Option to Expand a Vacant Land Option

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Pricing options (calls and puts) in general is a complex issue, given the assumptions that one has to make and sometime markets are asymmetric. McKean-Samuelson (1965) is the first model that prices a perpetual American option on a vacant land. Years later, Black and Scholes (1973) create a formula to price a call option on corporate liabilities. In the context of real estate discipline, it seems that there is no formula that prices a call on commercial building, specifically office building on a vacant land. The contribution of this study is exactly responding to the latter statement. The results illustrate that the formula of a commercial building on a vacant land is simply two call options—similar to option straddle.

Keywords: call on call, commercial building option, vacant land option

Introduction

Most of the research work that has been established with regards to real estate is focused on housing markets within the South African context. Land economics is for the most part related to either housing or agriculture. There is a lack in the amount of research work that has been directed to the commercial real estate industry. The reason why there is much research and data on the residential market rather than commercial is because South Africa is constituted with more residential properties. Both formal and informal than commercial, i.e., offices. The agricultural aspect of land economics takes more research because the food industry depends on it, and that is one of the biggest industries in South Africa. The country is still seeking for ways to transform and improve the real estate industry.

The main focus of this research project is to attempt to model a more accurate way of pricing the value of an option to expand a vacant land option. This is to be done using a mathematical equation, wherein this value is expressed by three main components. The components are the real-option value of land, the real-option value of a commercial building, and the real -option value of the option to expand the vacant land into a commercial building, i.e., offices. This research undertakes a qualitative and quantitative analysis of available data. The current themes that have been recorded by other researchers and academics with regards to this theme are also both qualitative and quantitative.

The value of an option on undeveloped land as well as the value of an option on a commercial building (offices) can be determined in more accurate ways. In both cases, there is only one underlying asset involved in

the calculations as opposed to the value of an option to expand a vacant land where there are two underlying assets. The land itself, as well as the commercial building. For an option value where the underlying asset is only vacant land, there is a mathematical model that was developed by Samuelson-McKean (1965) and Black Scholes (1973) model.

The value that can be placed on land is based on what that land is going to be used for, in other words, the intention of the potential buyer of the land determines the value as well as the market conditions. Other scholars argue that the value of land without any improvement is however is dependent on the value of the improvement. This further highlights the difficulty in finding land value individually, and the value of an improvement individually (Özdilek, 2016).

The purchase price or value of a building can be determined based on the type of property it is and reason of existence. There are various ways to compute the value of land as well as the improvements on it. Mainly the income capitalisation method, the discounted cash flow method, the sale's comparable method, and the cost/depreciation approach method.

The real option value on land or a developed land would then be a certain percentage of the value of the land or development on it. As an illustration, there is a potential investor who also wants to be a first time homebuyer but is uncertain of the future and does not have funds readily available. This potential investor can buy the option to be able to rent with the intention of owning at the end of the lease period. This is an illustration of a real estate option. The option value is what makes the investment more attractive for both the buyer and the seller; one can say it is the icing on the cake.

The real estate office market in South Africa has had slow traction with regards to investment. In the past few years, however there has been an increase in market participants due to infrastructural improvements such as the rail way, and other efficient transit systems such as the Rea Vaya (Boshoff, 2017). This research paper is based on the second option, which is expansion option, as explained in the introduction above (Sebehela, 2012). It seems that there is an option formula/equation of pricing an option on vacant land.

The contribution of this study is to answer to the following main question. What is the option formula for a commercial building on land that used to be vacant? In answering the main the following three sub-questions are asked: (i) What are some of the macroeconomic variables that influence the value of an office building, (ii) what are the traditional ways of pricing the value of land, and (iii) what are the characteristics of an office market?

The findings are as follows. In terms of the contribution, for this study there is both academic and industry contributions. For academic contribution, the study seeks to model a more accurate way of pricing a particular real option. In this case, an option to expand a vacant land, by identifying macroeconomic variables that drive the value of a commercial building (GDP and interest rate). With the aid of a mathematical equation to arrive at the value, the value is then expressed in three components, which are: the real option value of land, the real option value of a commercial building, and the option value to expand a vacant land. The study will benefit investors, developers, and researchers when it comes to choosing a more accurate tool for valuing a commercial building on a vacant land. This will be in opposition to relying on the application of the discounted cash flow (DCF) alone. On the other hand, the industry contribution shows it is better to value commercial building using ROA because flexible value is captured in that environment. In addition, real options can factor in a strategic element to the decision making of a business, and a dynamic element that NPV and DCF analysis fail to do. One dynamic

element that can be incorporated in capital budgeting is the ability to be able to include points in the future of being able to expand a commercial building on vacant land.

The balance of the article is structured as follows. Section 2 is on literature review. Section 3 is on methodology. Section 4 is data. Section 5 is on analysis and the last section concludes the article.

Literature Review

Background to Valuation Methods

An appraisal formulae is used to derive the formulae for the value of an option; in terms of the value of the stock, this is subject to conditions such as, the interest rate being known, the stock being European, meaning it can only be exercised when it reaches maturity and that there are no costs in terms of transaction (Black & Scholes, 1973).

Subject to conditions or reasonable assumptions, the value of option depends solely on the price of the stock and variables that are constant. From this, it can be concluded that it is possible to reduce the risk of an investment; this is called a hedged position. The hedged position comprises of long position when it comes to the stock and short position when it comes to the option (Black & Scholes, 1973).

To explain further on the hedged position, assume that you are given the price of the stock as R15, and that the value of the option begins at R5; assume that given a regression line, the slope of the regression line is ½. In such a scenario, a hedged position is created, and thus you buy one share of the stock and you will sell two options short. When the hedged position does not change this means there in ambiguity in the value of the equity, with this approaching a finite interval (Black & Scholes, 1973).

Other additional methods are used to derive the formula. The paper takes into account other alternative derivation methods, such as the "capital asset pricing model". This model gives a broader understanding of discounting the value of an option to its present value given a future value. This uses discount rates that are subject to the time and the price of the stock. *Ceteris paribus*, the capital asset pricing model explains the relationship/linkage between risk and the expected return on a capital asset. The expected return behaves in the following manner: It gives the discount rate that should be applied when it reaches maturity or when it reaches the end of the stipulated period of the value to calculate the present value. Subsequently the assets pricing model gives an over-all approach for discounting under conditions that are uncertain (Black & Scholes, 1973).

Corporate liabilities as opposed to warrants are not generally realized or viewed as options. Take for instance a company that has outstanding common stock and bonds, and the only asset of that company is the shares of the stock of a second company; assume that the bonds are pure discount bonds that have no coupon. This gives the right of a fixed amount of money to the holder, provided the company can pay it in 10 years as the rate of maturity, and that the company has plans to sell at maturity, which is in 10 years. With the final assumption, the company does not have restriction on the bonds. In the assumptions mentioned above, it shows that the holders of the stock have the corresponding right to an option on the assets of their company. Consequently, the bond holders own the assets in the company; however the options are given to stockholders so that they can buy back the assets. When maturity is reached, the end of the period or the end of 10 years, the value of the common stock will equal to the assets of the company minus the FV (Face Value) of the bonds; it can either be zero; it also depends which is greater (Black & Scholes, 1973).

There are different kinds of real options, the main types being: expansion, abandonment, and deferral. As explained above, the paper researches on the option to expand on vacant land. To explain further, in terms of

what an expansion option is, it is an option that is generally caused by market conditions; the other two are similar in that they occur due to circumstances that could have been forecasted, or speculated (Sebehela, 2012). According to Sebehela (2012), the increase in an expansion option is due to various factors or parameters, namely the interest rate, the output, uncertainty and variable cost of conversion.

As mentioned above, the paper is purely quantitative; methods to be used for this research problem are based on the kind of problem we chose to attempt. It is a combination analysis because the problem involves both several, numerical, factual data as well as theories and concepts that need to be critiqued and analysed. A method of doing a detailed analysis of journal articles and unstructured interviews with an expert in the finance and investment industry to have a view of industry trends and behaviours.

Development of the Hypothesis

The first question is: Which part of the commercial real estate markets is the largest? Studies reveal that there are major variations in trading activity and the liquidity of variety asset category; based on each asset category, there can be a meaningful difference over a period of time between markets and asset (Devaney, McAllister, & Nanda, 2017). In private real estate, the standard of transaction processes tends to be approaches associated with the prevailing market conditions. Several participants and other parameters such as market maturity and size (Devaney et al., 2017). This study explores the variations in transaction processes among a variety of national commercial real estate markets in Asia-Pacific and Europe.

The core study is to look at how and why turnover changes over a period of time between varieties of commercial real estate markets. In big classes of asset, measures of transaction processes are often the easiest and most widely available indicators of market liquidity (Devaney et al., 2017). There are three key measures of liquidity which are: "time-to-transact", "cost-to-transact", "certainty of market price" (Devaney et al., 2017).

The argument pointed out by the experts is that transaction process may be small in a market not because assets are nearly impossible to sell, however, rather because existing investors prefer to hold at ongoing price standards (Devaney et al., 2017). According to Devaney et al. (2017), there are many measure parameters that describe the relationship between investment performance and transaction activity in the commercial real estate markets.

Based on what has been discussed, a market's standard transaction process is presumed to be directly proportional to real estate investment and vice versa. Investment performance is having to be conducted by the range of real estate market, capital market, and economic variables (Devaney et al., 2017). Determinants measures forecast that the effects of the number of buyers and sellers are expectedly to be directly proportionally related with transaction process (Devaney et al., 2017). This implies a positive relationship between a market's global economic integration and the level of transaction activity is expected. To conclude this study, transaction process is a significant measure of commercial real estate market conditions. Though, it is linked with liquidity, which is more multifaceted concept whose measure is elusive (Devaney et al., 2017). In addition to the analysis, transaction activities tend to deescalate when buyers' and sellers' asset diverge.

This field explores formal and informal participants that affect the time it takes to buy and sell commercial assets. The outlook will be focusing on the Nigeria's major city, which is Lagos. The close information is based on the unique insight into the phases and approximate period (Agboola & Scofield, 2018). Several studies conducted insisted that the issue of time to transact from the seller's perspective must be highly considered (Agboola & Scofield, 2018). According to Agboola and Scofield (2018), in the Sub-Saharan Regions, it is only

the World Bank that is conducting the study it takes to buy/sell commercial real estate from an investor's perspective. To study the participants in the market, Devaney and Scofield (2015) conducted a sample of about 578 commercial property transactions finished between 2004 and 2014; the significant observations is that the median time to obtain commercial real estate is between 104 and 135 days to dispose.

Another observation that was made is that big properties take longer to transact and that longer marketing periods correlate with price discounts (Agboola & Scofield, 2018). In Nigeria, the most highly significant process in the national real estate market is the economic contraction which was brought by the decline in worldwide oil prices in 2014 (Agboola & Scofield, 2018).

The Nigerian analysis divides the transaction activity according to the participants (Ayodele, 2019). The participants involved estate surveyors, appraisers, and commercial real estate attorneys (Agboola & Scofield, 2018). Furthermore, the study reveals two key strategies to obtain commercial real estate in Lagos: "outright purchase" and "joint Venture" (Agboola & Scofield, 2018). These major routes particularly joint venture and give the context of the Nigerian partnership arrangement between a prospective investor and the current owners of the land or property for sale. The second question that one asks is which variables affect the value of commercial building.

Fluctuations and cyclical behaviors are characterized as the returns of direct commercial real estate (Akinsomi, Mkhabel, & Tadera, 2017). These characteristics are caused by different parameters and different commercial real estate has different performance traits. This study explores the information of macroeconomic and property performance parameters in relation to commercial real estate investments in South Africa. According to Baum (2009), the economy and the capital markets are major determinants of the performance of the real estate sector.

Investors need to know the factors that affect a sector's performance in order to create informed investment decisions for the required standard of risk (Akinsomi et al., 2017). About 5% of South Africa's economy is composed of commercial real estate investment (Akinsomi et al., 2017). Among the contributors to the economy's growth, sustainable performance is included, which is significant to the decision that must be made by an investor (Akinsomi et al., 2017). In the case of direct commercial property investment, factors like illiquidity, long-term capital-intensive investments, are considered as low transparency and heterogeneous transactions (Akinsomi et al., 2017). Investment decision-making can be disturbed by low transparency which results from potential distorted information (Akinsomi et al., 2017).

The macroeconomic variables research based on direct commercial real estate has been studied globally. Gross domestic product (GDP) and inflation, are parameters which appear to be important, with regards to positively influencing the returns of direct commercial real estate returns (Akinsomi et al., 2017). In the case of developed markets, employment rate, inflation, and GDP are recurring macroeconomic parameters in research conducted on "determinants of direct commercial investment real estate" (Akinsomi et al., 2017). Literature studies show that there are disparities in the determinants of direct commercial real estate that explain the effect in the developed and UN-develop markets (Akinsomi et al., 2017). "It is also over-simplistic to assume that emerging markets are similar to one another" (Akinsomi et al., 2017). Partly, the values of commercial buildings are affected by valuation methods utilized in valuations.

When making an investment decision in the market, valuation reports for commercial property are major factors (Newell, Najib, & Juanil, 2015). Therefore, what is fundamentally important is to understand the standards of the valuation practice and the quality of the valuation reports (Newell et al., 2015). Some of the

major concerns in the future economy crisis are the lack of understanding in the valuation of properties which can also be associated with risk measures (Newell et al., 2015). This shows that the issue of practice valuation standards has be a problem in recent years. These practices have also been a problem in the United States. In Malaysia, the Institute of Surveyors Malaysia (ISM) uses what is called a surveyor's method to acquire information based on the client's perceptions of the performance of the commercial property valuation report (Newell et al., 2015). By applying the format of client satisfaction survey, it forecasts the significant extent of valuation reports between clients/appraisers (Newell et al., 2015). The knowledge that is obtained from the survey will validate the integrity of the respondents to bring relevant user information based on the client's perspectives of the performance of commercial property valuation reports in Malaysia (Newell et al., 2015).

The traditional techniques in valuation investment are deemed incorrect (Ayodele, 2019). The model of real option analysis (ROA) is considered as a supplemental valuation approach to the traditional valuation methods under the conditions of irreversibility and uncertainty (Ayodele, 2019). According to this study, it has been noted that several investment appraisers are not prepared to create a paradigm approach to the incorporation of ROA into the investment valuation (Ayodele, 2019). The study reveals that the use of ROA in the UK appears to be uncommon even though it displays a significant role in the valuation approach. Among the issue that was deemed, is that ROA includes complex studies of mathematics/finance models which cause difficulties with regards to understanding and adoptability (Ayodele, 2019). The other problem included is that the increase in complexities in the financial studies also creates uncertainty. The study also suggested that there are not too many theories that breakdown the grounds between academics and industry stakeholders (Ayodele, 2019). Furthermore, the lack of support from top management makes it difficult to use ROA as an investment appraisal approach. In conclusion, the lack of expertise in the field of real option serves as a barrier to use the model for investment appraisal. In the context of option pricing, numerous methods have been used for some time now.

Many models that have been used before such as Black and Scholes (1973)—including The Cox-Ross-Rubinstein (1979) can all be regarded as golden level of option pricing (Belze, Larmande, & Schneider, 2019). There are differences among these models that have been noticed. They are all in common with Nobel's strategy of a price based on full replication hedging (Belze et al., 2019). When using the Black and Scholes (1973) there is a "risk model" that is arising (Belze et al., 2019). This kind of risk, associated with the assumptions created in the model, results to the reliability of option fair value predictions when transaction costs are substantial (Belze et al., 2019).

It has been noted that Black and Scholes (1973) cannot give a reliable estimation when transaction costs are processed; therefore, the approximation made by companies to cope with these frictions may be biased or unverifiable (Belze et al., 2019). The model risk is different from the other kinds of risks like "parameter risk"; however, the model may be correct, but its date may be badly forecasted. From the analysis, it is important to distinguish when transaction costs occur, when trading the frontline stock occurs, and when trading the option occurs (Belze et al., 2019).

Since Black and Scholes (1973) can predict the transaction at zero cost, the significant factor is the transaction costs affecting the underlying stock. The replication notion pricing is called into question, which gives rise to issues as to the correction of the fair values created by the Black-Scholes model (Belze et al., 2019).The analysis shown by the finance literature indicates that an interval of possible prices now can be found for the option without possibility for riskless arbitrage (Belze et al., 2019).It can be concluded that from

the results acquired, depending on which piece is selected, the possibility of fair value management exists (Belze et al., 2019).

Key Findings from the Literature Review

Key findings are as follows: Improvements on the land such as a building are proven to have a positive effect on the value of the land; it increases the options value on the land. Although this is true, the increase of an option vale due to a number of economic variables such as interest rate can be proven to be disputable. The literature that has been studied states that the most common option that one can find in the real estate industry or development is both the expansion and abandonment option.

In unusual cases, compound options do come up in the real estate development and the construction sector. According to Sebehela (2012), the owner of an empty stand or unused land can benefit from applying the real option analysis, to value their land, because there is more value obtained from the real options analysis. It is without a doubt that the market does tend to understate the difference in variance when it comes to valuing or rather pricing an option. It is either undervalued or overvalued hence the usage of real options is not vastly used; a more common approach is the discounted cash flow among stakeholders, companies, and investors.

Methodology

Introduction

The value of real option is one that is still not quantifiable when being considered alone, outside of other factors. This is mainly because of the research gap that exists, which the lack of studies is done on this particular topic. Most of the studies that have been carried out, on real estate are on Nigeria, despite the fact that South Africa has the largest real estate market in Africa. The normal traditional way of valuing a potential investment project is the discounted cash flow (DCF) method of discounting future cash flows to their current value using a discount rate that reflects the risk associated with that project. Although, this method has been used and trusted in the industry, it fails to capture in the flexibility associated with a project. It does not record other factors that can cause a project to strive. The DCF does not take into strategic investment decisions of firms. It has also been found that real options can be considered as divisions of investment, however only if the cost of the option is less than the value of the option (Trigeorgis & Reuer, 2017). This in simple terms implies that, real options are investments; however, there are intimidating problems that arise with the implementation of real options as potential investment.

Models

The pricing of options and corporate liabilities. The Black-Scholes (from here, B-S) model was formed by Fischer Black and Myron Scholes in 1973. According to Black and Scholes (1973), an option is explained as a security that affords the right to be able to buy or sell an underlying asset, subject to certain conditions. Mathematical modelling allows us the opportunity to be able to solve real world situations and scenarios. In this research, one focuses on a theoretical scenario. The study focuses on modelling the option to expand an option on a vacant land. In this quest to find an equation that prices the value of this particular real option, the study makes a few key assumptions to help us eliminate some factors that may make it challenging to construct a formula for this option value. Thus, the study considers the variables that are of utmost importance to our chosen theme.

B-S model. The formula for Black-Scholes model is as follows:

$$C = S_t N(d_1) - Ke^{-rt}N(d_2) \tag{1}$$
$$P = Ke^{-rt}N(-d_2) - S_t(-d_1) \tag{2}$$

where

$$d_1 = \frac{\ln\frac{S_t}{K} + \left(r + \frac{\sigma_v^2}{2}\right)t}{\sigma_s\sqrt{t}} \tag{3}$$

and

$$d_2 = d_2 - \sigma_s\sqrt{t} \tag{4}$$

The B-S model requires five input variables: the strike/exercise price of an option, the current stock price, the time to expiration, the risk-free rate, and the volatility. From the above formulas: $C(P)$ represents the call (put) option price, S is the stock price, K is the exercise price, t being the time to maturity, σ_v^2 is the variance rate of return on the on the stock. The cumulative normal density function is the natural logarithm ln. and $N(d)$ at which N is normal distribution. Unknown parameters are represented by Ke^{-rt}. And, lastly there is r as the risk-free interest rate.

Samuelson-McKean (1965) Model

The model was developed by Paul Samuelson and his mathematician partner Henry McKean at in 1965; the model was derived as a perpetual American warrant. This model is the most popular when it comes to land valuation (Samuelson, 1965). An American option can be exercised at any given time up to the point where the date of the option reaches expiration, as opposed to the European option which is exercised at a specific time (Black & Scholes, 1973). The Samuelson-McKean (from here, S-M) model works as a model for land because land never expires, hence perpetual and improvements/developments can be done at any time by the owner.

Samuelson (1965) used an understanding from the Bachelier's absolute—Brownian motion of how the office prices change in relation to future commodities and common stocks in the United States of America. Algebraic sign-patterns and table of random numbers like head and tail toss are commonly recognized (Samuelson, 1965). The variables that are involved are: the buyer of the stock, the stock itself, the necessarily-matched resultant of buyer's, and seller's pressures to form (Samuelson, 1965). The formula for S-M model is:

$$\text{Land} = (V^* - K)\left(\frac{V}{V^*}\right)^\eta \tag{5}$$

where V^* is the critical value of the developed property below which the land should be held undeveloped for the time being and above which is optimal to develop the land immediately. K denotes construction cost, V is the value of the building and η denotes option elasticity measure and; $\eta = \dfrac{\left\{y - r_f + \frac{S^2}{2} + \left[\left(r_f - y - \frac{S^2}{2}\right)^2 + 2r_f S^2\right]^{1/2}\right\}}{S^2}$, where r_f is the risk-free, y is the dividend yield rate (i.e., return on equity in this case), and S is the volatility of revenues.

Analysis

Introduction

Based on prior studies, the foundation, walls, and roofing are affected by three variables: (i) GDP, (ii) interest rates, and (iii) unemployment. Note that unemployment is exogenous variable while GDP and interest

rates are endogenous variables. Based on Eq. (5), the parameters of S-M model are all endogenous. In the option elasticity for S-M model, the interest rate is a risk free one. This study takes real interest rate (r_r) as suggested by the prior studies as real estate is affected by r_r, similar to consumer price index (CPI) and/or consumer price index excluding mortgage costs (CPIX).

Formulation

One assumes the following: Firstly, investors own the commercial real estate building; therefore, it is a call option. Secondly, the building will be there forever, i.e., perpetual. This makes the building to be consistent with the land option as it (i.e., land option) is perpetual. Similarly, the building is an American option. Thirdly, the two options (i.e., land and commercial building options) are additive. And, that leads to investment in the total option. Fourth, in order to simplify the calculation, land option is represent by A and commercial building option by B. The latter statement implies:

$$A + B = B + A \tag{6}$$

where $A \equiv land\ option = (V^* - K)\left(\frac{V}{V^*}\right)^\eta$ and $B \equiv C_{com} = S_t N(d_1) - K r^{r_r T} N(d_2)$. In Eq. (6), C_{com} is the commercial building option. Based on Eq. (6), then one has:

$$= \underbrace{\left[(V^* - K)\left(\frac{V}{V^*}\right)^\eta\right]}_{A\ (i.e.Land\ Option)} + \underbrace{[S_t N(d_1) - K r^{r_r T} N(d_2)]}_{B\ (i.e.C_{com})} \tag{7}$$

Note that in Eq. (7), r_f is replaced by r_r for reason stated earlier on. Remember that

$$\eta = \frac{\left\{\overset{(1)}{\overbrace{y - r_f + \frac{S^2}{2}}} + \left[\left(\overset{(2)}{\overbrace{\left(r_f - y - \frac{S^2}{2}\right)^2}}\right) + \overset{(3)}{\overbrace{2 r_f S^2}}\right]^{1/2}\right\}}{S^2}.$$ Looking at η, one can see that as interest rate increases, *ceretis paribus*,

part one of η decreases, part two increases, and part three increases. The latter statement explains the effect due to changes in interest rates. Now, take into account changes in GDP. When GDP increases, then the entire option value increases. That implies that the full/total option has minimum and maximum values. Based on the earlier argument of option on land, the study focuses on changes in B not A as A is already there. Thus, one looks on how GDP and interest rates affect B. Firstly, changes in call option with respect to (w.r.t.) interest rates:

$$\frac{\partial C}{\partial r_r} = 0 + r_r K e^{(r_r - 1)T} N(d_2) \tag{8}$$

$$= r_r K e^{(r_r - 1)T} N(d_2) \tag{9}$$

Note that in Eq. (9), the r_r decreases the discounted exercise price over time. Thus, the option gets smaller. Now, changes in call option w.r.t. GDP:

$$\frac{\partial C}{\partial GDP} = S_t N(d_1) - K r^{r_r T} N(d_2)|^H \tag{10}$$

Where $|^H$ symbolises that increase in GDP increases the C_{com}. Here, GDP acts like an underlying asset. Fundamentally, commercial building and vacant land options are two options together-call on call option. Thus;

$$O_{Total} = [S_t N(d_1) - K r^{r_r T} N(d_2)] + [S_t N(d_1) - K r^{r_r T} N(d_2)] \tag{11}$$

where O_{Total} is the total option value.

$$= 2[S_t N(d_1) - Kr^{r_r T} N(d_2)] \tag{12}$$

Eq. (12) illustrates that when building a commercial building on vacant land, the value of vacant land increase twofold. Peiser (1987) found that buildings increase values of vacant land. Thus, the finding of Eq. (12) is consistent with prior studies. Put it simply, the option value of a commercial building on a vacant land it is simply the value of a long call option put together twice.

Conclusion

This study explored the macroeconomic parameters that are affecting the value of the commercial property. The commercial building is split into three, i.e., foundation, walls, and roofing. The parameters were mainly focusing on these three phases of the building. The study investigated the following macroeconomic variable: gross domestic product (GDP), unemployment, and interest rate. It is significant to notice that unemployment is exogenous variable while GDP and interest rates are endogenous variables. This study takes interest rate suggested by the prior studies as real estate that affects building in industry like CPI and/or CPIX. The study shows that when building a commercial property on vacant land, the value of the vacant land increases by two folds. Furthermore, the option value of a commercial building on a vacant land is simply the value of a long call option put together twice. Based on the hypothesis, the study finds that considering changes in GDP, when GDP increases, the entire option increases. When GDP decreases, the entire option decreases. This implies that the full or total option has both the minimum and maximum values. The B-S equation for the warrant is impartial of the expected on the stock price. This implies that if there are two investors with a variety of assessments of the expected return, therefore, both will settle on the correct warrant price for a given stock price level. The massive analysis of the B-S is the ongoing-trading assumption since the instantaneous in the only limit of the stock price perfectly and warrant price. This is needed to establish a perfect hedge. It is significant that the option price satisfies the B-S equation; otherwise, this will form a chance for arbitrage profits.

The application of option pricing in the valuing of real estate assets is usually overlooked due to other forms of valuation existing such as discounted cash flow method. These traditional methods such as DCF are not always efficient as they can sometimes underestimate the value of certain real estate assets, especially those that have to do with business activities. The application of real options can give business partners and executives an opportunity to make more financially sound decisions about future investments.

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