

**Optimal phasing: a deterministic and probabilistic analysis of different real estate development profiles**

by

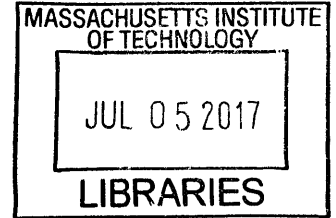
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**ARCHIVES**

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## **ABSTRACT**

The ever evolving macro and microeconomic environment makes real estate developers evaluate their development strategies. They do so in order to generate a maximum present value of profits from their projects. More importantly, they want to avoid completing the projects in an unfavorable environment and missing the financial targets. As the complexity in the production of a real estate project increases, orchestrating the various parts becomes even more important in reaching the desired financial outcomes. Hence, phasing plays an important role as it brings the flexibility to break the whole project into various parts or phases, which could function as standalone entities with or without other parts or phases. And so, it is important to consider how to delineate the project components between the various phases to achieve maximum profitability? The model developed here provides a framework for users to arrive at an optimal phasing scheme for their proposed projects. It is a transparent, easy to use model, which can help a user understand the value generating parameters while evaluating various schemes. It helps one conduct a deterministic analysis, i.e. without uncertainty, to explain the impact of four different parameters – project production profile and duration, real estate cycle periods and phases – on the phasing flexibility of a project. Eventually, a user can run probabilistic analysis including uncertainty in the real estate cycles and phases to determine an optimal phasing. The output from the deterministic analysis combines large amounts of data in a graphical array bringing clarity in phasing decisions. Finally, the probabilistic analysis combines information from the deterministic analysis helping the user arrive at the optimal phasing.

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## INTRODUCTION

Real estate developers are constantly wrestling with the question of how much product to build in each of their development projects. Assuming no regulatory constraints and enough demand for the new supply to be absorbed, it is profitable for the developers to build as much and as fast as they can in order to realize the maximum present value of profits from those developments. However, the key point in the previous statement is the word “assuming”. In reality, the future is highly uncertain; developers never know for sure how much demand there would be for a built asset when it is complete. And, real estate products, especially large, multi-building developments, follow complicated routines with numerous steps required to be completed before the delivery of a product. Therefore, it is natural to contemplate dividing large, multi-building, projects into phases or parts. Not all parts or phases in the development should be fully committed to up front in advance. Flexibility can, and usually does exist, to delay, or even ultimately abandon, parts of a large, multi-building project. That raises an important question that this thesis tries to address: What is the optimal way to phase large, multi-building projects under uncertainty such that the developer maximizes the value of this phasing flexibility?

### 1. THE BASE PLAN, PHASING AND EXPANSION OPTIONS

A real estate project has various physical components (infrastructure, buildings, landscape, etc.) that come together to form a successful development. In this section, we discuss the two different component conceptualizations in any project: one type, we refer to as “phases” within or inside of a base plan and the other as “expansion options” beyond or outside of the base plan. However, in order to better understand these two conceptualizations, it is first important to understand what is meant by the term base plan. The “Base Plan” essentially reflects that part of the proposed development that the developer is fully committed to completing and thus has a very high probability of realizing either now or in the future whenever the conditions are favorable. For example, one might say with 90% confidence that all phases in the base plan will get built eventually. And so, phasing refers to those parts that constitute the base plan, whereas, expansion options are those that are in addition to the base plan. We next move to a detailed discussion of phasing and expansion options:

- a) “*Phasing*” of a real estate development project means dividing the project into two or more parts or phases with the flexibility to delay the start times of each of those parts or phases. Its two main characteristics are: firstly, the overall project is divided into a few discrete phases or parts, either different or similar, which are self-sufficient and can generally operate independent of the other parts; and secondly, once started, a phase must be completed. A phase is an integrated complex that cannot function well unless at least that specific phase is completed. These phases may be planned as parallel or sequential in their temporal relationship with one other. Parallel phases can be built in any order, they are not temporally dependent whereas, the sequential phases are dependent upon each other. As an example, Phase 2 in a project cannot be started until Phase 1 has at least started and has reached some degree of physical completion or full operation. Thus, with sequential phasing, there is temporal order and dependency between the phases. The sequencing may arise due to physical reasons,

or it may arise due to the economic or urban planning reasons. It is the sequential phases that form the subject of this thesis.

b) “*Expansion Options*” on the other hand, is a kind of embedded option that allows the developer to expand the project in the future. The expansion options should be thought of as an additional phase or phases in a project that would get built if the “base plan” outcome turns out to be favorable. A developer might plan for an expansion option rather than put everything in the base plan with a subsequent phase because of various reasons:

- (i) Lack of sufficient expected demand (sales, absorption) within a reasonable span of time;
- (ii) Lack of sufficient supply capacity, that is, lack of developer’s ability to produce the quantity of product envisaged including the expansion product, either due to management, operational resource or financial constraints;
- (iii) Functional desirability of allowing a self-sufficient internally coherent Base Plan part of the project to be completed and operated for a while perhaps reaching some threshold of maturity or occupancy prior to finalization of plans for contingent remainder of the project (the expansion option), i.e. desirability of learning from the experience of the completion and operation of the first (Base Plan) part of the project before deciding what to do with the rest (and when).

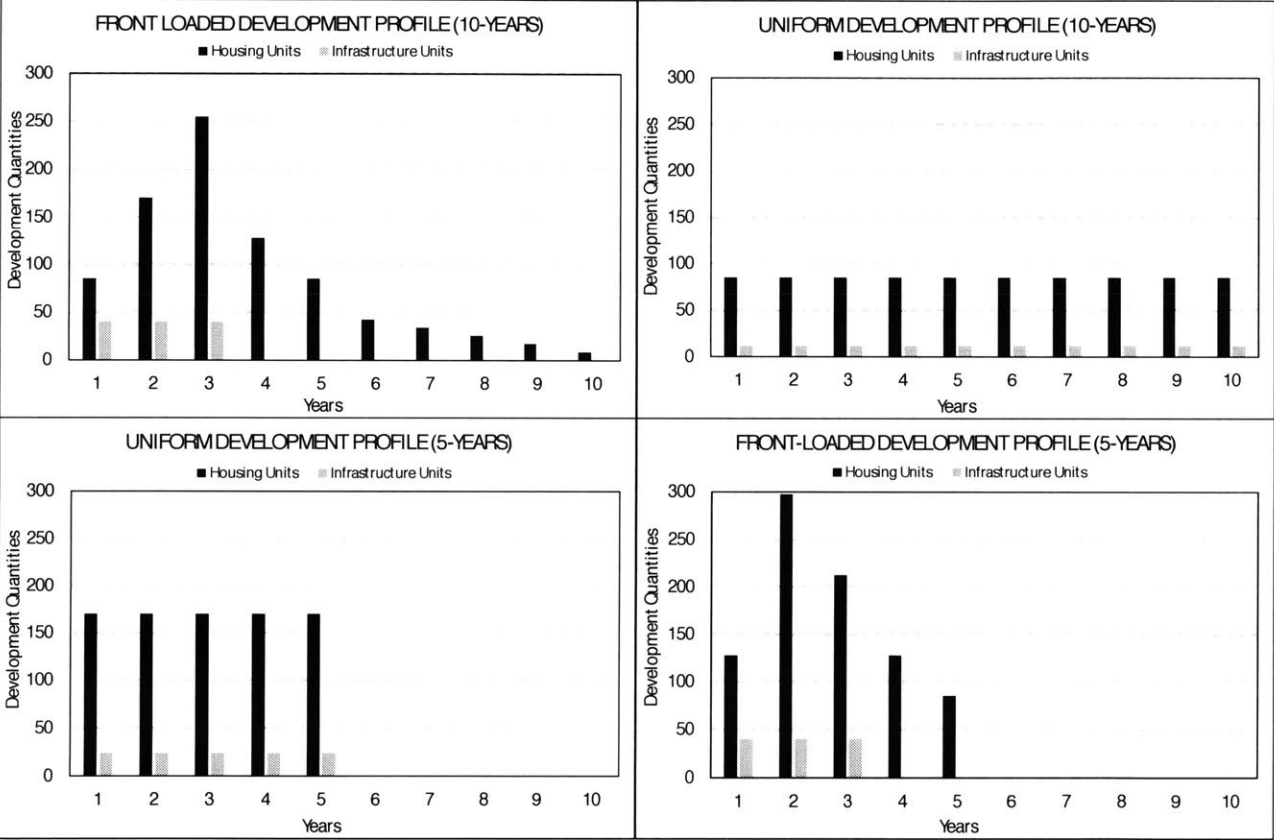
Essentially, expansion options are very similar to phasing of real estate developments. Vertical expansions can be viewed as a two-phase sequential project with the first phase being the base building which contains the option for the second phase (Vertical Expansion). On the other hand, horizontal expansion option is the option to build an additional new project which can be considered provided the necessary land is physically available (and then the option can be valued to check if the land can be bought for  $\leq$  that option value). A distinguishing feature between the two is that phasing is “defensive” in nature, as it helps one delay a phase in the face of unfavorable circumstances; expansion options, on the other hand, are “offensive” in nature as they present the option to go over and beyond the initial commitment in the face of favorable outcomes.

After making the planning distinction between phasing and expansion options, we move forward and answer the optimal phasing question, i.e. how to phase a project to get maximum value of flexibility from the defensive option to delay phases within the base plan? As we show in the analysis that follows, the answer to this important question can change from market to market, the current phase of the real estate cycle and finally, the temporal development profile (governed by physical constraints on the delivery of the real estate product). As we show, the analysis can reveal some important non-intuitive pieces of information to benefit the financial strategy of a developer.

## **2. METHODOLOGY**

The question of optimal phasing can be further split into two sub-parts: (a) how many phases should a project be broken into? and (b) once the number of phases are decided, how to delineate between those different phases? The first question is outside the focus of this thesis. Logically, start-delay flexibility i.e. the ability to delay the start of a project, creates maximum value followed by splitting a project into two phases with the option to delay the second

phase in case the flexibility to delay the project start does not exist. Beyond this, adding any more phases, holding the project scale constant, does add value, but it does so with a diminishing marginal benefit. As an example, converting a two-phase project into three phases adds value but not nearly as much as converting a single-phase project without start delay flexibility to two phases. With this thesis specifically, we try to answer the second question, how to delineate the phases, and gain some insight. We can do this most effectively by considering the simplest case of a project with only two phases. Insights we gain from the two-phase case should be useful for building our general intuition about the principles of optimal phase delineation.



**Figure 1. Four archetypical real estate development profiles.**

We start by identifying four archetypical development profiles to model the essence of the physical production of a project. The “development profile” refers to the relative rate of production of the project’s overall built space, whenever the project is “active” (i.e. it has not been delayed). For example, two different development profiles would be where 75% and 25% of the built space is produced in the first 25% of the active construction duration. The former would be a “front-loaded” profile, while the latter would be a “uniform” development profile. Figure 1 depicts the two archetypical development profiles: front loaded production profile (top left and bottom right panels) and uniform production profile (top right and bottom left panels). The front-loaded profiles have a peak rate of production closer to the start of the project with much smaller quantities produced towards the end. Compared to this, a uniform-loaded profile represents a uniform rate of production throughout the lifetime of the project. An

example of a front-loaded project would be a project that involves a first building that is 40 stories, followed by another one that is 20 stories; a uniform project would be suburban housing over large tracts of land wherein the developer keeps on developing housing units as the demand appears. Finally, the two top panels are 10-year projects and the bottom panels are 5-year projects. The 5-year and 10-year durations are representative of typical project durations for a majority of the real estate development projects and the two production profiles would seem to span the typical production patterns.

Next, we consider all the possible two-phase combinations into which the above four profile combinations could be divided. We start with a scheme that has no phasing, i.e. the entire project is developed in a single phase. Now, if this single phase project has no start delay flexibility, then we have an extreme scheme which forms the benchmark against which all the other phasing schemes would be evaluated. If the project does have start delay flexibility, it can benefit from this, but once implemented, such a flexibility does not exist for the remaining part of the project. We call this “Scheme 0”. From here on, all the other schemes would have two phases and the first phase in each of those schemes would have no timing flexibility; it must start immediately and finish without any delay. To further explain this scheming mechanism, in “Scheme 1”, phase 1 would consist of first years’ production and the remaining would be placed under phase 2. Similarly, in “Scheme 2”, phase 1 would consist of the first two years’ of production while the remaining would be placed under phase 2, and so on. Thus, the 10-year development profiles consist of 9 and the 5-year profiles consist of 4 such two-phase combination schemes. In addition, each of these profiles have the scheme with complete project start delay flexibility. Thus, we evaluate 5 alternative phasing schemes for 5-year development profiles and 10 alternative phasing schemes for 10-year development profiles against the respective single-phase, inflexible benchmark schemes.

The next step for this analysis is to evaluate the interaction of all the two-phased combinations of different profiles with the real estate cycles. We choose four cycle periods – 5, 10, 15 and 20 years; the cycle periods range from being equal to the short duration five-year base plans to twice the duration of the ten-year base plans. Finally, in order to develop our intuition of the financial outcomes (i.e. NPV or IRR of the individual two-phased combinations of different profiles), we test four deterministic phases of real estate cycles as shown in Figure 2: mid-cycle heading up, peak heading down, mid-cycle heading down, and bottom headed up. There are various other determinants of flexibility value in the real estate projects such as the delay decision rule, opportunity cost of capital, volatility in the property markets etc. however, for the purpose of evaluating the question of phase design, we start by focusing on the four specific determinants for now i.e. development profile types, development duration, real estate cycle period and phase. Later in the thesis, we add uncertainty into this analysis.

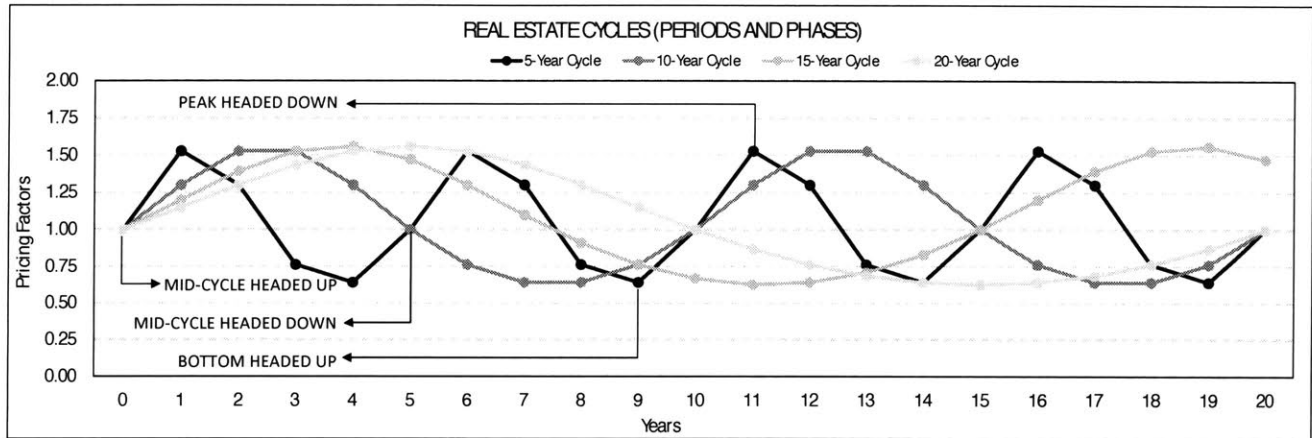


Figure 2. Real estate cycles (periods and phases).

### 3. RESULTS

This section summarizes the overall results of this analysis. Figure 3 conveys the results graphically; it is a systematic array of graphs and is based on the flexible project NPV compared to the single-phase, inflexible benchmark scheme. We obtain similar results if we use the IRR metric, however, it is the NPV results that we present here.

We start with a description of the organization and the information conveyed by the array of graphs in Figure 3. At a broader level, the four rows of graphs represent the resulting NPV (flexible minus the inflexible NPV results) for the four archetypical development profiles, also shown in the extreme right column. Starting from the left, the first four columns of graphs show the NPV results when the four development profiles interact with the four deterministic phases of the real estate cycles. So, the graphs in column 1 summarize the results when the real estate cycle is in the mid-cycle phase headed up; column 2 shows the results when the real estate cycle is at peak headed down phase; column 3 shows the results for the real estate in mid-cycle headed down phase, and column 4 is for bottom headed up phase. The final column of graphs i.e. column 5 represents the averages of the results across all four real estate phases. Within each of the charts, the vertical axis represents the four different real estate cycle periods (5-year, 10-year, 15-year and 20-year cycles) that we have chosen for our study. Also, 0 and 25 on this axis have no significance, they were required to setup the results. The horizontal axis represents the different two-phase schemes described earlier in Section 2. On the extreme left of this axis is the NPV results of a project with complete start delay flexibility relative to the inflexible benchmark (represented by the 0 tick mark). Moving to the right, we see the NPV results of other two-phased schemes. Hence, for a 10-year development profile, we see results for 10 alternative schemes and for the 5-year development profiles, we see results for 5 alternative schemes. The last point on the horizontal axis represents the inflexible benchmark, therefore, show no NPV gains. Again, -1 and 10 on this axis have no significance. Each point within the graphs thus represents a result when a particular phasing scheme is applied to a particular base plan duration and profile, in a particular real estate cycle phase and real estate cycle period. Finally, the diameter of the dots represents the relative magnitude of the NPV to the inflexible, single-phase benchmark scheme. The solid dots represent a positive NPV while the hollow dots represent a negative NPV.

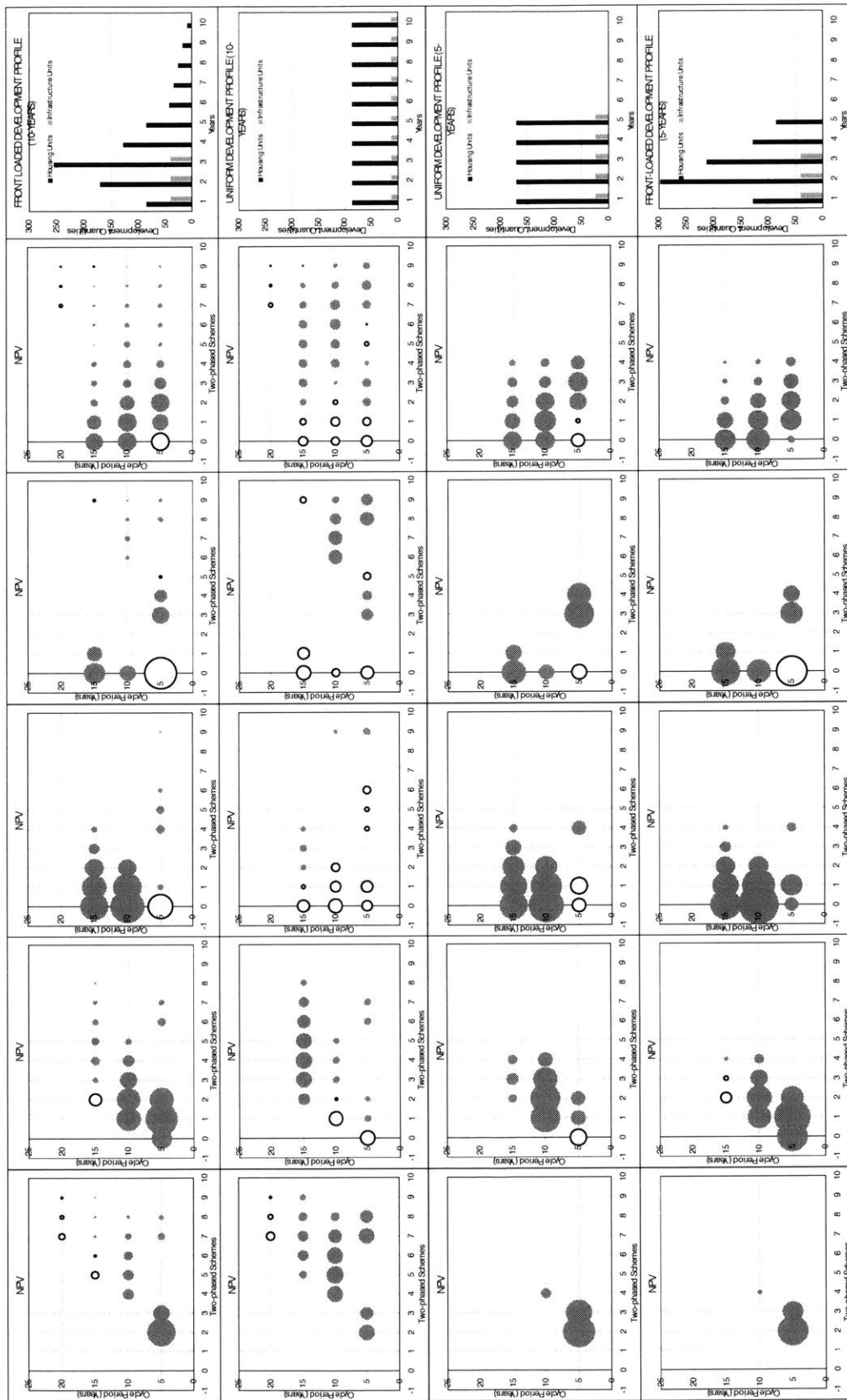


Figure 3. NPV difference between flexible and inflexible cases (deterministic cases).

The observations from the graphs above can be classified into two broad categories: one relating to development profiles (front-loaded and uniform profiles) and project duration (5-year and 10-year), and the other related to real estate cycle periods (5-year to 20-year) and cycle phases (mid-cycle heading up, peak headed down, and so on). In the sub-sections below, we present and discuss these observations:

**A) Development project profile and project duration related observations:**

- a) Shorter or front-loaded projects (i.e. projects in which all or most of the product is produced in the first few years) gain substantially from the delay flexibility and phasing, provided most of the project's production has start-delay flexibility. In other words, either place all of the product in a single phase and give that phase start-delay flexibility, or else if the project does not have start-delay flexibility, then place most (almost all) of the project in a second phase that has delay flexibility.
- b) The only exception to the above observation is seen in long-duration uniform development projects. Such projects gain very little, if at all, from delay flexibility or phasing. They are largely unaffected by the cycle, as their uniform production and long duration provides a sort of "profitability diversity" across the cycle; profits lost in one period are made up for in the next period. In fact, they could actually lose from a highly profit-sensitive decision rule (i.e. a decision rule that makes the developer delay a project sensing the first signs of a loss) delaying a project when the real estate cycle is at the peak or mid-cycle, heading down. This suggests that in such long, uniform projects, the developer shouldn't worry too much about delaying the project during a downturn which is eventually followed by an upturn.

**B) Real estate cycle period and cycle phase related observations:**

- c) In general, gains in NPV are smaller for shorter duration (5-year) real estate cycles, increasing for longer-term (10 to 15-year) cycles and finally completely disappearing for extremely longer-term (20-year) cycles. However, this general observation changes based on the phase that the real estate cycle is in. The general case described above occurs when the real estate cycle is at a peak or mid-cycle headed down phases, but during a mid-cycle headed up phase, it's the shorter term (5-year) cycles that see the maximum gain in NPV value.
- d) The majority of NPV gains are when the real estate cycle is at a peak or mid-cycle headed down phases indicating that it helps to either delay the projects entirely (i.e. project start-delay flexibility to ride out a mid-cycle headed down phase) or to build the first few years of planned development (just before the cycle enters the mid-cycle headed down phase from the peak headed down phase) in order to successfully ride out the downturn.
- e) Building further on the intuition of the impact of real estate cycle phases upon when the project starts, we find that:
  - if a project starts in a mid-cycle headed up phase, then the gains in NPV are achieved by setting aside later years' unit deliveries in the second phase. This is because the cycle is currently on an upswing and delaying units upfront does not lead to any gains in the NPV. On the other hand, delaying later period units closer to when the cycle enters the downswing mode can add a lot of value to the projects financial outcomes.

- if a project starts in a peak headed down phase, it still has some years of profitability ahead before the project starts missing the original financial pro forma targets. Hence, more value is added by having fewer units being built and more units being placed in the second phase. Also, the gains exhibit an inverted V-curve shape reaching the maximum point by setting aside units closest to when the cycle enters the mid-cycle headed down phase.
- if a project starts in a mid-cycle headed down phase, the maximum value is added to the project by having a complete project start delay flexibility (i.e. the project should not be started at all) and one should wait to ride out the downturn before re-starting the project. Also, this gain in NPV follows an L-curve, exhibiting higher gains upfront and gradually decreasing as the number of years of development in the first phase increases.
- if a project starts in a bottom headed up phase, there are some gains in the NPV by having a complete project start delay flexibility in order to ride out the beginning few years after the cycle has hit the bottom, however, the gains quickly diminish as the cycle turns favorable for development again.

**C) Observations related to unfavorable outcomes:**

The availability of flexibility to completely delay projects or phases of projects does not always result in favorable outcomes (i.e. a positive increase in NPV or IRR in the flexible cases compared to the inflexible cases). This subsection explains certain unfavorable outcomes of flexibility implementation and the underlying cash flows that result in those outcomes:

- f) One of the unfavorable outcomes we find is that having complete project start delay flexibility can actually result in lower (or, negative) gains in NPV compared to having no delay flexibility at all, for some projects. This can be explained by the impact of project delay on the timing of cash flows. To illustrate this point, we start with Figure 4 below, which represents the flexible minus inflexible case for a long-duration (10-year) uniform development project. The “solid” dots indicate a gain or an increase in NPV in the flexible case. The hollow “circles” represent a loss or a decrease in the NPV in the flexible cases. As before, the size of the dots / circles represents the relative magnitude of the gain or the loss. The vertical axis represents the real estate cycle periods (i.e., 5-year to 20-year cycles) and the horizontal axis represents the various two-phased schemes described earlier. Finally, the real estate cycle is in a mid-cycle headed down phase. The highlighted data point (with dotted outer circle, marked A) in the figure represent a negative NPV due to complete project start delay flexibility in the project for 5-year to 15-year cycle periods.

In order to understand this outcome, we look at the effect of this delay from a cash flow timing perspective. This is summarized in Figure 5 below. Figure 5a presents a comparison of product quantities being developed in both the inflexible and flexible cases. Also, for the flexible case, it presents all the different phases in which the product is being developed. Figure 5b presents the present value of future cash flows for both the inflexible and the flexible cases. Finally, to reiterate, the data point being discussed essentially has one phase with the flexibility to delay that phase (i.e. a project with start-delay flexibility). This flexibility delays the project completely only letting it start when the cycle is more favorable to development. However, this delay



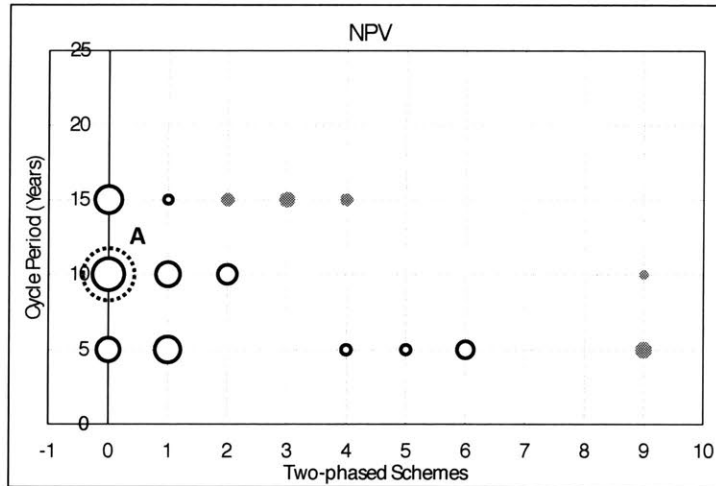


Figure 4. NPV difference: long-duration (10-year) uniform development profile starting in a mid-cycle headed down phase

ends up hurting the NPV of the project since the cash flows (shown here as discounted cash flows) occur at a later time period. This is a result of a developer being extremely sensitive to any changes in the markets (myopic in their decision-making) and in the real world, the developer's might not be so totally myopic, and/or uncertainty in the markets might mitigate these negative results in many cases.

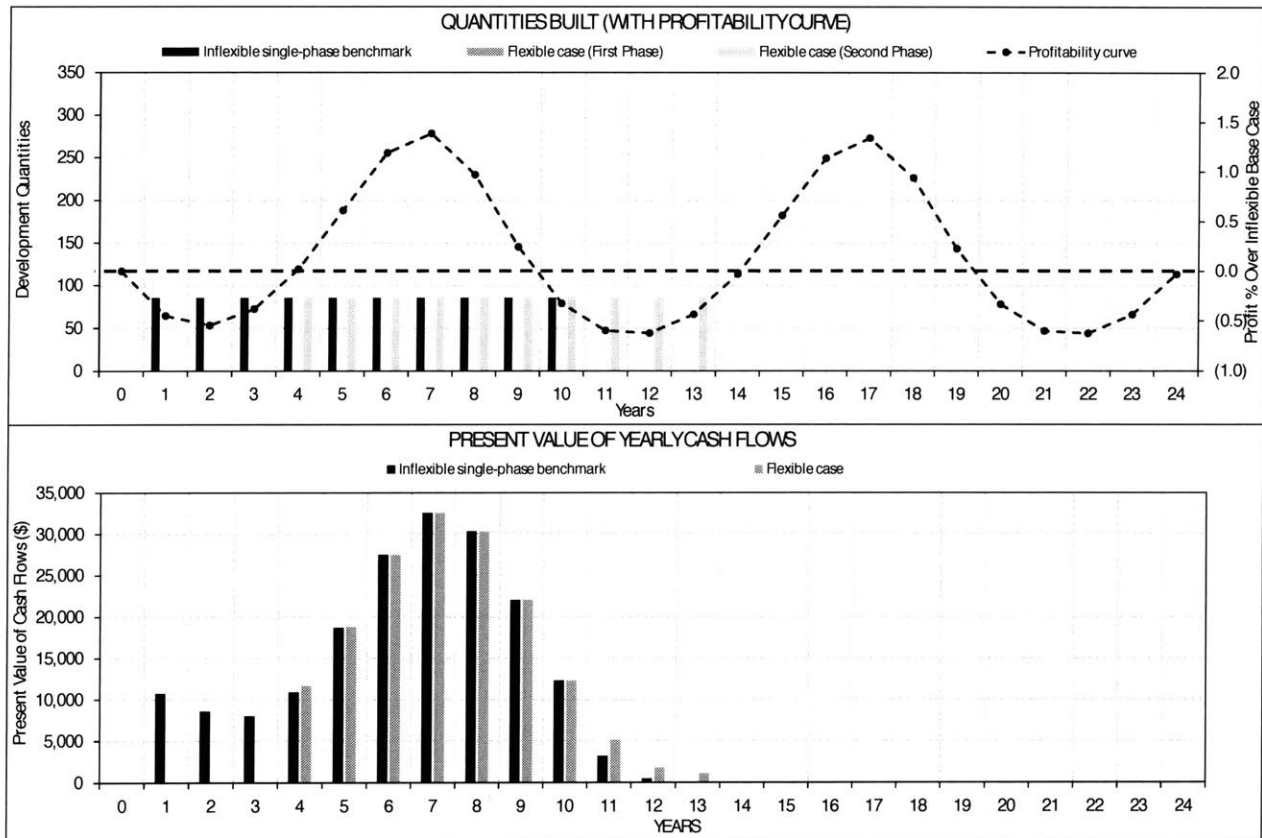


Figure 5. (a) Product development and (b) cash flow timing over the years.

- g) Another point (marked B) for a front-loaded project in a 15-year cycle starting in a peak headed down phase, experiences a negative NPV when the year with maximum planned units is delayed as shown in Figure 6 below:

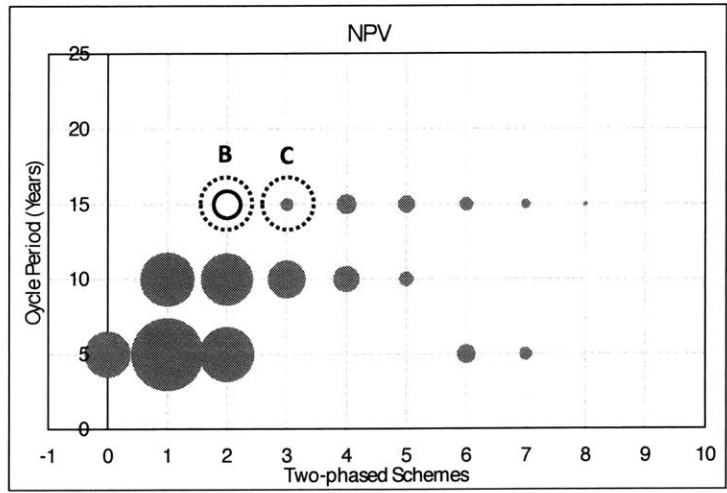


Figure 6. NPV difference: long-duration (10-year) front-loaded development profile starting at a peak headed down phase.

We investigate these quantities along with the cash flows resulting from these developments. Figure 7 below summarize the cash flows for this data point.

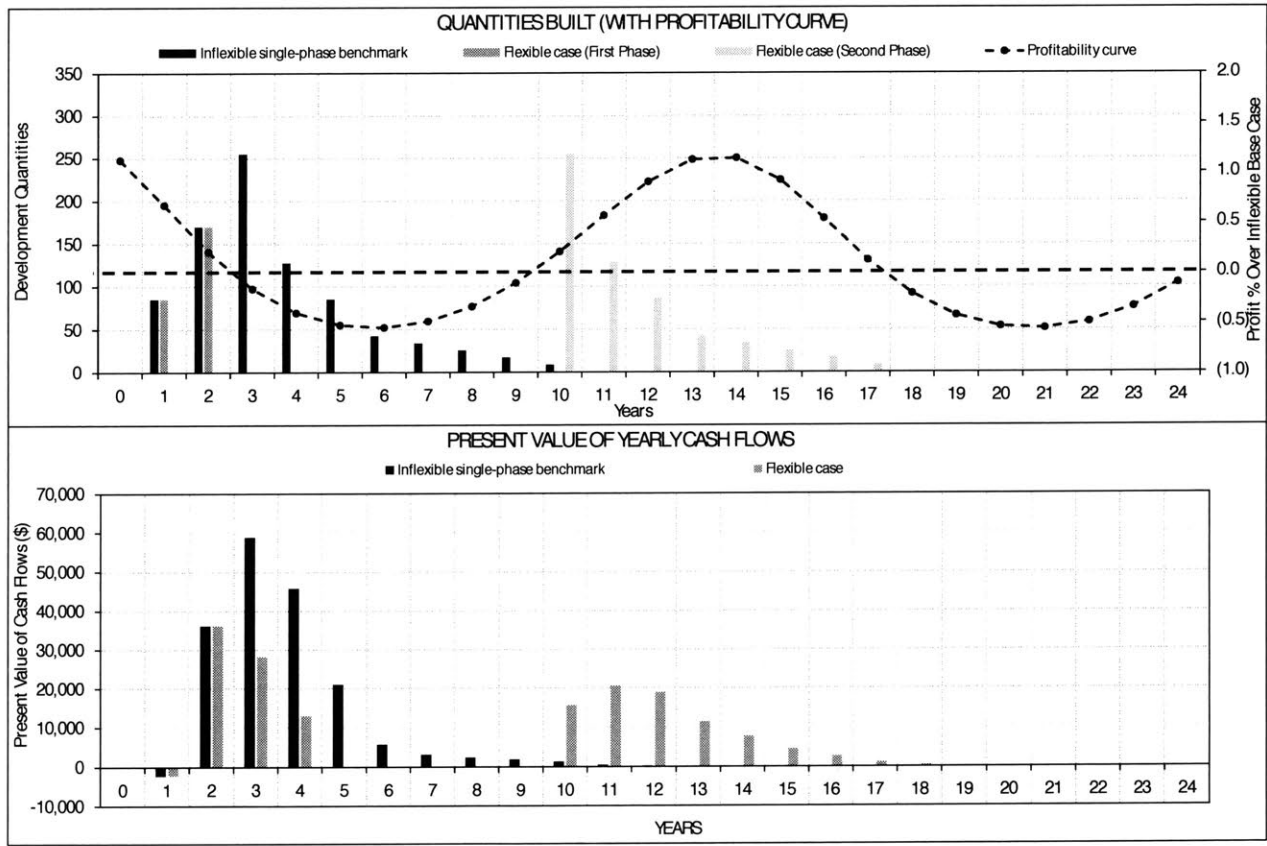


Figure 7. (a) Product development and (b) cash flow timing over the years

Looking at Figures 7a and 7b above, it seems rather logical for a developer to halt construction of the majority of the units in a development and wait for the cycle to turn favorable. However, as it turns out, in a longer period cycle, halting delivery of the most number of units can impact the outcome significantly. As in our example above, the second phase units are delivered starting in the Year 10, but the resulting discounted cash flows are much smaller and thus negatively impact the project NPV. However, if the developer's threshold to delay the project was slightly higher, in other words the profitability trigger to delay the second phase was a bit lower, then the developer might have been more biased to start rather than delay the project. Alternatively, if s/he had decided to go ahead with the delivery of another years' units then the outcome (marked C in Figure 6 above) would have been very different as explained by the development phasing and the cash flows in Figures 8a and 8b below.

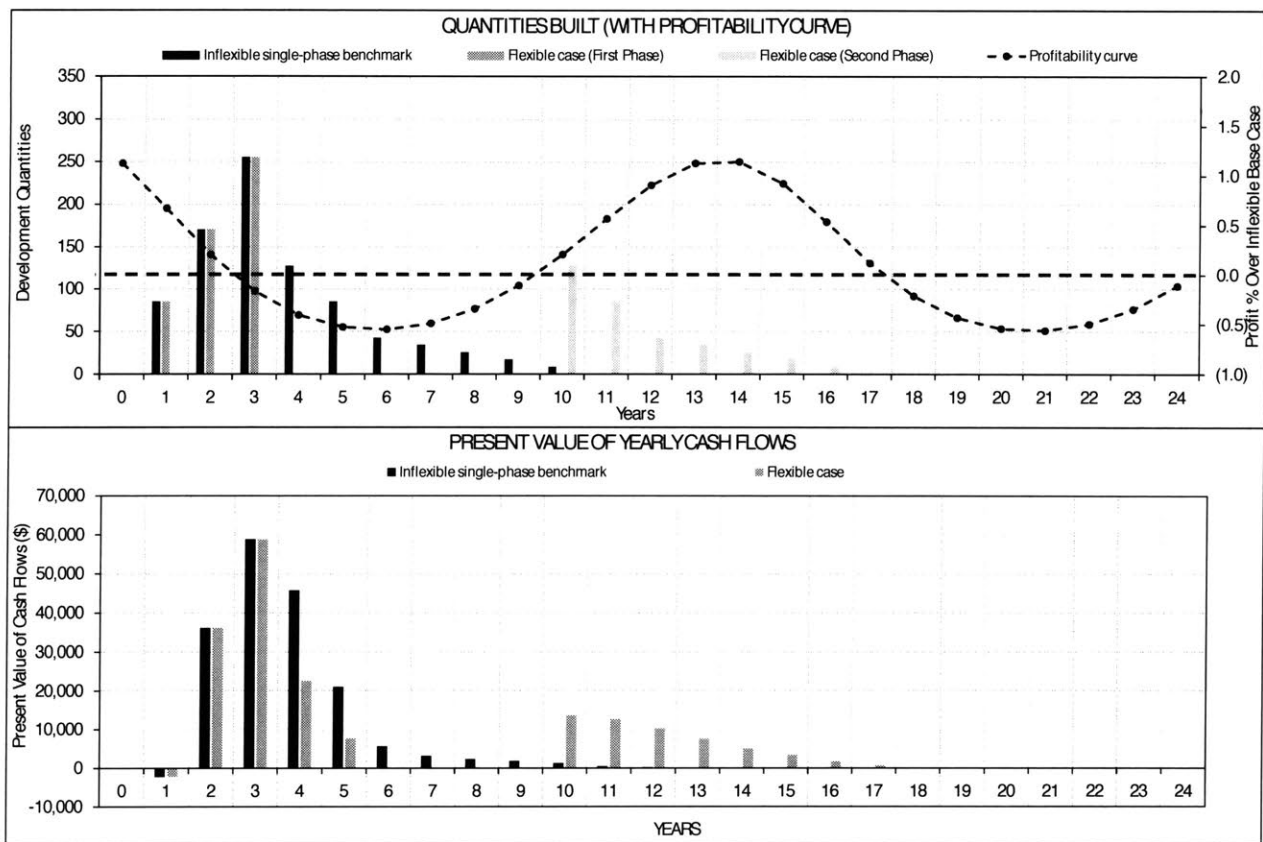


Figure 8. (a) Product development and (b) cash flow timing over the years

#### 4. PHASING RESULTS WITH UNCERTAINTY

In this section, we shift from deterministic analysis to understand the impacts of phasing flexibility on the financial outcomes of real estate development projects in the face of uncertainty. In this analysis, our four archetypal development profiles are subject to real estate cycles using Monte Carlo simulation methodology. The real estate cycles include all the components of the actual cycles: market volatility, cyclicalness, mean reversion, autoregressive behavior and idiosyncratic noise. Figure 9 summarizes the results of this analysis; it essentially combines all the information presented earlier in the array of graphs used for deterministic analysis purposes. Every data point

essentially represents the average gains or (losses) in NPV across 10,000 simulated financial outcomes of the four development profiles for each of the phasing schemes with delay flexibility. Compared to the deterministic analysis above, the results across four real estate cycle periods and real estate cycle phases have been combined into a single point for each of the schemes and 10 points for the long-duration development profiles (10-year) and 5 points for the short-duration (5-year) development profiles.

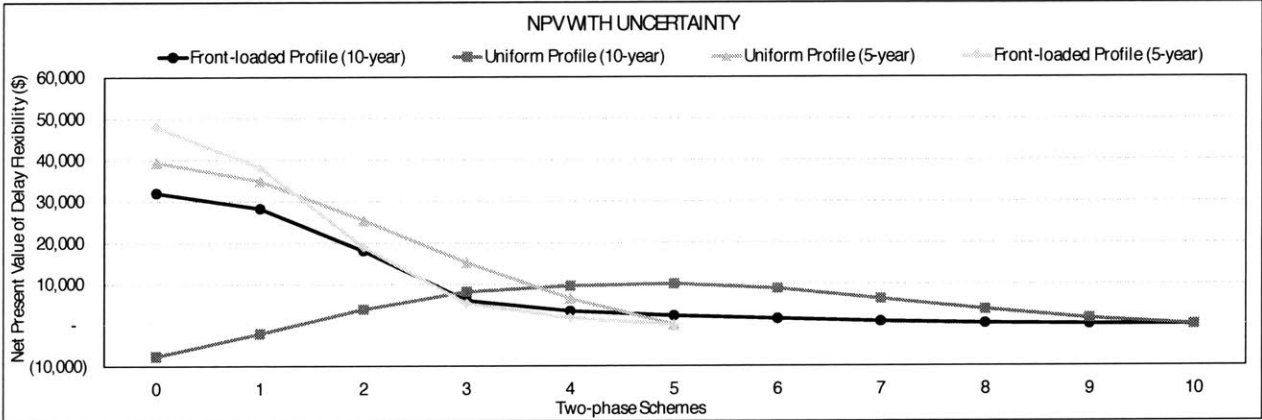


Figure 9. NPV difference between flexible and inflexible cases (including uncertainty).

The results in the figure above reinforce the observations discussed in Section 3 above: phasing and delay flexibility adds value to all short-term and front-loaded development projects, with the exception being long-duration uniform development projects where the added value does not have a large economic significance. Next, project start delay flexibility adds the maximum value to a project and as more and more portions of the development are placed under the first phase inflexible part, the marginal benefit of delaying the second phases gradually diminishes. Finally, flexibility can sometimes lead to losses, as shown by start delay flexibility in long-duration uniform projects since they already possess some amount of “profit diversification” and do not benefit from any additional flexibility.

### 5. CONCLUSIONS

This thesis addresses the question of delineation of development quantities between phases once the number of phases in a project has been agreed upon. In order to help build our intuition, the impacts of real estate cycle periods, real estate cycle phases, combinations of two-phase schemes with delay flexibility on the four archetypical development profiles were first presented in a deterministic analysis. Later in the thesis, we added uncertainty to our analysis. The deterministic analysis helped in breaking down the lumped results of the uncertainty analysis and the uncertainty analysis in turn helped reinforce the findings of the deterministic one. Simply put, the results can be summed up in a single statement: “Incorporate flexibility in a project as early as possible, making as much of the project flexible as possible, but while doing so, keep in mind the real estate cycle implications.”