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Determinants of CO₂ equivalent offset price: A case study of the voluntary carbon offset market in Australia

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Abstract— Carbon offsetting is one of the topical issues in the twenty-first century since climate change has been given priority in the global development agenda. The voluntary carbon offset market emerged in Australia at the beginning of this century. The market has been growing rapidly recently as a result of increased public awareness regarding adverse climate change impacts on the globe. This paper aims to analyse the growth, development and current state of the voluntary carbon offset market in Australia. Furthermore, estimating a linear regression model on the available limited number of observations, this study aims to explain the variation in the offset prices charged by the offset providers. The results of the regression model indicate that more than one third of the variation in the offset price can be explained by the product differentiation in this market. The nature of the offset providers (profit or non-profit), has strong explanatory power too.

INTRODUCTION

Global climate change caused by anthropogenic greenhouse gas (GHG) emission is no more a fiction [1]; it is the reality of this century. According to the Intergovernmental Panel on Climate Change (IPCC) fourth assessment report [2], annual emissions of GHGs (principally CO₂) are still rising and these trends will continue to rise in the absence of proper policy initiatives. In addition, some degree of mitigation through change in behaviour and technology can serve as an important pathway to reduce human induced emissions. Keeping in mind that change in human behaviour can be a part of the solution to reduce anthropogenic carbon emission, the idea of offsetting carbon came into being through the Kyoto Protocol's (KP) flexibility mechanisms namely Clean Development Mechanism (CDM) and Joint Implementation (JI).

CDM requires the countries with GHG reduction targets to produce tradable emissions credits (particularly CO₂) through offsetting projects conducted in developing countries [3]. As a result, CDM brought in the concept of the carbon offset market for the first time since 1997. Carbon offset can be defined as neutralising a tonne of CO₂ equivalent that has been emitted in one place by avoiding the discharge of a tonne of CO₂ elsewhere [4]. The offset market that has evolved due to CDM and JI is mostly a compliance market with a certain cap set for it. In addition to the compliance market, a parallel market has developed known as the 'voluntary carbon offset market', which enables individuals, companies and organisations to offset their part of CO₂ emissions outside the regulatory market [4].

According to the latest study conducted on the voluntary carbon offset market, companies, individuals, event organisers, regional authorities and association are found to be the demand driver of offsets in the market [5]. In the supply side dominance of project developers, offset

providers and retailers are found. Though the market for voluntary carbon offset is smaller compared to the compliance market, it is expanding rapidly with a promising potential due to its possibility to be extended to countries, customers and technologies not considered by the current compliance market. In 2006, more than 10 million tons of CO₂ has been traded in this market with a 200 percent growth rate [5]. Most experts have projected the voluntary offset market as one of the largest commodity market in the upcoming years [6].

One key feature of the market is voluntary carbon offset credits are free of procedural complexities associated with the regulatory scheme [4]. In addition, being relatively new the voluntary offset market is a topical issue requiring further assessments. Therefore, the focus of the study is the newly emerged voluntary market of carbon offset. In particular, this paper analyses the growth, development and current state of the voluntary carbon offset market operating in Australia. Furthermore, the paper quantitatively examines the variation in the offset prices charged by the offset providers in the market by estimating a linear regression model on the available limited number of observations.

The rest of this paper is organised into several sections. Section One discusses the growth and current status of the voluntary carbon offset market in Australia. Section Two highlights the process of product differentiation in the market and hypothesis development. Section Three discusses data operationalisation procedure and model estimation. Section Four discusses the results and finally, Section Five concludes.

VOLUNTARY CARBON OFFSET MARKET IN AUSTRALIA

The voluntary offset market comprises entities such as government departments, NGOs, companies, and individuals which buy or sell carbon credits voluntarily to become carbon neutral. There are no regulatory bindings imposed on these entities involved in trading carbon credits. According to a report of the Ecosystem Market Place [7], though the market for voluntary carbon offset has been effectively operating since 1999, it started evolving rapidly in the last few years. In addition, the year of 2006 is considered momentous due to significant growth in the number of retailers, brokers, and other stakeholders that enter the market. The report further confirmed that over the year 2006 the number of carbon offset providers grew by 200 percent and online retailers were the fastest growing [7]. A total amount of 23.7 million MT of CO₂-e has been traded worldwide over the year 2006. Though the response from businesses to the climate change issue in Australia has been slower than in the US or the UK, the rapid growth in the voluntary offset market is also reflected in Australia and the Australian carbon offset market has a substantial share (10 percent) in this [7].

The primary force that pushed the growth of the Australian carbon offset market was the economic advantage of being proactive in dealing with climate change issues [8]. In addition, there has been a growing awareness regarding the adverse impact of climate change, hence a growing demand from individuals and institutions to become carbon neutral. In response to these drivers the Australian government developed a 'Greenhouse Challenge Plus' program in 2005 to provide help to businesses operating inside Australia to improve energy efficiency and reduce GHG emissions [9]. This program provides technical assistance and support for voluntary emission reduction projects. One feature of the program is the development of the 'Greenhouse Friendly' certification mechanism. In addition to the government initiative there has been a remarkable growth in the voluntary offset market in Australia over the last few years.

A number of transactions take place in any voluntary offset market, including procuring of credits by institutions or individuals from the retailers, purchasing of credits directly from project developers for retirement or resale, and in exchange of credits donating GHG reduction projects by companies [7]. However, in the Australian market offsets are sold in three ways: directly by the carbon offset projects, by the intermediary broker and directly by the service providers. This paper focuses on the offset service provider's part of the market.

At present more than 30 offset providers are operating in the Australian market [10]. They are either involved in project development or direct trading. Offsets are generated through different types of projects. The most commonly found are forestry projects, renewable energy and energy efficiency. Forestry projects or bio sequestrations act as carbon sinks. In other words, in forestry projects trees are planted such that growing trees absorb carbon through photosynthesis. The sequestered carbon offsets the emitted carbon elsewhere. Therefore, individuals or institutions can purchase offsets that are already sequestered or that are expected to be sequestered over the growth period of those planted trees [8]. Due to the long time frame involved in the tree growth and its associated uncertainty, bio sequestration projects are subject to criticism. However, these projects have the potential to deliver carbon offset as well as other ecosystem services such as biodiversity protection, critical habitat recovery, and natural amenity, if they are designed and managed properly.

Biomass, wind, geothermal, and solar are typically involved in renewable energy projects. Carbon offsets are created under the renewable energy scheme by calculating the amount of energy generated that has displaced some GHG emissions. One of the features of renewable energy projects is their long life time. Due to long life these projects continue to offset GHG emissions into the future. They have another benefit in terms of developing an alternative energy strategy for future [8]. Energy efficiency projects work to improve energy use efficiency by introducing efficient processes and technologies to produce same amount of energy. These projects typically involve improving building design, improving energy management technology, installing energy saving appliances, and swapping fuel use options. Carbon offsets are created by calculating the differences between pre and

post energy efficiency adoption measures [8].

In the current offset market, Australian offset buyers and sellers are faced with the quality of the offsets. At present it seems difficult for buyers to differentiate between high and low quality offsets and to be assured that their purchases will offset their emissions. Being relatively new no universal standard for product quality has been developed in the voluntary carbon offset market in Australia. However, there are some certification mechanisms such as the Gold Standard, the Voluntary Carbon Standard, the Australian Greenhouse Office (AGO) Greenhouse Friendly Standard, and Green Power. Each of these standards has a set of rules to determine quality, and hence they vary significantly from each other in terms of certification. The first two are international standards, while the last two are national. Among them the AGO Greenhouse Friendly is the most popular. This standard certifies bio sequestration, energy efficiency and renewable energy projects. In addition, it certifies methane flaring and waste recycling projects. According to the AGO standard, the abatement project must be located somewhere in Australia and should meet the additionality criteria. The AGO does not certify offsets that are sold in advance.

Two major types of providers are active in the current voluntary offset market in Australia. The majority are found to be profit, while a number are non-profit type. The non-profit organizations have been operating comparatively longer than their profit counterparts. In addition, web based marketing has emerged as a key component for all the offset providers operating in the market. Most prefer to circulate information through their web sites considering the flexibility of the online mechanism and advancement in information and communication technology [8].

Comparative information provided by the Global Sustainability Report [8] and the Carbon Offset Guide [10] regarding offsetting services available across Australia shows that there is considerable difference in price charged per tonne of CO₂ offset. According to the report, the bio sequestration project oriented service providers charge less than the renewable energy and energy efficiency focused service providers. However, the report also reveals that verification cost, quality assurance cost, calculation methods, and additional benefits (such as education, administration, and marketing) cost can be the other reasons for price variation across providers [8].

Although this study focuses on the Australian offset providers, variation in offset prices across providers is a general reflection of the global offset market. In the Voluntary Carbon Offset Report based on the UK, it has been considered a drawback of the offset market that for a set amount of carbon, the price of offset can vary depending on the provider used. They argued the absence of standard techniques for calculating quantities, and the pricing structure can explain this variation. In another study Hamill [11] argued that the price per tonne of CO₂ equivalent offset varies primarily due to the difference in cost of conducting a project by the service providers and the type of organisation. Therefore, product differentiation seems to be an important factor in influencing carbon offset price.

PRODUCT DIFFERENTIATION IN THE VOLUNTARY CARBON
OFFSET MARKET

From economic theory, similarities can be drawn between the current voluntary offset market and the monopolistically competitive market. Theoretically, in any monopoly there will be many producers and many consumers, and producers will have some control over the pricing mechanism. Since there are new providers entering each month and new products are developed each week in the current carbon offset market [8], we can generalise the carbon offset market operating in Australia as a monopolistically competitive market. To remain competitive and to influence the market price of their products the offset providers are continuously altering their products through types of projects adopted, accreditation quality and website quality. In this way, each of the service providers is offering slightly different products, which are not the perfect substitute of each other. Therefore, each of the providers has some degree of monopoly power in the market.

Three major types of projects are adopted by most of the offset service providers in the market. The providers who are involved in the bio-sequestration project are generally active in the voluntary market longer and are found to be managing their project with comparatively less expense than the providers who are involved in energy efficiency or renewable energy projects. Further, there is no universal standard for product certification. Therefore, quality assurance is one of the biggest challenges for both the providers and the consumers. Hence, most providers are using their accreditation quality as an important product differentiating factor by being certified by different authorities with different standards. Moreover, web based providers are growing faster than others and website quality is another key differentiating factor for the products offered. Web sites of some providers offer comprehensive information about their projects, methodologies considered, carbon emission calculation process, and accreditation quality. However, there are websites of some providers which are not as comprehensive and informative. Therefore, web site quality also plays a vital role in the product differentiation mechanism.

Based on the theory discussed in the earlier section, theoretical assumption of monopolistic shape of the offset market and product differentiating factors discussed above, the theoretical model explaining the variation in price charged per tonne of CO₂ offset by the service providers can be written as:

$$\text{Price}_i = f(\text{PD}(\text{T_Proi}, \text{Accri}, \text{Webi}), \text{N_Orgi})$$

Where, Price_i refers to the amount of money charged by the providers for per tonne of CO₂-e offset, PD is the product differentiation function which is determined through the types of project conducted by the providers (T_Proi), accreditation quality (Accri), and the quality of the website provided by the providers (Webi), and N_Orgi refers to the nature of organisation (profit/non-profit).

From this theoretical framework, the market for voluntary carbon offset in Australia can be considered as monopolistically competitive with influence on price of the product due to product differentiation. We also note that product differentiation is created through accreditation

quality, website quality and types of projects the providers are involved in. Therefore, it is expected that the price variation in the market can be explained by these variables.

This paper hypothesises that the type of project will have an impact on the offset price such that providers who are involved in the low cost projects will charge less than that of high cost projects. The study further hypothesises that providers with more informative and comprehensive websites will charge more than that of less comprehensive and less informative websites. In other words, the website quality will be positively associated with the offset price. The 'Greenhouse Friendly' accreditation provided by the AGO is found to be dominant in the Australian offset market. The procedure followed by the AGO Greenhouse Friendly is found to be one of the most stringent and expensive. Therefore, it is hypothesised that providers with AGO accreditation will charge a higher price than the providers accredited with others.

In addition to product differentiation, this study also considers the nature of the organization, such as profit or non-profit type, to have some influence on the offset price. If the provider is a profit organisation, it is expected that they will charge a higher price than that of non profit organisation.

DATA OPERATIONALISATION AND MODEL ESTIMATION

Data for this study have been collected from a highly reliable secondary data source, which is the first and only web based independent directory of Australian carbon offset providers¹. The website aims to be a resource for businesses, government agencies, other institutions and individuals seeking information about offsets in Australia. It provides data on 30 offset providers operating in Australia as of 2007 update. The study, therefore, analyses the variation in offset price based on the year 2007 data. The explained variable of this study is the price charged by the offset providers. This variable is operationalised by taking the range of price charged by each of the providers. The range is then averaged to obtain the mean offset price charged by each provider for per tonne of CO₂-e offset.

The explanatory variables of this study are project types, accreditation quality, website quality and nature of offset providing organisation. The variable project types is operationalised by considering the involvement of the providers in different types of projects such as bio sequestration, renewable energy, energy efficiency, and methane flaring. A dummy variable was created to gauge the impact of different types of projects on the price charged by the providers. All the providers not involved in bio-sequestration were labelled as 0, and the providers involved in other projects as well as the bio-sequestration were labelled as 1.

Accreditation was operationalised by taking into account the different certification services adopted by the offset service providers. To quantify the accreditation data another dummy variable was created. For this, providers accredited by the AGO were labelled as 1; otherwise they were labelled as 0. Website quality was conceptualised on the basis of range of information provided, number of linked pages, calculator information, calculation

procedure information, page loading time, degree of interactivity and degree of user friendliness. To operationalise the variable, each of the 30 websites was scrutinised and evaluated on these basis. The websites were ranked as very good, good, average and poor with a label 3, 2, 1 and 0 respectively.

The statistical model of this study is based on the economic theory and hypotheses developed earlier. Therefore, the statistical model through which the hypotheses are to be tested and price variation is to be estimated takes the form:

$$Price_i = \beta_0 + \beta_1 N_Org_i + \beta_2 T_Pro_i + \beta_3 Accr_i + \beta_4 Web_i + \varepsilon \dots\dots\dots (1)$$

Table I describes the explanatory variables and the expected signs of the coefficients.

Table I Hypotheses and explanatory variables

Variable	Definition	Hypothesised sign
N_Org	Nature of org. (non-profit = 1, otherwise = 0)	-
T_Pro	Type of project (bio-sequestration = 1, other = 0)	-
Accr	Accreditation (AGO = 1, otherwise = 0)	+
Web	Website quality (very good =3, good = 2, average = 1 and poor = 0)	+

RESULTS

A multivariate linear model is employed to analyse the variation in the offset price. The statistical model described in 1 is estimated using Stata/SE9.0. The results of the regression analysis are presented in Table II.

Table II Regression results

Variable	Coefficient	t-value	P > t
N_Org	-5.700 (3.11)*	-1.83	0.080
T_Pro	-4.586(2.20)**	-2.08	0.049
Accr	-5.602 (2.12) **	-2.64	0.015
Web	+2.805 (1.21)**	2.31	0.030
No. of obs	28		
R ²	47.05%		
Adjusted R ²	37.85%		
F-statistic	F _(4, 23) = 5.11		
Root MSE	5.55		
Prob > F	0.0043		

*, **, and *** denote statistical significance at 10%, 5% and 1% levels respectively.

The F statistic (5.11) confirms the overall validity of the model at 1% significance level. In addition, the adjusted R² value denotes that more than 38% of the variation in the offset price can be explained by the model. Table II lists the regression coefficients, their standard errors, respective t-statistic and P values. The model has been tested for omitted variables and heteroskedasticity problems. The omitted variable test result does not show enough evidence that the model might lack some important variables. Further, the Breush-Pagan test shows that the heteroskedasticity is not likely to be present. The nature of the organisation is negatively correlated to the offset price. This implies that non-profit organisations charge less for per tonne of CO₂-e offset than profit organizations. In other words, when the provider is a non-profit organisation it charges on average \$5.70 less for per tonne of CO₂-e offset than the provider which is a profit organisation holding all other variables constants. The coefficient is

significant at 10% level with t = -1.83. The finding in terms of the nature of the organisation complies with the initial hypothesis. The type of project is negatively correlated to the offset price as expected. That is, when the providers are involved in the bio-sequestration project, on average they charge \$4.586 less for per tonne of CO₂-e offset than the providers who are involved in other projects such as renewable energy, energy efficiency and methane flaring, holding all other variables constants. The coefficient for types of projects is significant at 5% level with t-statistic = -2.08. Accreditation is found to be negatively associated with the price, as opposed to our initial hypothesis. The negative association implies that providers having accreditation with the AGO are charging less than the providers certified by other authorities. Therefore, it can be interpreted as holding all other variables constant, the providers having accreditation with AGO charges \$5.602 less for per tonne of CO₂-e offset than the providers accredited with other certification bodies. The coefficient is significant at 5% level with t statistic = -2.64. This finding does not comply with our initial hypothesis that AGO accredited providers will charge less than that of other providers. The website quality is positively associated with offset price as expected in the initial hypothesis. Though the coefficient cannot be interpreted specifically due to the qualitative nature of the variable, however a general interpretation can be drawn based on the estimation. Providers with higher quality websites are estimated to charge more than the providers with comparatively poor quality websites who are the same in other respects (including nature of organisation, type of projects, and accreditation quality). The coefficient for website quality is significant at 5% level with t = 2.31.

DISCUSSION AND CONCLUSION

The study was aimed at analysing the growth, development and current state of the voluntary carbon offset market in Australia. The analysis revealed that at present the voluntary carbon offset market operating in Australia is contributing to more than 10 percent of the global offset trading. In addition, the market is expanding very rapidly with a huge influx of offset providers, retailers and buyers of the offsets. The main driver of the growth has been identified to be the economic incentive of holding a proactive stance in the climate change challenge.

In addition, this study undertook an empirical analysis to explain the variation in the offset prices charged by the offset providers. The theoretical analysis showed how the current carbon offset market in Australia is adopting the shape of a monopolistically competitive market with a large number of offset providers and consumers. Based on the theoretical analysis, it was drawn analytically that the offset providers are influencing the price for per tonne of CO₂-e offset by differentiating their products through types of projects, accreditation quality and website quality. Apart from that, the nature of the organisations was also considered to have some influence on the offset price.

Four hypotheses were tested by the study. The undertaken analysis established three of them which were related to the nature of the offset providing organisations, the type of projects they are involved in and the website quality of the offset providers. It has been found that

providers with non-profit type organisation, bio-sequestration type projects and low website quality charge less, and vice versa. However, the hypothesis related to accreditation could not be established. It has been found that providers having accreditation with the AGO charge less than those accredited with others. Finally, the results of the regression model showed that more than one third of the variation in the offset price can be explained by the product differentiation in this market. In addition, the nature of the offset providers (profit or non-profit) can also explain some degree of the variation in offset price.

This study relies on a limited number of observations obtained from a secondary source. However, the statistical analysis of data, choice of variables, operationalisation process, and interpretation of regression coefficients ensures the reliability and validity of the research. Despite all the inadequacy, this study provides an important insight into the offset price debate in the current carbon offset market. In addition, the recent release of the interim Garnaut Climate Change Review makes this study especially pertinent at this time. The research, hence, is timely in contributing to policy suggestions for the carbon offset market operating in Australia. Moreover, it opens up a stimulating area for further research in the field of offset pricing mechanism. For example, a primary data dependent rigorous analysis can be conducted using a wider range of variables to explain the additional determinants of the offset price in the carbon offset market.

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