether the patent system benefits only the rich [1], [2]. However, even though Malaysia is a developing country, there is reason to be optimistic that patenting activity benefits this country as one of the emerging economies.

A patent involves many fields of technology. Some technology fields represent fast moving technology, while some do not, with the former having a higher obsolescence rate compared to the latter [3, 4]. In spite of this situation, there are firms that undertake patenting activity in both fast and slow moving technology fields.

Some firms patent products and processes either to be sold in the market or to be used in their own firms. The former may directly maximize the firm's sales revenue in order to maximize profits, while the latter is used to reduce the business costs in order to maximize profits [5, 6]. Indirectly, the latter may also maximize the firm's sales revenue once the firm's business costs have been reduced. Hence, patenting an invention represents a profit-maximizing strategy both in the short and long run.

The objective of this study is to examine how far does the patent technology field given impact on the financial performance at the Malaysian firm level. By segregating the patent technology field into two categories, 1) Human Necessities and Performing Operations, and 2) Mechanicals and Electronics, this study measures the financial performance based on the patent application and renewal stocks from within the patent system. This study applied a panel dataset from 1994 to 2008 and the model is estimated using panel least square, fixed effects model, and random effects model. The orientation of this paper introduces the institutional background, followed by literature review, hypothesis development and research method. It ends with findings and conclusion of the study.

2. Institutional background

Malaysia's economic history shows had a large quantity of manufactured products are assembled in that country from foreign components parts, and that these products are then exported to other parts of the world [7]. Statistics show that Malaysia's manufacturing industries constitute its largest exporting industries compared to other industries, with the U.S. being Malaysia's largest trading partner since the 1990s [8–10]. Furthermore, more research has been carried out into the patenting activities of manufacturing firms within the advanced economies [11–13] than into other types of industries. In fact, 73% of Malaysian firms in our sample data that have been granted patents in Malaysia and the U.S. are manufacturing firms; thus, this study would expect that Malaysian firms that have manufactured new products or processes and exported to the U.S. would also want to secure patent protection in the U.S. territory.

The Ninth Malaysia Plan reported a higher average annual growth rate of 12% of patents applied for to domestic residents compared to only 5% to non-residents in terms of the science and technology (S&T) indicator. However, as shown in Table 2.3, the number of patents filed by Malaysian residents is still much lower than for non-residents [10]. Malaysia's cumulative patent application and registration is dominated by foreigners, as demonstrated by the very large gap between residents and non-residents. In another statistic produced by MyIPO [14], of the total number of patent applications in Malaysia, only approximately 7% are applied for by Malaysian residents. On the other hand, out of the total number of patents granted in Malaysia, only 3% have been granted to Malaysian residents. Furthermore, the royalties paid to acquire foreign technological capability had an average annual growth rate of 29% compared to only 6% paid for local technology acquisition, as indicated in table 1. With patenting activity and royalty earnings dominated by foreigners, it is apparent that Malaysia is still dependent on foreign technological capability [15]

Table 1. Science and Technology (S&T) Indicators in Malaysia.

Indicators	2002	2005	Average Annual Growth Rate
Total Patents Filed (Residents)	322	522	12
Total Patents Filed (Non-Residents)	4615	5764	5
Royalties (Receipts – RM million)	74	98	6
Royalties (Payments – RM million)	2399	5851	29

*Source: Ninth Malaysia Plan [10]

In terms of technological field, Section C (chemistry; metallurgy) was the field in which the highest number of patents were granted followed by Section H (electricity), and Section B (performing operations; transporting). As discussed previously, foreigners have dominated Malaysian patent applications; hence, the technological fields were also influenced by the foreigners' technological fields. According to the Seventh and Eighth Malaysia Plan [8, 9] which reported Malaysia's progress between

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1996 and 2005, technology inflows from foreigners came from electrical and electronics products; followed by chemical and chemicals products and transport equipment, 10 years in a row. The report matched with MyIPO data on patents granted based on technological field in table 2. There is no doubt that Malaysia is still dependent on foreign technological capability. This is evidenced through the technology inflows from foreigners; royalties paid to foreigners to acquire their technology; and the patenting activity undertaken by foreigners rather than Malaysian residents

Table 2. Patents Granted Based on Field of Technology in MyIPO.

Year	Section								Total
	A	B	C	D	E	F	G	H	
1993	215	169	503	15	37	52	155	138	1,284
1994	260	267	505	12	71	79	192	243	1,629
1995	336	268	542	27	48	61	194	277	1,753
1996	285	323	483	31	76	103	178	322	1,801
1997	151	138	196	13	32	45	82	132	789
1998	104	98	141	4	18	31	64	106	566
1999	132	112	191	9	21	49	68	139	721
2000	61	59	110	8	19	42	36	70	405
2001	155	233	288	18	44	102	231	399	1,470
2002	206	236	334	19	42	104	228	323	1,492
2003	224	242	396	28	38	119	190	341	1,578
2004	325	377	625	25	50	132	321	492	2,347
2005	333	452	600	30	82	164	316	531	2,508
2006	948	1,155	1,275	101	197	448	1,042	1,583	6,749
2007	1,179	1,213	1,748	109	221	407	883	1,223	6,983
2008	423	421	451	33	98	159	293	364	2,242
Total	5337	5763	8388	482	1094	2097	4473	6683	34317

*Source: MyIPO [14]

3. Literature review and hypothesis development

The patent system requires that the patent's technological fields and citations are included in the patent specification. This involves classifying the patent's technological field and citing other patents upon which the patent is built. The value of patent varies across technological fields [3, 16-17].

Griliches [18] argued that caution must be taken when studying the classification system in a patent. A patent's technology field is not the same as the industrial classification mainly categorized by economists. Thus, a researcher must have a clear understanding of the differences between these two in an attempt to answer any research questions. This is due to the fact that one technology field can be patented by many industries, and vice versa. To complicate matters, a patent can exhibit a combination of several technology fields. Some researchers have measured the technology field based on the patent's international patent classification (IPC) [3, 19] others have successfully created their own technology field [20, 21]; while others have based their classification on the industrial sector normally classified by economists [22, 23]. The most popular measure is to segregate the patents based on the technology field [3, 16]. However, other researchers have combined the technology field in an attempt to examine the dispersion of technology from its own traditional setting [19], which may create a superior technology.

Conceptually, some technology fields have a shorter technological life than others. Normally, biotechnology and pharmaceuticals have a longer technological life, compared to technical products that deal with basic human necessities which may have a shorter technological life. With regard to the former, generally at the early stage of their invention these firms would apply for a patent for defensive purposes [24, 25]. Thus, there is no commercialization of patents taking place at the early stage of the invention. Nevertheless, once the invention is ready to go into the market, it may last for a longer time period and boost the firms' sales revenues and profits. There are studies that show that pharmaceuticals, biotechnology, chemicals and other inventions classified as science-based are more valuable compared to other technological fields [16, 26]. However, the value of technological fields may also depend on the patent territory [27]. Based on Pavitt's [28], concept of the technological area which is grounded in differences in the process of innovation rather than product-based industrial classification. Greenhalgh and Rogers [21] found that the science-based technology field has the strongest effect on market value for UK patents. Schankerman [3] realized a similar result to that of Greenhalgh and Rogers [21] in his work on U.K. patents. However, he was more specific as he used the renewal behavior model [29] across the technology field, and found that pharmaceuticals and chemicals have a slow decay in private returns compared to mechanical and electronic patents which have much faster obsolescence.

In Malaysia, the pharmaceuticals and biotechnology fields are relatively new and targeted as a new source of growth [10]. The National Biotechnology Policy was launched in 2005 and divided into three main phases which end in 2020 [30]. Thus, this study expects that it is highly unlikely that Malaysian firms would have many patents in this area. Our sample contains more technical and mechanical technological area patents than pharmaceutical, biotechnology or chemical field patents. For example, even though in Table 2 it is evident that Section C (chemistry and metallurgy) has the highest granted patents compared to other technology fields, the results in show that in our sample Section C has the second lowest patents granted to Malaysian firms. This is unsurprising, as Section C in Table 2 involves all granted patents in Malaysia. Comparing with our sample, this situation obviously shows that foreign firms are dominating the Section C technology field in Malaysia. It is evident that our sample mostly comes from the human necessities, performing operations/ transporting, mechanical engineering, and electronics technology fields. This is to be expected as Malaysia has moved from post-colonial status to primary product exporter to being an industrially oriented economy [7, 31] in which these technology fields commonly rest in the aforementioned sectors.

Maintaining the unit of analysis with Malaysian firms which have been granted patent in two territories (Malaysia and the U.S.) in two technological fields (a) human necessities and performing operations and (b) mechanical and electronic, this study developed the following hypotheses.

i. There is a positive significant relationship between patents applied for and granted to Malaysian firms in human necessities and performing operations technological field and their financial performance
ii. There is a positive significant relationship between patents applied for and granted to Malaysian firms in mechanical and electronic technological field and their financial performance

4. Research method

Based on the IPC and composition of technology fields of patents granted to Malaysian firms in the two territories of Malaysia and the U.S., this study segregate the technology fields into two broad areas: 1) human necessities and performing operations, and 2) mechanicals and electronics. This study believe there is no significant difference between these two fields in terms of the impact of their patenting activity on the firms' financial performance relating to the sign and significance. This is because this study expects these two fields, both with fast moving technology, to have a short technological life. Nevertheless, the reason this study segregated these two fields is because the magnitude of their impacts may differ significantly.

In addition to segregating all the Malaysian firms which have been granted patents in the Malaysian and U.S. territories into the manufacturing industrial sector, this study were also interested in examining the impact of the technology field on the firms' financial performance. Thus, with the data in hand, this study rearranged all the firms based on the international patent classification (IPC). When segregating the firm into its technology field, this study based this on the first single alphabetical classification of its patent. For example, H01S 3/083 is classified in Section H, that is, electricity; another example C10J 3/26 is classified in Section C, that is, chemistry/ metallurgy. Nevertheless, as mentioned before, a patent can have multiple classifications within the technology field [18]. This study chose the majority number of classes in the patent specification to determine the classification of the technology field. This means that if there was a combination of two classes with only two fields, the first field classified in the patent specification was chosen. This study found the following composition of technology classes based on the broad classification in the IPC, as shown in figure 1

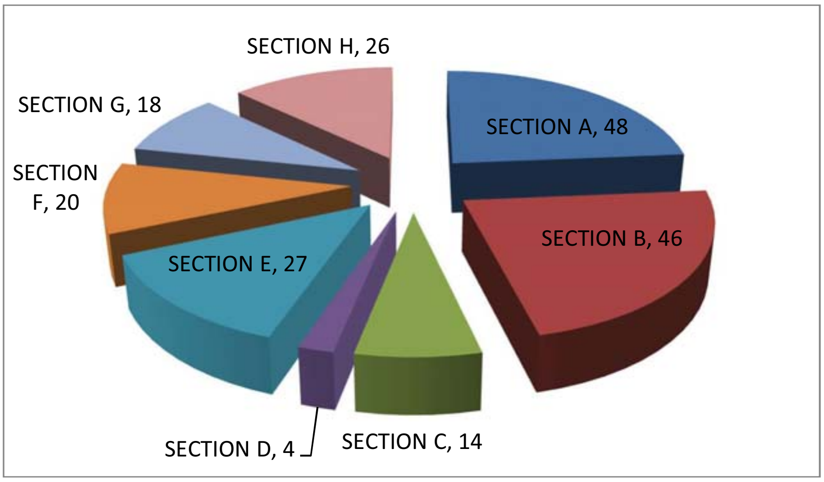

Figure 1. Patent Technology Field Based on International Patent Classification (IPC).

*Guide: Section A – Human Necessities; Section B – Performing Operations; Transporting; Section C – Chemistry; Metallurgy; Section D – Textiles; Paper; Section E – Fixed Constructions; Section F – Mechanical Engineering; Lighting; Heating; Weapons; Blasting; Section G – Physics; Section H – Electricity

Thus, to run the analysis with the patent renewal/ application, this study divided the technology field into two broad categories, that is, Section A to Section D and Section E to Section H. This study then reclassified them as Human Necessities and Performing Operations, and Mechanical and Electronics, respectively. The former comprised 112 firms with 1178 observations, while the latter was made up of 91 firms with 1047 observations for the analysis. This study applied a panel dataset from 1994 to 2008 and the model is estimated using panel least square, fixed effects model, and random effects model. This study also segregated model specification into three that Model 1 using sales, Model 2 using profits and Model 3 using profit margin as the dependent variable. Malaysian backward citations (MBWC), US backward citations (SBWC), Malaysian claims (MCL), US claims (SCL) and patent family (FAM) are the explanatory variables; tangible assets (LNTGA) and firms' age (NAGE) are the control variables

5. Findings

This study answers the research question as to the extent differences in the patent technology field impact on the financial performance of the firm at the Malaysian firm level. By segregating the patent technology field into two categories, 1) Human Necessities and Performing Operations, and 2) Mechanicals and Electronics, the measurement is based on the patent application and renewal stocks in Ghapar, Brooks and Smyth [32]. The panel model is estimated with panel least squares (PLS), fixed effects model (FEM) and random effects model (REM)

5.1. Diagnistic Test

This study tested for multicollinearity, autocorrelation, heteroskedasticity and misspecification to make sure that our results are robust, unbiased and consistent. As expected, this study found no multicollinearity problem with the patent renewal/ application measures in either of our samples as shown in table 3 and 4

Relating to autocorrelation, this study found serial correlation is present, and this study therefore corrected the first-order serial correlation with autoregressive errors of order 1 or an AR(1) model. This study also took measures to correct for the heteroskedasticity problem. This study chose the White Cross-Section coefficient covariance method to correct for heteroskedasticity in our panel model. This is due to the fact that White's coefficient covariance method gave us the majority of statistically significant explanatory variables compared to seemingly unrelated regression (SUR) and panel corrected standard error (PCSE). Finally, this study also tested for misspecification using the Ramsey [33]. Regressions Specification and Error Test (RESET) and normality of the residuals test of Jarque-Bera [34].

Interestingly, even though the number of observations in the human necessities/ performing operations sample is slightly higher than the mechanicals, none of the model specifications are found not to be misspecified. In the mechanicals/ electronics sample, all three models (models 1, 2 and 3) in this study had at least one effects specification which is not misspecified. All three models based on the patent renewal/ application measures had the REM estimations with a cross-section random effects specification, not misspecified. This situation shows that the internal factors (μ_i unobservable individual effect) in the mechanicals and electronics sample are not correlated with the explanatory variables. On the other hand, this study found the Jarque-Bera [34] normality residual test is not met in all of our specifications. Nevertheless, since our observations are large, this study followed the central limit theorem (CLT) assumptions

5.2. Panel Model Results

Our panel model is estimated using panel least squares (PLS), fixed effects model (FEM) and random effects model (REM). The model specifications were run with two separate samples which consisted of the human necessities/ performing operations technology field sample and the mechanicals/ electronics technology field sample. Both samples had similar R-squared in all model specifications to the samples discussed in the sub-topic of Research Method, even though their number of observations is much lower by nearly 50% - for example 2225 for the all firms sample and 1178 for the human necessities/ performing operations sample. On the other hand, when comparing the manufacturing firms sample with the mechanicals/ electronics technology field sample, the number of observations is nearly 40% lower - 1694 for manufacturing firms sample and 1047 for the mechanicals and electronics sample. The control variables of LNTGA and NAGE are found to have a positively statistically significant impact on the dependent variable in almost all three model specifications (see tables 5 to 10). However, this study found a near singular matrix problem in the mechanicals/ electronics sample with the FEM estimation. This study therefore omitted the NAGE variable from the FEM model in the mechanical/ electronics sample to obtain the parameter estimates.

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Table 3. Correlation Matrix Based on Patent Renewal/ Application Measures – Human Necessities and Performing Operations.

	LNSALES	LNPROFITS	LNPM	APPM	GRANM	APPS	GRANS	LNTGA	NAGE
LNSALES	1								
LNPROFITS	0.881314	1							
LNPM	-0.00688	0.466454	1						
APPM	0.115663	0.110534	0.0174	1					
GRANM	0.094177	0.101364	0.038215	0.075	1				
APPS	0.067081	0.07986	0.04343	-0.00041	-0.0695	1			
GRANS	0.014987	0.020216	0.014726	-0.00897	-0.02395	0.236078	1		
LNTGA	0.898781	0.867824	0.154045	0.147512	0.145262	0.052749	-0.00701	1	
NAGE	0.263487	0.264847	0.067243	-0.01147	0.231225	-0.03744	-0.02828	0.341686	1

*Note: LNSALES, LNPROFITS and LNPM are the dependent variable of three different model specifications; APPM, GRANM, APPS and GRANS are the explanatory variables; LNTGA and NAGE are the control variables. LNSALES, LNPROFITS and LNPM are the sales, profits and profit margin. APPM and APPS are the patents applied for in Malaysia and the U.S. respectively; GRANM and GRANS are the patents granted to in Malaysia and the U.S. respectively; LNTGA is the tangible assets; NAGE is the age.

Table 4. Correlation Matrix Based on Patent Renewal/ Application Measures – Human Necessities and Performing Operations.

	LNSALES	LNPROFITS	LNPM	APPM	GRANM	APPS	GRANS	LNTGA	NAGE
LNSALES	1								
LNPROFITS	0.913438	1							
LNPM	0.010685	0.416716	1						
APPM	0.310318	0.26238	-0.04847	1					
GRANM	0.102939	0.059695	-0.08326	0.473127	1				
APPS	0.267541	0.233795	-0.02315	0.181548	0.169877	1			
GRANS	0.311796	0.235522	-0.11776	0.101896	0.098631	0.319338	1		
LNTGA	0.957354	0.931984	0.151508	0.295359	0.093642	0.251546	0.310047	1	
NAGE	0.271809	0.257042	0.024431	0.006015	0.04672	0.133979	0.084867	0.230394	1

*Note: LNSALES, LNPROFITS and LNPM are the dependent variable of three different model specifications; APPM, GRANM, APPS and GRANS are the explanatory variables; LNTGA and NAGE are the control variables. LNSALES, LNPROFITS and LNPM are the sales, profits and profit margin. APPM and APPS are the patents applied for in Malaysia and the U.S. respectively; GRANM and GRANS are the patents granted to in Malaysia and the U.S. respectively; LNTGA is the tangible assets; NAGE is the age.

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Table 5. Panel Model Result for Model 1 with PLS, FEM & REM Estimations (Based on Patent Renewal/ Application Measures) – Human Necessities & Performing Operations.

Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Estimation	PLS	PLS[(a)]	FEM	FEM[(a)]	FEM	REM	REM
Effects Specification	-	-	cross-section fixed	cross-section fixed	cross-section & period fixed	cross-section random	period random
Explanatory Variables							
C	0.320761*	5.380935***	-2.144443	-4.355525	-3.69591	0.320761**	0.32039
	(0.190116)	(1.308738)	(3.867302)	(4.086912)	(4.550238)	(0.148784)	(0.254738)
APPM	-0.000823	0.027015*	0.042356***	0.038476**	0.037124***	-0.000823	0.002084
	(0.014381)	(0.01575)	(0.009574)	(0.01596)	(0.008396)	(0.011128)	(0.019074)
GRANM	-0.118015***	0.033208	-0.03262	-0.00562	-0.13198***	-0.118015***	-0.11825**
	(0.03645)	(0.037025)	(0.039998)	(0.047017)	(0.048588)	(0.030714)	(0.05317)
APPS	0.10147***	0.07481	-0.016752	0.014308	-0.016816	0.10147***	0.108929
	(0.03053)	(0.057233)	(0.023884)	(0.029119)	(0.020388)	(0.039167)	(0.066845)
GRANS	0.058548	-0.016563	-0.027393	-0.031547	-0.063468	0.058548	0.059862
	(0.051178)	(0.097251)	(0.059673)	(0.079228)	(0.057887)	(0.037008)	(0.063346)
LNTGA	0.968115***	0.639172***	0.747681***	0.634226***	0.733988***	0.968115***	0.969077***
	(0.012863)	(0.086584)	(0.051769)	(0.078951)	(0.059125)	(0.010006)	(0.017063)
NAGE	0.006619	0.027193	0.298601	0.495044**	0.387236*	0.006619**	0.006109
	(0.00436)	(0.012897)	(0.197065)	(0.206992)	(0.223093)	(0.002603)	(0.004442)
R-Squared	0.774437	0.915117	0.929983	0.940893	0.93188	0.774437	0.775277
Number of Observations	1178	1066	1178	1066	1178	1178	1178

*Note: The dependent variable is sales. C is the constant; APPM and APPS are the patents applied for in Malaysia and the U.S. respectively; GRANM and GRANS are the patents granted to in Malaysia and the U.S. respectively; LNTGA is the tangible assets; NAGE is the age. Values shown are the coefficient estimates. Values below the coefficient estimates in the parentheses are the robust standard error. ***, **, and * indicate the significance level at 1%, 5%, and 10% respectively. [(a)] The specification is run with AR(1) correction.

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Table 6. Panel Model Result for Model 2 with PLS, FEM & REM Estimations (Based on Patent Renewal/ Application Measures) – Human Necessities & Performing Operations

Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Estimation	PLS	PLS[(a)]	FEM	FEM[(a)]	FEM	REM	REM
Effects Specification	-	-	cross-section fixed	cross-section fixed	cross-section & period fixed	cross-section random	period random
Explanatory Variables							
C	-3.650614***	-3.108045***	-4.968208	-4.624205	-6.71898*	-3.650614***	-3.650614***
	(0.345586)	(0.89281)	(4.156469)	(4.943603)	(3.579345)	(0.259522)	(0.338929)
APPM	-0.023826	0.009206	0.040296**	0.040801	0.040784*	-0.023826	-0.023826
	(0.018504)	(0.026926)	(0.019747)	(0.031309)	(0.022227)	(0.016511)	(0.021563)
GRANM	-0.058705	-0.033069	0.07936	0.082286	-0.02229	-0.058705	-0.058705
	(0.056977)	(0.095442)	(0.072229)	(0.07635)	(0.07531)	(0.048922)	(0.063891)
APPS	0.118053	0.140019*	0.063203	0.08945	0.060465	0.118053**	0.118053**
	(0.056104)	(0.082786)	(0.051815)	(0.068914)	(0.057635)	(0.058341)	(0.076192)
GRANS	0.095949	0.168685**	0.10862	0.186192	0.09724	0.095949	0.095949
	(0.083215)	(0.07773)	(0.104843)	(0.183602)	(0.101912)	(0.067229)	(0.087799)
LNTGA	1.068035***	1.007785***	0.673611***	0.56421***	0.649133***	1.068035***	1.068035***
	(0.021903)	(0.055244)	(0.072097)	(0.095901)	(0.083663)	(0.016668)	(0.021768)
NAGE	-0.009354**	0.008368	0.348112*	0.412045**	0.449205**	-0.009354**	-0.009354**
	(0.004238)	(0.010104)	(0.194367)	(0.197725)	(0.181656)	(0.004087)	(0.005337)
R-Squared	0.756237	0.858793	0.874101	0.901642	0.877828	0.756237	0.756237
Number of Observations	893	721	893	721	893	893	893

*Note: The dependent variable is profits. C is the constant; APPM and APPS are the patents applied for in Malaysia and the U.S. respectively; GRANM and GRANS are the patents granted to in Malaysia and the U.S. respectively; LNTGA is the tangible assets; NAGE is the age. Values shown are the coefficient estimates. Values below the coefficient estimates in the parentheses are the robust standard error. ***, **, and * indicate the significance level at 1%, 5%, and 10% respectively. [(a)] The specification is run with AR(1) correction.

Table 7. Panel Model Result for Model 3 with PLS, FEM & REM Estimations (Based on Patent Renewal/ Application Measures) – Human Necessities & Performing Operations

Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Estimation	PLS	PLS[a]	FEM	FEM[a]	FEM	REM	REM
Effects Specification	-	-	cross-section fixed	cross-section fixed	cross-section & period fixed	cross-section random	period random
Explanatory Variables							
C	-4.268543***	-5.301705***	-2.371781	-2.582953	-4.420208*	-4.268543***	-4.268543***
	(0.342554)	(0.867938)	(2.273648)	(3.181364)	(2.459335)	(0.245086)	(0.320774)
APPM	-0.003035	-0.00131	0.005989	0.002479	0.012418	-0.003035	-0.003035
	(0.012807)	(0.019541)	(0.016233)	(0.020048)	(0.018976)	(0.015592)	(0.020408)
GRANM	0.029192	0.027014	0.123288***	0.04863	0.116725*	0.029192	0.029192
	(0.042626)	(0.067346)	(0.0471)	(0.058263)	(0.062722)	(0.046201)	(0.060469)
APPS	0.074561	0.10671	0.086471	0.095933	0.09194	0.074561	0.074561
	(0.051071)	(0.07944)	(0.065132)	(0.076597)	(0.0685)	(0.055096)	(0.07211)
GRANS	0.01974	0.054234	0.050489	0.033578	0.072619	0.01974	0.01974
	(0.077904)	(0.094949)	(0.107391)	(0.199106)	(0.104242)	(0.063489)	(0.083096)
LNTGA	0.083128***	0.124954**	-0.121562***	0.048829	-0.080797*	0.083128***	0.083128***
	(0.022111)	(0.051612)	(0.037526)	(0.06663)	(0.04674)	(0.01574)	(0.020602)
NAGE	0.002125	0.01344	0.069134	-0.048805	0.132062	0.002125	0.002125
	(0.005343)	(0.010878)	(0.101837)	(0.108953)	(0.102327)	(0.003859)	(0.005051)
R-Squared	0.025627	0.426405	0.497163	0.592546	0.506541	0.025627	0.025627
Number of Observations	893	721	893	721	721	721	721

*Note: The dependent variable is profit margin. C is the constant; APPM and APPS are the patents applied for in Malaysia and the U.S. respectively; GRANM and GRANS are the patents granted to in Malaysia and the U.S. respectively; LNTGA is the tangible assets; NAGE is the age. Values shown are the coefficient estimates. Values below the coefficient estimates in the parentheses are the robust standard error. ***, **, and * indicate the significance level at 1%, 5%, and 10% respectively. [a] The specification is run with AR(1) correction.

Table 8. Panel Model Result for Model 1 with PLS, FEM & REM Estimations (Based on Patent Renewal/ Application Measures) – Mechanicals & Electronics

Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Estimation	PLS	PLS[(a)]	FEM	FEM[(a)]	FEM	REM	REM
Effects Specification	-	-	cross-section fixed	cross-section fixed	cross-section & period fixed	cross-section random	period random
Explanatory Variables							
C	0.162634	1.95716***	3.844391***	5.427892***	4.325021***	1.779494***	0.162634
	(0.14044)	(0.619938)	(0.867848)	(1.621691)	(1.070468)	(0.430577)	(0.192207)
APPM	0.023367***	0.0205***	0.007788	0.00627	0.008811**	0.007764	0.023367**
	(0.005104)	(0.007886)	(0.004796)	(0.006333)	(0.003845)	(0.007378)	(0.009251)
GRANM	0.02458	0.025599	0.049446***	0.04126**	0.031811	0.038888	0.02458
	(0.020906)	(0.017473)	(0.01525)	(0.018772)	(0.020609)	(0.025815)	(0.037334)
APPS	-0.033032***	0.020059	0.005334	-0.007503	0.002903	0.00377	-0.033032
	(0.00971)	(0.020915)	(0.022443)	(0.025538)	(0.021373)	(0.02355)	(0.027343)
GRANS	0.035759**	0.086447***	0.125329***	0.099514***	0.115099***	0.122153***	0.035759
	(0.01766)	(0.025109)	(0.021119)	(0.029352)	(0.023516)	(0.027623)	(0.039013)
LNTGA	0.942718***	0.824395***	0.757674***	0.66741***	0.729623***	0.821316***	0.942718***
	(0.010259)	(0.04414)	(0.052169)	(0.096257)	(0.063988)	(0.024385)	(0.012102)
NAGE	0.028129***	0.037292***				0.045648***	0.028129***
	(0.003064)	(0.012823)				(0.012592)	(0.003856)
R-Squared	0.892186	0.961329	0.96432	0.973019	0.964678	0.59085	0.892186
Number of Observations	1047	956	1047	956	1047	1047	1047

*Note: The dependent variable is sales. C is the constant; APPM and APPS are the patents applied for in Malaysia and the U.S. respectively; GRANM and GRANS are the patents granted to in Malaysia and the U.S. respectively; LNTGA is the tangible assets; NAGE is the age. Values shown are the coefficient estimates. Values below the coefficient estimates in the parentheses are the robust standard error. ***, **, and * indicate the significance level at 1%, 5%, and 10% respectively. [(a)] The specification is run with AR(1) correction.

Table 9. Panel Model Result for Model 2 with PLS, FEM & REM Estimations (Based on Patent Renewal/ Application Measures) – Mechanicals & Electronics

Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Estimation	PLS	PLS[(a)]	FEM	FEM[(a)]	FEM	REM	REM
Effects Specification	-	-	cross-section fixed	cross-section fixed	cross-section & period fixed	cross-section random	period random
Explanatory Variables							
C	-3.896801***	-4.424141***	0.997305	1.884711	0.212789	-2.786286***	-3.885831***
	(0.176507)	(0.710276)	(1.374049)	(2.060409)	(2.236957)	(0.620448)	(0.270922)
APPM	0.000907	-0.011711	-0.002369	-0.01192*	0.003955	-0.003404	0.002571
	(0.005644)	(0.008212)	(0.005312)	(0.007183)	(0.006715)	(0.01234)	(0.011289)
GRANM	-0.088994	0.046969	0.029238	0.077321**	0.002782	-0.00218	-0.096288**
	(0.060322)	(0.057492)	(0.03633)	(0.036676)	(0.028941)	(0.04456)	(0.047746)
APPS	0.066228*	-0.061194	-0.026928	-0.087842	-0.022026	-0.024318	0.069595
	(0.037159)	(0.073311)	(0.043364)	(0.062955)	(0.044175)	(0.056847)	(0.057494)
GRANS	-0.254154***	-0.164104	-0.208049**	-0.240723*	-0.209232**	-0.23845***	-0.253379***
	(0.046996)	(0.120565)	(0.081376)	(0.13002)	(0.085727)	(0.06061)	(0.056888)
LNTGA	1.050285***	1.068679***	0.786027***	0.740954***	0.831766***	0.960258***	1.050304***
	(0.011507)	(0.033316)	(0.079254)	(0.116184)	(0.130203)	(0.037925)	(0.015994)
NAGE	0.017801***	0.023289***				0.034232**	0.017494***
	(0.003447)	(0.00664)				(0.014296)	(0.005146)
R-Squared	0.874543	0.921384	0.92431	0.942207	0.926208	0.50365	0.875163
Number of Observations	796	645	796	645	796	796	796

*Note: The dependent variable is profits. C is the constant; APPM and APPS are the patents applied for in Malaysia and the U.S. respectively; GRANM and GRANS are the patents granted to in Malaysia and the U.S. respectively; LNTGA is the tangible assets; NAGE is the age. Values shown are the coefficient estimates. Values below the coefficient estimates in the parentheses are the robust standard error. ***, **, and * indicate the significance level at 1%, 5%, and 10% respectively. [(a)] The specification is run with AR(1) correction.

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Table 10. Panel Model Result for Model 3 with PLS, FEM & REM Estimations (Based on Patent Renewal/ Application Measures) – Mechanicals & Electronics

Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Estimation	PLS	PLS[(a)]	FEM	FEM[(a)]	FEM	REM	REM
Effects Specification	-	-	cross-section fixed	cross-section fixed	cross-section & period fixed	cross-section random	period random
Explanatory Variables							
C	-4.367013***	-4.960039***	-2.207597*	-2.659236	-3.391773*	-3.692485***	-4.367013***
	(0.156928)	(0.984108)	(1.142117)	(1.841746)	(1.871437)	(0.573087)	(0.301286)
APPM	-0.023094**	-0.02939***	-0.009435	-0.018155**	-0.003091	-0.01119	-0.023094*
	(0.009555)	(0.010612)	(0.007074)	(0.007392)	(0.007565)	(0.012359)	(0.012578)
GRANM	-0.067548	0.057477	-0.01302	0.052911	-0.033464	-0.025494	-0.067548
	(0.052598)	(0.060301)	(0.04574)	(0.037779)	(0.041301)	(0.044756)	(0.052226)
APPS	-0.003836	-0.091129	-0.007814	-0.073945	-0.001245	-0.014898	-0.003836
	(0.038693)	(0.064034)	(0.036495)	(0.049968)	(0.03904)	(0.057046)	(0.064239)
GRANS	-0.295252***	-0.197426	-0.281012***	-0.28227**	-0.277328***	-0.301479***	-0.295252***
	(0.050559)	(0.129068)	(0.081192)	(0.126812)	(0.085707)	(0.060541)	(0.063042)
LNTGA	0.107774***	0.128895***	-0.023271	0.00297	0.045518	0.058609*	0.107774***
	(0.011123)	(0.047063)	(0.066438)	(0.104606)	(0.109388)	(0.035248)	(0.017875)
NAGE	-0.001922	0.001847				0.004946	-0.001922
	(0.004372)	(0.010491)				(0.012792)	(0.005748)
R-Squared	0.064369	0.459446	0.534289	0.627632	0.541946	0.036084	0.064369
Number of Observations	796	645	796	645	796	796	796

*Note: The dependent variable is profit margin. C is the constant; APPM and APPS are the patents applied for in Malaysia and the U.S. respectively; GRANM and GRANS are the patents granted to in Malaysia and the U.S. respectively; LNTGA is the tangible assets; NAGE is the age. Values shown are the coefficient estimates. Values below the coefficient estimates in the parentheses are the robust standard error. ***, **, and * indicate the significance level at 1%, 5%, and 10% respectively.
[(a)] The specification is run with AR(1) correction.

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5.2.1. Human necessities and performing operations technology fields. In the human necessities/ performing operations technology field, both APPM and APPS have a positive sign to the impact on the firm's sales, but only APPM is statistically significant. On the other hand, GRANM and GRANS both have a negatively statistically significant impact on the firm's sales. The positive impact of patents applied for may signal that the market demand and supply of the patented technology does last from when the patent is applied for until the time the patent is granted. However, the measurement of the granted patents that is based on the renewal behavior may reveal that the granted patents in the territories of both Malaysia and the U.S. are not well being demanded and supplied in the long run, which in turn leads to negative sales.

Surprisingly, however, the negative impact does not continue when this study move into model 2. All of our explanatory variables have a positive significant impact on the firm's profits. This may be due to the fact that the firms that patent in the human necessities/ performing operations technology fields patented the products or processes to be used in the firm to reduce the business costs. This contrasts with the argument in the preceding paragraph, as the patented product or process in this technology field may not be meant for sale directly to the consumers, but to be applied to their own firms. Moving into model 3 with profit margin as the dependent variable, only two variables are significantly reported with APPM having a negative impact and GRANM having a positive impact. The negative impact of APPM may be interesting, as earlier APPM gave a positive impact on both the firm's sales and profits. This may due to the lagged effects which result in a negative impact of APPM on the ratio of the firm's profits to its sales (profit margin).

5.2.2. Mechanicals and electronics technology fields. When comparing the result of the hypotheses development for mechanical/ electronics technology field sample, with the manufacturing firms sample, they are quite similar. The only difference involves one variable, that is, GRANM on the firm's sales with a positive impact in the mechanical/ electronics technology field sample, and a negative impact in the manufacturing firms sample. The significance of all variables in the two samples is also nearly the same. This is unsurprising, as pointed out in earlier that Malaysia has moved into an industrialized nation, with manufacturing industries and mechanicals/ electronics sectors providing the largest portion of manufactured products, as well as those that are exported to other parts of the world. The positive impact of GRANM on the firm's sales also shows that the firms with the patented invention in the mechanicals/ electronics technology field have a place in Malaysia until the patent is granted, and continues giving positive impact as the measurement involves the patent renewal behavior.

6. Conclusion

When comparing between the technology fields, firms that have patents in the mechanical/ electronics technology field have more statistically significant variables in model 2 and 3, compared to the human necessities/ performing operations technology field. If this study refer to the RESET test, the mechanicals/ electronics technology field has model 2 and 3 not to be misspecified compared to all models in the human necessities/ performing operations technology field that are found to be misspecified. Even though the RESET test does not tell us how to correct the misspecification, the results of this study have favor the mechanicals/ electronics technology field. That the result demonstrate more statistically significant variables in the mechanicals/ electronics technology field is unsurprising because Malaysia's largest export in the manufacturing industries is the mechanicals/ electronics technology field. Furthermore, this study also found that manufacturing firms have more statistically significant variables.

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