Dūshì Huāyuán (都市花园): Using Monte Carlo Simulation to Value Flexibility in a Chinese Real Estate Development Project

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ABSTRACT

Dūshì Huāyuán (都市花园):
Using Monte Carlo Simulation to Value Flexibility in a Chinese Real Estate Development Project

By Qing Ye and Eric Mo

Real estate development in China is a fast-paced business. Volatile market conditions have prompted Chinese developers to build and sell quickly in an attempt to mitigate market fluctuation risk, especially when the real estate market is hot. But are they leaving money on the table?

We've conducted a rigorous quantitative analysis of Dushi Huayuan—a large-scale residential project in the fictitious city of Gangkou Shi—from the standpoint of its developer Acumen Properties. The thesis takes the form of a traditional business case study: we first crafted the story based on actual events, then built a Monte Carlo simulation model using Excel to test the value of flexibility—specifically the value of dividing the project into multiple phases—at Dushi Huayuan, and finally designed three exercises for students to learn not only the technical aspects of modeling, but also the business concepts related to working in the Chinese real estate market. The exercises will walk students through the following: (1) build a simulation process to reflect the crucial exogenous dynamic economic variables that largely determine the project's financial outcome; (2) expand upon this model by introducing phases in the project to understand how this new flexibility can affect expected net present value; and (3) employ the use of a waterfall analysis to examine fairness from an investment perspective between joint venture partners using standard-market terms.

Chinese developers—along with most developers worldwide—typically make decisions based on their experiences and intuition but without the use of detailed quantitative analysis. Our thesis ultimately seeks to change generally accepted industry practice by creating a pedagogical tool to help future real estate leaders better understand the advantages of using quantitative methods to inform rational business decisions.

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I would like to thank my family for your endless support and encouragement. To my parents, for your love and support over the years. To Zheng, for reminding me and helping me to live life to the fullest.

- Qing Ye

Endless thanks and love to my family for your everlasting patience, unwavering support, and steadfast encouragement during my graduate studies here in Cambridge. You have always reminded me to keep life in balance—intellectually, physically, creatively, socially—and to cherish the good company of friends and family.

- Eric Mo

We would like to express our deepest appreciation to our advisor—David Geltner—for your guidance, support, and thoughtful feedback during the thesis process. Your insight has been extraordinarily influential in the classroom and we look forward to applying what we've learned from you in a professional context. You've inspired us to be life-long learners.

To our classmates and friends at the Center for Real Estate, we have had an unforgettable experience with you all in the past year and a half and look forward to seeing the amazing ways you will change the world.

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TABLE OF CONTENTS

INTRODUCTION

Our thesis was inspired by Professor David Geltner's "Tools for Analysis: Design for Real Estate and Infrastructure Development" course. After taking the class in the spring of 2015, we quickly understood its applicability to actual development projects despite the real estate industry's general disregard of using rigorous quantitative methods to analyze such projects. The course employed the effective use of business case studies and one specifically—Harvard Business School's Bardhaman Case—revealed how to best apply modeling tools, such as Monte Carlo simulation, to real-world situations.

Equipped with practical working real estate experience in China, we sought to create a similar case study based in the dynamic Chinese market and improve upon the models originally built for the Bardhaman Case. In so doing, we've gained not only insight into the policies and working customs for a relatively nascent industry in China, but also discovered new findings for valuing flexibility in a very different environment. Even though the Bardhaman case was set in a booming emerging market—India—quite similar to China's, our conclusions yielded unexpected results that are discussed in detail within the individual case exercises and are also summarized in the conclusion.

We've conducted a rigorous quantitative analysis of Dushi Huayuan—a large-scale residential project in the fictitious city of Gangkou Shi—from the standpoint of its developer Acumen Properties. The thesis is presented in the form of a traditional business case study: we first crafted the story based on actual events, then built a Monte Carlo simulation model using Excel to test the value of flexibility—specifically the value of dividing the project into multiple phases—at Dushi Huayuan, and finally designed three exercises for students to learn not only the technical aspects of modeling, but also the business concepts related to working in the Chinese real estate market. The exercises will walk students through the following: (1) build a simulation process to reflect the crucial exogenous dynamic economic variables that largely determine the project's financial outcome; (2) expand upon this model by introducing phases in the project to understand how this new flexibility can affect expected net present value; and (3) employ the use of a waterfall analysis to examine fairness from an investment perspective between joint venture partners using standard-market terms.

The thesis in its entirety consists of the written case study, three case exercises with solutions, and an accompanying Monte Carlo simulation model. A flowchart describing how the model was structured is provided in **Exhibit 1**.

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ERIC MO
QING YE

Dūshì Huāyuán (都市花园): To Phase, or Not to Phase?

Fa Ping leaned casually against her desk and gazed out of her office window. Her eyes fell upon a sea of spinning construction cranes hard at work, erecting a new central business district (CBD) in Gangkou Shi (港口市), a large port-city on China's eastern seaboard. Gangkou Shi's economy and population were growing at an unprecedented pace, prompting government officials to plan the new business hub emerging in front of Ping roughly five kilometers from the original city center. In 2009, the population of Gangkou Shi topped 5.7 million, growing 0.5 percent from the previous year[1]. A 450-meter tall skyscraper, cultural plaza, exhibition hall, and government city complex were already under construction in the new CBD (see **Exhibit 1**).

Beyond the new CBD—about a 10-15 minute drive—was Gangkou Shi's "High-Tech Economic Development Zone" (EDZ), anchored by high-tech businesses, research and development labs, and other technology-focused institutions. For example, situated directly across the river from the High-Tech EDZ was Gangkou Shi's largest university. The new CBD was strategically positioned between the original city center and the High-Tech EDZ (see **Exhibit 2**).

A warm smile and lithe physique masked Ping's sharp business intellect and formidable negotiation ability. Fresh off leading the successful delivery of Loyal Gardens—a master-planned residential community designed to house approximately 2,500 people, or 800 households—Ping was recently promoted to the Head of Development for Acumen Properties (Acumen), a highly sophisticated and well-respected real estate developer. Several residential projects recently delivered in the new CBD. One such project, New City, was built by Acumen and sold out in record time. It was early 2010 and Acumen had just closed on a land deal with the government late last year for ¥2.1 billion Chinese yuan (CNY). Acumen's Chairman turned to Ping to head the development of this new endeavor, which would be very similar to Loyal Gardens in scale and product mix.

Chinese Context

In August 2013, the real estate industry was confirmed as a "pillar industry" by the Chinese State Department; in other words, the Chinese government designated it as an essential segment of

[1] Survey Office of the National Bureau of Statistics in Gangkou Shi

Eric Mo and Qing Ye of the Massachusetts Institute of Technology Center for Real Estate prepared this case for the sole purpose of class discussion. The case describes an actual situation but in the interests of confidentiality, certain names and other identifying information have been altered. The case is not intended to serve as an endorsement, source of primary data, or illustration of effective or ineffective management.

China's overall economy. Direct investments strictly into Chinese real estate contributed about 6.6 percent of China's Gross Domestic Product (GDP). But China's real estate industry at-large, as a percentage of GDP, was even greater due to ancillary investments into real estate-related industries like design, construction, and infrastructure. From 2003 to 2009, China's GDP more than doubled with an average annual growth rate of roughly 11 percent as shown in **Table A**.

Table A China's Gross Domestic Product (GDP) and Purchasing Power Parity (PPP), 2003-2009

Year	GDP (¥10 million CNY)	PPP (International Dollars)	GDP Growth Rate (%)
2009	34,562.92	10,716.27	9.2
2008	31,675.17	9,851.02	9.6
2007	26,801.94	8,837.65	14.2
2006	21,765.66	7,328.00	12.7
2005	18,589.58	6,403.64	11.3
2004	16,071.44	5,611.50	10.1
2003	13,656.46	4,966.03	10.0

Source: National Bureau of Statistics of the People's Republic of China, Third National Economic Census.

When Acumen made its land purchase in 2009, the Chinese real estate market was booming. Finding an affordable apartment in urban areas became a challenge for homebuyers and complaints about high housing prices were regular media fixtures on television, in newspapers, and online. Meanwhile, affluent Chinese buyers snapped up condominiums as speculative investment properties. They sought growth in value mostly from appreciation and less so from a steady stream of income, since renting these units were generally unprofitable. Many of these investment units remained vacant for years. Economists and urban planners criticized China's housing affordability issue and China's government responded by enacting a number of regulations in an attempt to deflate an emerging housing bubble. These regulations ranged from reducing the land supply available for development to tightening access to capital.

China's land ownership structure is unique. The Chinese government owns and controls all urban land in the country. Unlike common law countries where fee simple ownership constitutes absolute ownership in property by multiple owners, the Chinese government alone has complete control over the supply of land. In China, all land is purchased directly from the government in the form of 70-year ground leases—for residential projects—and come packaged with pre-determined development rights and allowable density. When the Chinese government decides to constrain the supply of land, it can simply cease leasing out new land parcels to private developers. Since there are no recurring annual property taxes collected in China, proceeds from the upfront sale of ground leases generate a significant source of revenue for the government. As China continues to rapidly expand its urban footprint, income from ground leases is often used to build public infrastructure to support the increased density enabled by new development.

In many ways, the Chinese government at the municipal level runs like a traditional real estate developer acting in the early stages of development. When urban expansion occurs, it buys out existing leasehold agreements from farmers on the fringes of urban areas at a "fair market value," assembles larger contiguous tracts of land, creates a masterplan for the aggregated land, and finally leases out individual parcels in the new masterplan. The overall process creates value and tends to push land prices upward. As a result, a consequence of the government's role in city building is exorbitantly high land prices as a percentage of total development costs (TDC). However, TDCs as a whole in emerging real estate markets like China are significantly lower than those of projects in more mature ones, in large part because labor and construction costs are so inexpensive.

The History

Acumen was established in 1990 and is headquartered in Gangkou Shi. It has a long history—relative to China's recent institutionalization of the real estate industry—specializing in urban luxury high-rise condominiums and townhomes. Over the years, Acumen has earned the enviable position of preeminent developer in the local market for building high-quality residential communities. They've capitalized on their successes. Unmatched brand loyalty in the market enabled Acumen to sell units at a 10 to 20 percent price premium over comparable projects sponsored by competing developers. In 2015, Acumen was a dominant residential developer in Gangkou Shi, marked by the 30 percent market share it had captured among all housing units in the city.

What really distinguished Acumen from its competitors was its capacity to innovate new products. In China's urban areas, single-family detached homes were not permitted by the building code. But there was still demand for this type of product from buyers who preferred the character of a single-family home over one of a high-rise condominium. As often occurs, the building code gave rise to the invention of something new. In this case, it was the Acumen townhouse: four attached single-family homes surrounding a shared central courtyard, a style reminiscent of the historically ubiquitous Chinese siheyuans (see **Exhibit 8**). The townhouses were typically two to three stories tall above a one- to two-story basement. Underground built spaces did not count toward allowable density, measured by floor area ratio (FAR), which meant the townhouse basements were effectively "bonus spaces" that could be marketed to prospective buyers as part of the total area of the townhouse unit. For developers who weren't concerned with speed to market in delivery, there was a strong incentive to dig deep—literally—and build elaborate, amenity-filled basements to extract additional value. Since construction costs were so cheap—even costs associated with building underground—townhouse basements turned into a significant source of value creation for Acumen and other developers.

In early 2009, Acumen purchased a ground lease to develop Loyal Gardens, which was located approximately 10 minutes driving distance from Gangkou Shi's new CBD. The simplicity of the townhouse design specifically at Loyal Gardens made swift construction achievable; Acumen was able to begin preselling townhouses nine months after purchasing the ground lease. Ping opted to forgo including basements for the townhouses at Loyal Gardens, despite how lucrative they were, because Acumen's Chairman pushed her for quick delivery. The Chairman knew there were too many projects to handle in the pipeline and wanted to wrap up Loyal Gardens as efficiently as possible. Without a basement to worry about, Ping was able to satisfy the Chairman's sense of urgency. And by many standards, Loyal Gardens was wildly successful. Merely selling off the townhouse portion of the project—representing only about 28 percent of the total floor area—at or above underwritten sales prices was the approximate breakeven point. Acumen broke even, and then some.

As Ping worked on Loyal Gardens, she noticed escalating demand for luxury buildings in the High-Tech EDZ. Exceptionally educated and appropriately compensated, the workforce attracted to the High-Tech EDZ was accustomed to a luxurious standard of living. There was a shortage of suitable residential product to meet their needs. Acumen hoped to help fill this void with its next project located in the High-Tech EDZ, Dushi Huayuan. In addition to the workforce, Acumen's target market included wealthy individuals looking for real estate investments with high growth potential.

Land Primed for Development

The site for Dushi Huayuan was situated along the banks of a river that connected Gangkou Shi to the East China Sea (see **Exhibits 2** and **3**). Trapezoidal in shape, the parcel was bounded on three sides by newly built roads and on the remaining side by the river. Infrastructure under the new roads surrounding the site, including gas and electricity, were also recently installed and in immaculate condition. At the time of purchasing the ground lease, the site was entirely vacant and home to overgrown, wild vegetation. In short, Acumen had a blank slate to work with.

Basic details of the parcel including allowable density and various restrictions can be found in **Table B** below. Its location boasted excellent access to various transportation nodes, including various highways, an airport, and a harbor. To strategically maximize the value of the site, Ping decided to place the high-rise condominium towers along the river so that a greater number of units could take advantage of river views (see **Exhibit 4**). She also proposed the following land allocation: high-rise condominium floor area totaling 143,000 square meters—644 units—spread over 32,625 square meters in land area and townhouse floor area totaling 60,000 square meters—175 units—filling the remaining 73,225 square meters of the site's total land area.

Speed to market for this project wasn't a high priority; amenity-filled basements would be built for the townhouses at Dushi Huayuan. In China, presales for residential units cannot begin until construction rises above one meter from ground level, which meant the additional time to build out basements and underground parking would delay the start of presales.

Table B Dushi Huayuan: Basic Land Information

Category	**Specifications**
Ground lease	Executed December 2009 for ¥2.117 billion CNY
Land area	105,850 square meters
FAR	2.0
Building coverage	35 percent (as designed)
Height limit	80 meters, negotiable with the government up to 100 meters
Land use	Residential; permitted ground floor retail and social amenities in the podium of the high-rise towers
Parking	Residential: 1 parking space per unit <120 square meters 1.5 parking spaces per unit 120-180 square meters 2 parking spaces per unit >180 square meters Retail: 1 parking space per 100 square meters

Source: Company documents.

Financial Idiosyncrasies

Instead of the traditional construction loan offered by a bank, Dushi Huayuan was able to negotiate a construction revolving loan that functioned similar to a credit card. (One with a very high credit limit!) The loan featured a loan-to-value (LTV) ratio of 60 percent, meaning when Acumen needed to draw from the loan to pay for expenses, it would be able to borrow 60 percent while contributing the remaining 40 percent with equity. In the same way a traditional revolving loan behaves, Acumen could pay back all or some of the outstanding loan while the line of credit remained open, meaning additional borrowed funds could be drawn out to finance subsequent phases. The construction revolving loan carried an annual interest rate of six percent and the land was used as collateral to secure the loan.

Taxes related to the project could be split into two categories: (1) land taxes and (2) sales-related taxes. A land contract tax of three percent would be paid upfront at the time of land purchase. Also, a land use tax of ¥10 CNY per square meter of the total land area would be charged for each year construction occurred. The sales-related taxes, of which there were four, are expectedly all a percentage of sales revenue. Sales taxes of five percent, added value taxes of three percent, other taxes and fees of 0.60 percent, and sales commission of 0.50 percent accounted for all sales-related taxes.

Joint Venture Partner

Ping tapped her professional network to find a suitable partner to invest in Dushi Huayuan. She recalled meeting with associates at a local private equity firm over the holidays who expressed interest in working with Acumen on its next project after hearing about the success of Loyal

Gardens. The group—Golden City Capital (Golden City)—recently closed on its second fund in 2009 and was eager to start deploying capital into new investments. After an expeditious series of negotiations, the joint venture (JV) documents were finalized according to standard-market terms in China (see **Table C** below) and the Golden City China Residential Opportunistic Fund II (GCROF II) was set to invest in its first project. The JV partner splits for the first hurdle would be paid *pro rata*—meaning "in proportion" to each partner's contribution of equity—and all hurdles in the promote structure would be paid *pari passu*—meaning the general partner (GP) and limited partner (LP) would have equal priority claim on and responsibility for any cash flows; there would be no seniority between the equity partners.

Table C Dushi Huayuan: JV Partner Splits and Promote Structure

IRR Hurdles	**Acumen (GP)**	**Golden City (LP)**
≤ 18.00%	51.00%	49.00%
> 18.00% and ≤ 21.00%	60.00%	40.00%
> 21.00%	70.00%	30.00%

Source: Company documents.

Logistically, the IRRs would be calculated on a contemporary "look-back" basis. In each period of the cash flows, the IRR is calculated until the first hurdle of 18 percent has been reached. The cash flows up to that point would then be split *pro rata pari passu*, as described previously. Cash flows beyond the 18 percent IRR mark are continuously calculated until the next IRR hurdle at 21 percent. Those series of cash flows beyond the 18 percent IRR mark and up to the 21 percent IRR mark would be distributed *pari passu* according to the promote structure in **Table C**. The same method applies to the final hurdle for all cash flows above the 21 percent IRR mark.

Pro Forma Cash Flows

Before Acumen purchased the ground lease for Dushi Huayuan, Ping needed to determine a number of assumptions before modeling the base case pro forma as provided in **Exhibits 10** and **11**. For your edification, the final ex post cash flow—how the project actually performed as of year-end 2015, or "Year 6"—has been included in **Exhibit 12**[2]. The future years in the ex post cash flow were completed with modified assumptions to the ex post sales curves.

The Phasing Decision

Since Acumen had been accustomed to working in a thriving real estate market, their general business strategy became "build quickly and sell." But Ping was wise beyond her years. She knew

[2] While the case project is fictional, it is patterned after a real project that was actually built in China, and so we can examine the actual historical results of that project. The numbers are slightly changed to mask identity, but the essence of the project's actual results are described in the Ex Post Project Cash Flow.

there was intrinsic value in holding on to a piece of land and not necessarily building upon it immediately. In the same way call options in the stock market have value because they offer an "option but not the obligation" to execute a transaction, unbuilt land carries that same value. As Ping settled back into her desk chair and flipped open her laptop, the billion yuan question remained: "How could she quantify that value?" And consequently, "Is the value of optionality greater than no optionality at all?"

To find out, she began logically dividing the project into three separate phases (see **Exhibit 9**). (1) The "Initial Phase" would include the ground floor (podium) of the high-rise buildings and with it, the full basement serving as the foundation for the high-rise buildings, some 46 percent of the high-rise units, slightly over half of the townhouse units, and the full basement under this portion of townhouses. (2) A "High-Rise Expansion Phase" would include a vertical expansion of the remaining 54 percent of the high-rise units on the high-rise podium. In other words, the high-rise podium will be built in the Initial Phase with the structural capacity to support the construction of approximately 25-30 additional floors of condominium units above the planned retail and amenity space in the podium. (3) Finally, a "Townhouse Expansion Phase" would build out the remainder of the land site, almost doubling the number of townhouse units. The Townhouse Expansion Phase would require construction of additional basement space under the expanded townhouse section of the site. Thus, it should be noted that the marginal cost of production would be much lower in the High-Rise Expansion Phase compared to the Townhouse Expansion Phase because the latter involves significant amounts of additional infrastructure costs, especially as it relates to the buildout of the basement foundation of the townhouses.

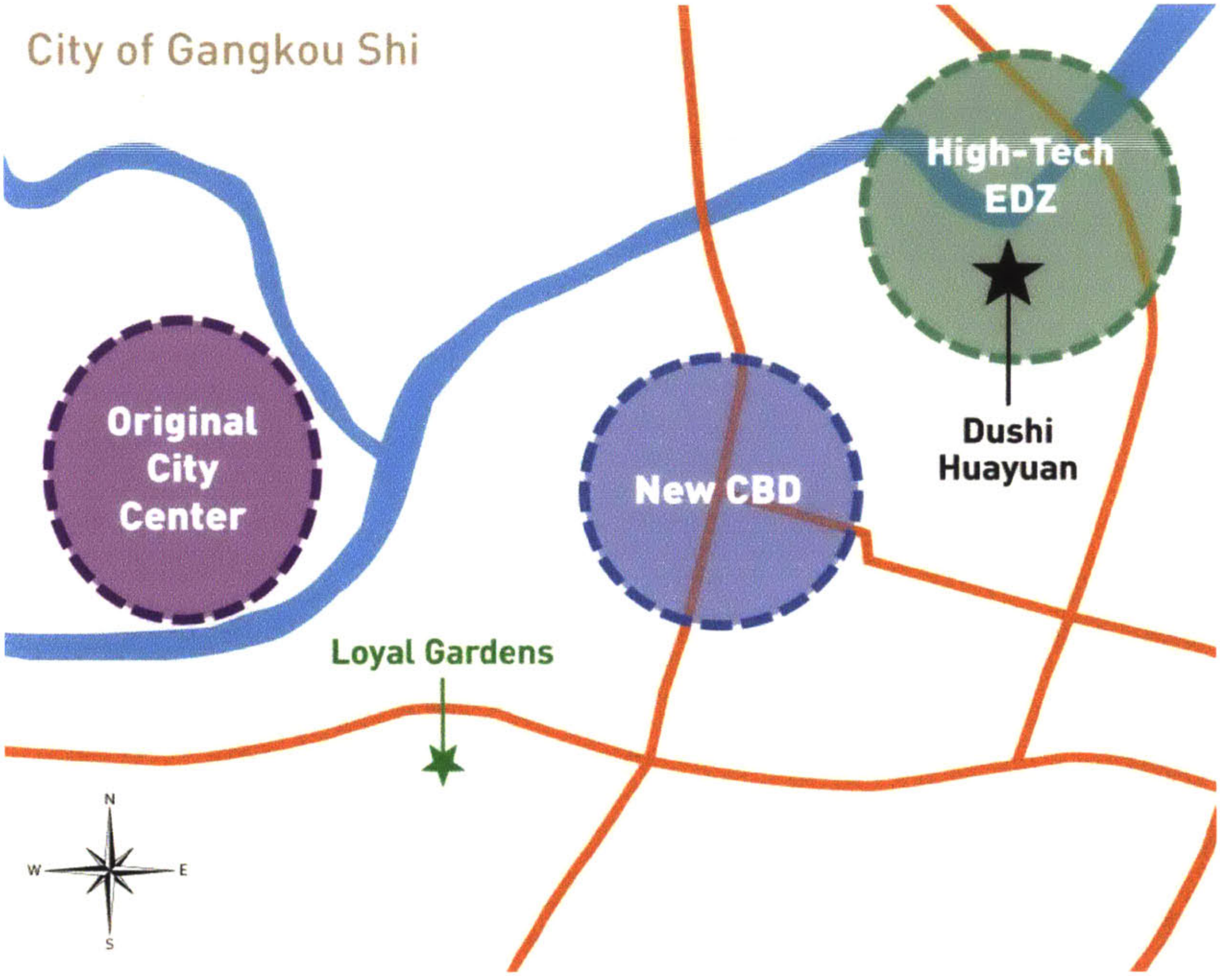
All phases would have the flexibility to be delayed. If the residential market took a downward turn, Ping had the authority to delay buildout of the entire project or any phase as yet not started, avoiding any further expenditures. Commencement of the Initial Phase would be a prerequisite for the commencement of the other two expansion phases. If the Initial Phase is delayed, the expansion phases must be delayed, too, because design elements in the expansion phases are dependent on the buildout of the Initial Phase. As an example, the High-Rise Expansion Phase would be built directly on top of the high-rise podium erected in the Initial Phase. Similarly, the basement—which includes underground parking—in the Townhouse Expansion Phase would directly integrate with the underground parking circulation (e.g. ramps, utilities, etc.) already built in the Initial Phase. Thus, both vertical and horizontal expansion options would need to be modeled such that they could only be exercised after the Initial Phase has been triggered. However, the horizontal expansion option is not dependent on the vertical expansion option, or vice versa.

Ping had a busy morning contemplating these thoughts as her belly managed a slight grumble. It was well past lunch hour and she knew working on an empty stomach wasn't all too productive. She hastily folded her notes, stuffed them in her blazer pocket, and looked forward to bouncing her ideas off her colleagues over a late lunch.

Exhibit 1 Renderings of Gangkou Shi's New Central Business District (CBD)

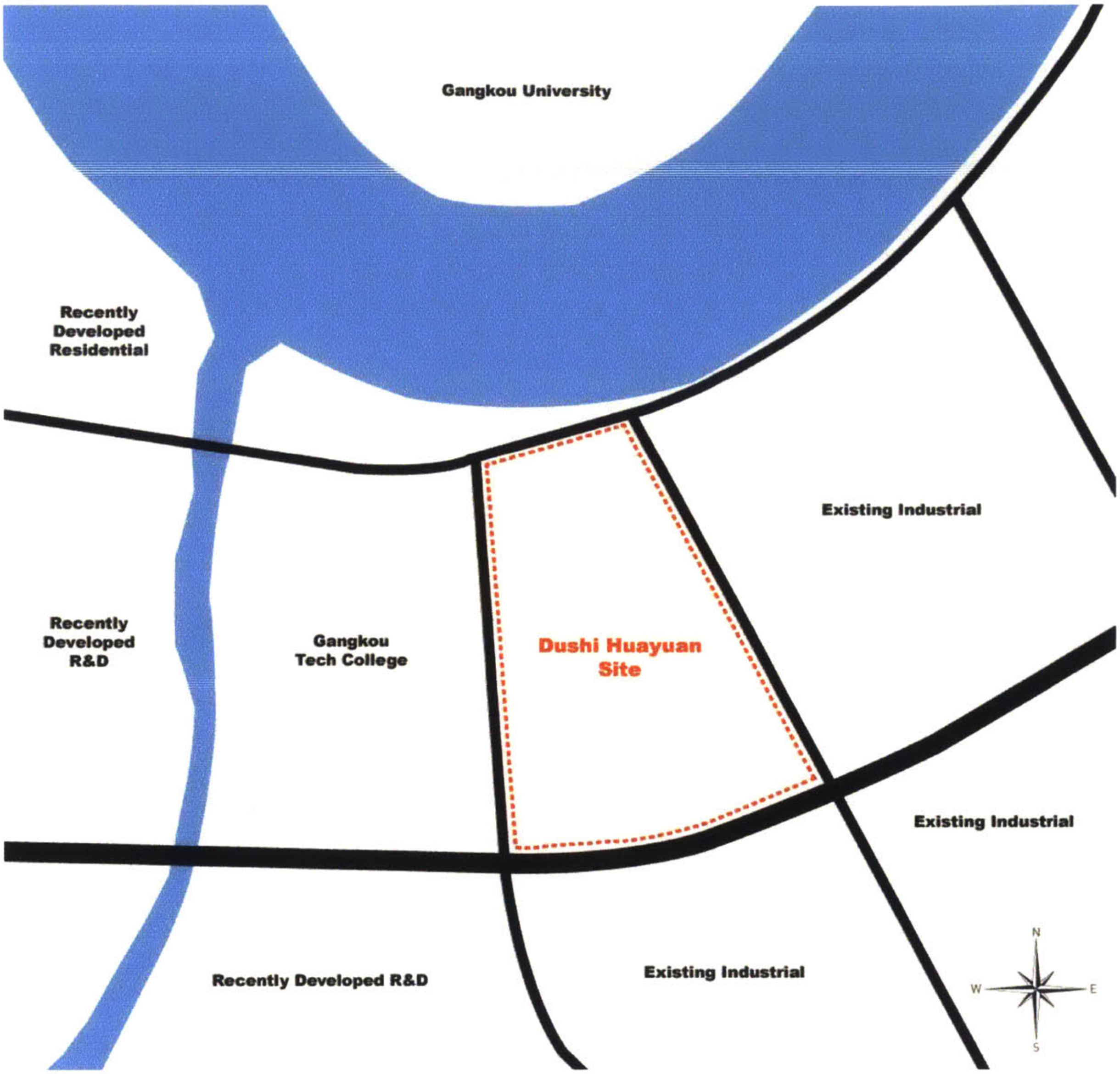
Source: People's Government of Gangkou Shi website.

Exhibit 2 Map of Gangkou Shi's Original City Center, New Central Business District (CBD), High-Tech Economic Development Zone (EDZ), and the Dushi Huyuan Site



Source: Fictitious map of Gangkou Shi created by the case authors.

Exhibit 3 Map of Dushi Huayuan Site and Surrounding Area



Source: Fictitious contextual map of Dushi Huyuan site created by the case authors.

Exhibit 4 River Views from the Dushi Huyuan Site

Source: Photos taken by the case authors.

Exhibit 5 Dushi Huyuan Site Plan

Source: Courtesy of Acumen Properties.

Exhibit 6 Bird's-Eye Rendering of Dushi Huyuan Built Out

Source: Courtesy of Acumen Properties.

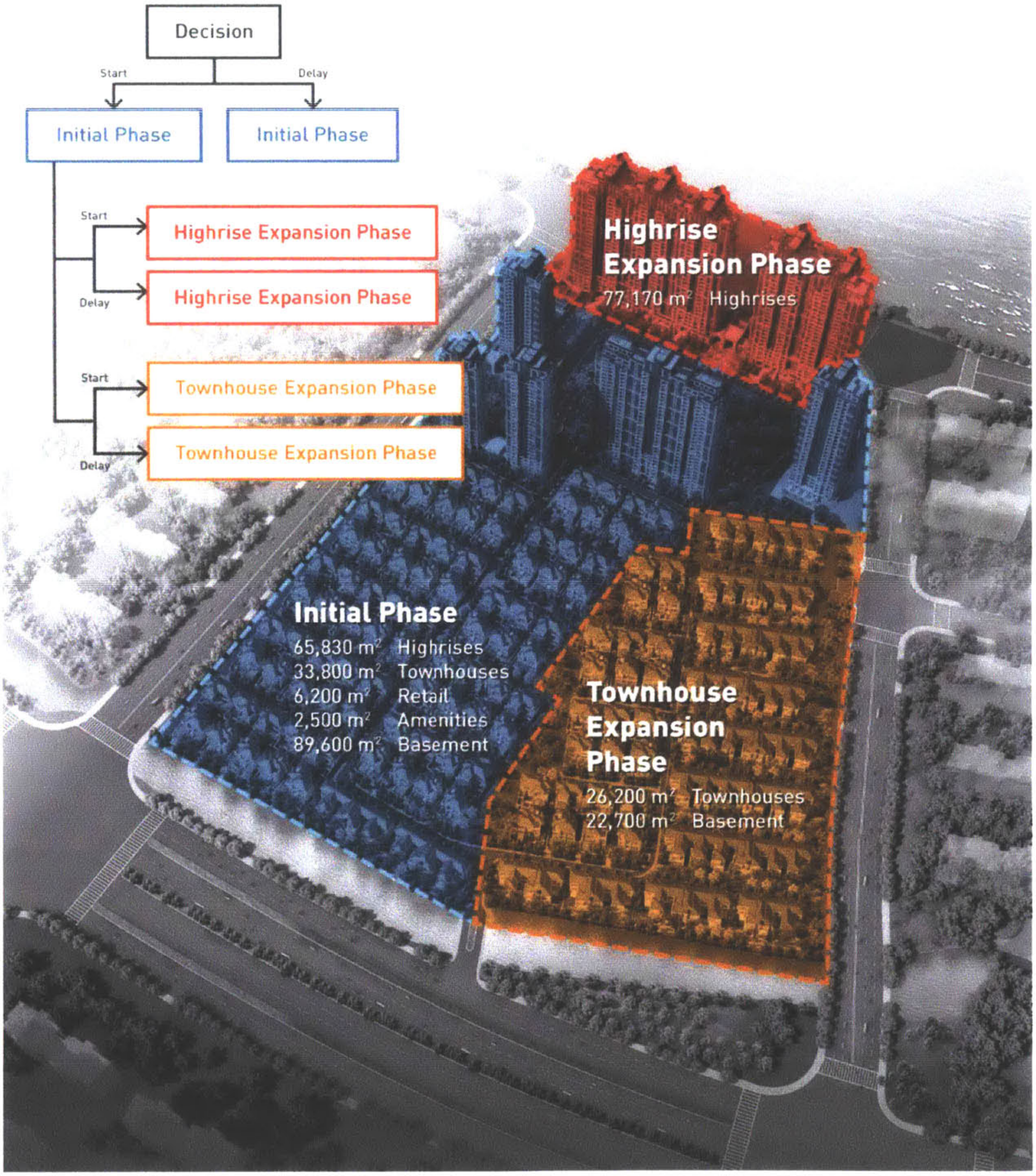
Exhibit 7 Renderings of Typical High-Rise Condominium Buildings at Dushi Huayuan

Source: Courtesy of Acumen Properties.

Exhibit 8 Renderings of Typical Townhouse Buildings at Dushi Huayuan

Source: Courtesy of Acumen Properties.

Exhibit 9 Illustration of Proposed Phasing Strategy at Dushi Huayuan



Source: Created by the case authors.

Exhibit 10 Development Pro Forma Assumptions

FLOOR/LAND AREA ALLOCATION			
Highrise Group	Floor Area [FA] (m²)	FAR	Land Area [LA] (m²)
Highrise Housing	143,000		
Retail	6,200		
Amenities	2,500		
SUBTOTAL HIGHRISE GROUP	151,700	4.65	32,625
Townhouse Group	Floor Area (m²)	FAR	Land Area (m²)
Townhouse Housing A	19,700		
Townhouse Housing B	40,300		
SUBTOTAL TOWNHOUSE GROUP	60,000	0.82	73,225
TOTAL	**211,700**		**105,850**

SALES PRICES AND COSTS	Price/m² (CNY)	Cost/m² (CNY)	Profit/m² (CNY)	No. of Units	FA (m²)	Avg Size/ Unit (m²)
Highrises	¥32,800	¥1,800	¥31,000	644	143,000	222.05
Townhouses	¥33,000	¥2,000	¥31,000	175	60,000	342.86
Retail	¥32,800	¥1,800	¥31,000	60	6,200	103.33
Amenities	¥0	¥1,800	-¥1,800	0	2,500	0.00
SUBTOTAL				879	211,700	
Underground Parking	¥2,763	¥2,350	¥413	1,674	72,700	43.43
Allocated to Highrises	¥2,763	¥2,350	¥413	1,222	53,070	43.43
Allocated to Townhouses	¥2,763	¥2,350	¥413	452	19,630	43.43
Other Basement Space	¥0	¥2,350	-¥2,350	0	39,600	0.00
SUBTOTAL				1,674	112,300	
TOTAL				**2,553**	**324,000**	

Source: Adapted by case authors from company documents. Some figures have been disguised.

Exhibit 10 (continued)

LAND PRICE	
Price/FA (CNY/m^2)	¥10,000
Buildable FAR	2.00
Price/FA*FAR (CNY/m^2)	¥20,000
Land Area (m^2)	105,850
TOTAL LAND PRICE (000 CNY)	**¥2,117,000**

CONSTRUCTION COSTS AND FEES	(000 CNY)
Primary Infrastructure	¥98,000
Pre-Construction	¥25,000
Consultant Fees	¥34,000
Social Infrastructure	¥400
Indirect Fees	¥38,000
Mgmt Fees & Overhead (for Sales & Constrn Yrs)	¥500

TAXES AND OTHER SALES-RELATED COSTS	
Land Taxes	
Land Contract Tax (% of Total Land Price)	3.00%
Land Use Tax (CNY/m^2 for Construction Yrs)	¥10.00
Sales-Related Taxes	
Sales Tax (% of Sales Rev)	5.00%
Added Value Tax (% of Sales Rev)	3.00%
Other Taxes and Fees (% of Sales Rev)	0.60%
Sales Commission (% of Sales Rev)	0.50%
TOTAL SALES-RELATED COSTS (% of Sales Rev)	**9.10%**

TIMING	
Year to Start Highrise Group Construction	Year 4
Total Years to Build Out Highrise Group	3 Year(s)
Year to Start Townhouse Group Construction	Year 3
Total Years to Build Out Townhouse Group	4 Year(s)

CONSTRUCTION REVOLVING LOAN	
Loan-to-Value [LTV] Ratio	60.00%
Annual Interest Rate	6.00%

Source: Adapted by case authors from company documents. Some figures have been disguised.

Exhibit 11 Pro Forma Project Cash Flow and Capital Structure

SALES CURVES	Totals	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Housing Discount			100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Highrise	100.0%		0.0%	0.0%	0.0%	60.0%	20.0%	10.0%	10.0%	0.0%	0.0%	0.0%
Townhouse	100.0%		0.0%	0.0%	60.0%	20.0%	10.0%	10.0%	0.0%	0.0%	0.0%	0.0%
Retail	100.0%		0.0%	0.0%	0.0%	0.0%	0.0%	60.0%	20.0%	10.0%	10.0%	0.0%
Parking	100.0%		0.0%	0.0%	0.0%	0.0%	60.0%	20.0%	10.0%	10.0%	0.0%	0.0%

COST CURVES	Totals	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Primary Infrastructure	100.0%		0.0%	0.0%	5.0%	10.0%	10.0%	65.0%	10.0%	0.0%	0.0%	0.0%
Pre-Construction	100.0%		5.0%	90.0%	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Consultant Fees	100.0%		30.0%	30.0%	10.0%	10.0%	20.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Social Infrastructure	100.0%		0.0%	0.0%	0.0%	15.0%	70.0%	15.0%	0.0%	0.0%	0.0%	0.0%
Indirect Fees	100.0%		0.0%	20.0%	10.0%	20.0%	30.0%	20.0%	0.0%	0.0%	0.0%	0.0%
Basement	100.0%		0.0%	40.0%	30.0%	10.0%	10.0%	10.0%	0.0%	0.0%	0.0%	0.0%

SUMMARY CASH FLOW		Totals	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Land & Infrastructure Cost													
Land Purchase	000 CNY	(2,117,000)	(2,117,000)										
Primary Infrastructure	000 CNY	(98,000)		0	0	(4,900)	(9,800)	(9,800)	(63,700)	(9,800)	0	0	0
Pre-Construction	000 CNY	(25,000)		(1,250)	(22,500)	(1,250)	0	0	0	0	0	0	0
Consultant Fees	000 CNY	(34,000)		(10,200)	(10,200)	(3,400)	(3,400)	(6,800)	0	0	0	0	0
Social Infrastructure	000 CNY	(400)		0	0	0	(60)	(280)	(60)	0	0	0	0
Indirect Fees	000 CNY	(38,000)		0	(7,600)	(3,800)	(7,600)	(11,400)	(7,600)	0	0	0	0
Management Fees & Overhead	000 CNY	(4,500)		(500)	(500)	(500)	(500)	(500)	(500)	(500)	(500)	(500)	0
Land Taxes													
Land Contract Tax	000 CNY	(63,510)	(63,510)										
Land Use Tax	000 CNY	(5,293)		0	(1,059)	(1,059)	(1,059)	(1,059)	(1,059)	0	0	0	0
Total Land & Infrastructure Cost	000 CNY	(2,385,703)	(2,180,510)	(11,950)	(41,859)	(14,909)	(22,419)	(29,839)	(72,919)	(10,300)	(500)	(500)	0
Revenue and Construction Costs													
Closings													
Highrises	m^2	143,000		0	0	0	85,800	28,600	14,300	14,300	0	0	0
Townhouses	m^2	60,000		0	0	36,000	12,000	6,000	6,000	0	0	0	0
Retail	m^2	6,200		0	0	0	0	0	3,720	1,240	620	620	0
Parking (only Highrise)	Spaces	1,222		0	0	0	0	733	244	122	122	0	0
Sales Revenue													
Highrises	000 CNY	4,690,400		0	0	0	2,814,240	938,080	469,040	469,040	0	0	0
Townhouses	000 CNY	1,980,000		0	0	1,188,000	396,000	198,000	198,000	0	0	0	0
Retail	000 CNY	203,360		0	0	0	0	0	122,016	40,672	20,336	20,336	0
Parking (only Highrise)	000 CNY	146,640		0	0	0	0	87,984	29,328	14,664	14,664	0	0
Subtotal Sales Revenue	000 CNY	7,020,400		0	0	1,188,000	3,210,240	1,224,064	818,384	524,376	35,000	20,336	0

Exhibit 11 (continued)

Construction Costs													
Highrises	000 CNY	(257,400)		0	0	0	(85,800)	(85,800)	(85,800)	0	0	0	0
Townhouses	000 CNY	(120,000)		0	0	(30,000)	(30,000)	(30,000)	(30,000)	0	0	0	0
Retail	000 CNY	(11,160)		0	0	0	(3,720)	(3,720)	(3,720)	0	0	0	0
Amenities	000 CNY	(4,500)		0	0	0	(1,500)	(1,500)	(1,500)	0	0	0	0
Basement	000 CNY	(263,905)		0	(105,562)	(79,172)	(26,391)	(26,391)	(26,391)	0	0	0	0
Subtotal Construction Costs	000 CNY	(656,965)		0	(105,562)	(109,172)	(147,411)	(147,411)	(147,411)	0	0	0	0
Total Revenue and Construction Costs	000 CNY	6,363,435		0	(105,562)	1,078,829	3,062,830	1,076,654	670,974	524,376	35,000	20,336	0
Sales-Related Costs													
Sales Tax	000 CNY	(351,020)		0	0	(59,400)	(160,512)	(61,203)	(40,919)	(26,219)	(1,750)	(1,017)	0
Added Value Tax	000 CNY	(210,612)		0	0	(35,640)	(96,307)	(36,722)	(24,552)	(15,731)	(1,050)	(610)	0
Other Taxes and Fees	000 CNY	(42,122)		0	0	(7,128)	(19,261)	(7,344)	(4,910)	(3,146)	(210)	(122)	0
Sales Commission	000 CNY	(35,102)		0	0	(5,940)	(16,051)	(6,120)	(4,092)	(2,622)	(175)	(102)	0
Total Sales-Related Costs	000 CNY	(638,856)		0	0	(108,108)	(292,132)	(111,390)	(74,473)	(47,718)	(3,185)	(1,851)	0
Unlevered Summary Net Cash Flow			**(2,180,510)**	**(11,950)**	**(147,421)**	**955,812**	**2,748,279**	**935,425**	**523,582**	**466,358**	**31,315**	**17,985**	**0**
Cumulative			(2,180,510)	(2,192,460)	(2,339,881)	(1,384,069)	1,364,211	2,299,636	2,823,218	3,289,576	3,320,891	3,338,876	3,338,876
Unlevered IRR			**23.37%**										
Construction Revolving Loan													
Loan Proceeds			1,308,306	7,170	88,452	0	0	0	0	0	0	0	0
Cumulative Loan Proceeds			1,308,306	1,393,974	1,566,065	1,660,029	803,819	0	0	0	0	0	0
Interest			(78,498)	(83,638)	(93,964)	(99,602)	(48,229)	0	0	0	0	0	0
Loan Payoff			0	0	0	(955,812)	(852,048)	0	0	0	0	0	0
Levered Summary Net Cash Flow			**(872,204)**	**(4,780)**	**(58,968)**	**0**	**1,896,231**	**935,425**	**523,582**	**466,358**	**31,315**	**17,985**	**0**
Cumulative			(872,204)	(876,984)	(935,952)	(935,952)	960,279	1,895,704	2,419,286	2,885,644	2,916,959	2,934,945	2,934,945
Levered IRR			**35.62%**										

Exhibit 11 (continued)

CAPITAL FLOWS		
Bank Line Drawn		1,403,928
Max Capital In (Ceiling)		7,500,000
Total Capital Required		935,952
Acumen	51.00%	477,336
Golden City	49.00%	458,617
Total	100.00%	935,952

		Totals	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Levered Net Cash Flow Before Distributions		2,934,945	(872,204)	(4,780)	(58,968)	0	1,896,231	935,425	523,582	466,358	31,315	17,985	0
Capital Contributions													
Acumen	51.00%	477,336	444,824	2,438	30,074	0	0	0	0	0	0	0	0
Golden City	49.00%	458,617	427,380	2,342	28,894	0	0	0	0	0	0	0	0
Project	100.00%	935,952	872,204	4,780	58,968	0	0	0	0	0	0	0	0
Project Distributions													
Distribution to First Hurdle	18.00%	845,019	(872,204)	(4,780)	(58,968)	0	1,780,971	(0)	0	0	0	0	0
Distribution to Second Hurdle	21.00%	197,805	0	0	0	0	115,261	82,545	0	0	0	0	0
Distribution to Final Hurdle		1,892,121	0	0	0	0	0	852,880	523,582	466,358	31,315	17,985	0
Partner Distributions													
Acumen CF to First Hurdle	51.00%	430,959	(444,824)	(2,438)	(30,074)	0	908,295	(0)	0	0	0	0	0
Golden City CF to First Hurdle	49.00%	414,059	(427,380)	(2,342)	(28,894)	0	872,676	(0)	0	0	0	0	0
Acumen CF to Second Hurdle	60.00%	118,683	0	0	0	0	69,156	49,527	0	0	0	0	0
Golden City CF to Second Hurdle	40.00%	79,122	0	0	0	0	46,104	33,018	0	0	0	0	0
Acumen CF to Final Hurdle	70.00%	1,324,484	0	0	0	0	0	597,016	366,507	326,450	21,921	12,590	0
Golden City CF to Final Hurdle	30.00%	567,636	0	0	0	0	0	255,864	157,075	139,907	9,395	5,396	0
Overall Net Cash Flows													
Acumen		1,874,127	(444,824)	(2,438)	(30,074)	0	977,451	646,543	366,507	326,450	21,921	12,590	0
Golden City		1,060,817	(427,380)	(2,342)	(28,894)	0	918,780	288,882	157,075	139,907	9,395	5,396	0
Project		**2,934,945**	**(872,204)**	**(4,780)**	**(58,968)**	**0**	**1,896,231**	**935,425**	**523,582**	**466,358**	**31,315**	**17,985**	**0**

JV & PROJECT RETURN METRICS	IRR	NPV	Gross Payback Ratio
Acumen	39.64%	$484,857	4.93
Golden City	30.64%	$204,662	3.31
Project	35.62%	$1,045,329	4.14

Source: Created by case authors from company documents. Some figures have been disguised.

Exhibit 12 Ex Post Project Cash Flow and Capital Structure

SALES CURVES	Totals	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Housing Discount			100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	90.0%	90.0%	100.0%	100.0%
Highrise	100.0%		0.0%	0.0%	0.0%	40.0%	-1.0%	14.8%	20.0%	15.0%	10.0%	1.2%
Townhouse	100.0%		0.0%	0.0%	72.0%	9.0%	-2.4%	11.4%	10.0%	0.0%	0.0%	0.0%
Retail	100.0%		0.0%	0.0%	0.0%	0.0%	0.0%	30.0%	30.0%	15.0%	15.0%	10.0%
Parking	100.0%		0.0%	0.0%	0.0%	0.0%	2.7%	28.2%	28.0%	20.0%	15.0%	6.1%

COST CURVES	Totals	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Primary Infrastructure	100.0%		0.0%	0.0%	5.0%	10.0%	10.0%	65.0%	10.0%	0.0%	0.0%	0.0%
Pre-Construction	100.0%		5.0%	90.0%	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Consultant Fees	100.0%		30.0%	30.0%	10.0%	10.0%	20.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Social Infrastructure	100.0%		0.0%	0.0%	0.0%	15.0%	70.0%	15.0%	0.0%	0.0%	0.0%	0.0%
Indirect Fees	100.0%		0.0%	20.0%	10.0%	20.0%	30.0%	20.0%	0.0%	0.0%	0.0%	0.0%
Basement	100.0%		0.0%	40.0%	30.0%	10.0%	10.0%	10.0%	0.0%	0.0%	0.0%	0.0%

SUMMARY CASH FLOW		Totals	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Land & Infrastructure Cost													
Land Purchase	000 CNY	(2,117,000)	(2,117,000)										
Primary Infrastructure	000 CNY	(98,000)		0	0	(4,900)	(9,800)	(9,800)	(63,700)	(9,800)	0	0	0
Pre-Construction	000 CNY	(25,000)		(1,250)	(22,500)	(1,250)	0	0	0	0	0	0	0
Consultant Fees	000 CNY	(34,000)		(10,200)	(10,200)	(3,400)	(3,400)	(6,800)	0	0	0	0	0
Social Infrastructure	000 CNY	(400)		0	0	0	(60)	(280)	(60)	0	0	0	0
Indirect Fees	000 CNY	(38,000)		0	(7,600)	(3,800)	(7,600)	(11,400)	(7,600)	0	0	0	0
Management Fees & Overhead	000 CNY	(5,000)		(500)	(500)	(500)	(500)	(500)	(500)	(500)	(500)	(500)	(500)
Land Taxes													
Land Contract Tax	000 CNY	(63,510)	(63,510)										
Land Use Tax	000 CNY	(5,293)		0	(1,059)	(1,059)	(1,059)	(1,059)	(1,059)	0	0	0	0
Total Land & Infrastructure Cost	000 CNY	(2,386,203)	(2,180,510)	(11,950)	(41,859)	(14,909)	(22,419)	(29,839)	(72,919)	(10,300)	(500)	(500)	(500)
Revenue and Construction Costs													
Closings													
Highrises	m^2	143,000		0	0	0	57,200	(1,430)	21,164	28,600	21,450	14,300	1,716
Townhouses	m^2	60,000		0	0	43,200	5,400	(1,440)	6,840	6,000	0	0	0
Retail	m^2	6,200		0	0	0	0	0	1,860	1,860	930	930	620
Parking (only Highrise)	Spaces	1,222		0	0	0	0	33	345	342	244	183	75
Sales Revenue													
Highrises	000 CNY	2,180,321		0	0	0	903,760	(22,594)	334,391	406,692	305,019	225,940	27,113
Townhouses	000 CNY	1,520,640		0	0	1,105,920	138,240	(36,864)	175,104	138,240	0	0	0
Retail	000 CNY	49,600		0	0	0	0	0	14,880	14,880	7,440	7,440	4,960
Parking (only Highrise)	000 CNY	61,100		0	0	0	0	1,650	17,230	17,108	12,220	9,165	3,727
Subtotal Sales Revenue	000 CNY	3,811,661		0	0	1,105,920	1,042,000	(57,808)	541,605	576,920	324,679	242,545	35,800

Exhibit 12 (continued)

Construction Costs													
Highrises	000 CNY	(257,400)		0	0	0	(85,800)	(85,800)	(85,800)	0	0	0	0
Townhouses	000 CNY	(120,000)		0	0	(30,000)	(30,000)	(30,000)	(30,000)	0	0	0	0
Retail	000 CNY	(11,160)		0	0	0	(3,720)	(3,720)	(3,720)	0	0	0	0
Amenities	000 CNY	(4,500)		0	0	0	(1,500)	(1,500)	(1,500)	0	0	0	0
Basement	000 CNY	(263,905)		0	(105,562)	(79,172)	(26,391)	(26,391)	(26,391)	0	0	0	0
Subtotal Construction Costs	000 CNY	(656,965)		0	(105,562)	(109,172)	(147,411)	(147,411)	(147,411)	0	0	0	0
Total Revenue and Construction Costs	000 CNY	3,154,696		0	(105,562)	996,749	894,590	(205,219)	394,195	576,920	324,679	242,545	35,800
Sales-Related Costs													
Sales Tax	000 CNY	(190,583)		0	0	(55,296)	(52,100)	2,890	(27,080)	(28,846)	(16,234)	(12,127)	(1,790)
Added Value Tax	000 CNY	(114,350)		0	0	(33,178)	(31,260)	1,734	(16,248)	(17,308)	(9,740)	(7,276)	(1,074)
Other Taxes and Fees	000 CNY	(22,870)		0	0	(6,636)	(6,252)	347	(3,250)	(3,462)	(1,948)	(1,455)	(215)
Sales Commission	000 CNY	(19,058)		0	0	(5,530)	(5,210)	289	(2,708)	(2,885)	(1,623)	(1,213)	(179)
Total Sales-Related Costs	000 CNY	(346,861)		0	0	(100,639)	(94,822)	5,261	(49,286)	(52,500)	(29,546)	(22,072)	(3,258)
Unlevered Summary Net Cash Flow			**(2,180,510)**	**(11,950)**	**(147,421)**	**881,201**	**777,349**	**(229,797)**	**271,990**	**514,120**	**294,633**	**219,973**	**32,042**
Cumulative			(2,180,510)	(2,192,460)	(2,339,881)	(1,458,679)	(681,330)	(911,127)	(639,137)	(125,016)	169,617	389,590	421,632
Unlevered IRR			**3.34%**										
Construction Revolving Loan													
Loan Proceeds			1,308,306	7,170	88,452	0	0	137,878	0	0	0	0	0
Cumulative Loan Proceeds			1,308,306	1,393,974	1,566,065	1,660,029	878,429	291,664	309,164	55,724	0	0	0
Interest			(78,498)	(83,638)	(93,964)	(99,602)	(52,706)	(17,500)	(18,550)	(3,343)	0	0	0
Loan Payoff			0	0	0	(881,201)	(777,349)	0	(271,990)	(59,067)	0	0	0
Levered Summary Net Cash Flow			**(872,204)**	**(4,780)**	**(58,968)**	**0**	**0**	**(91,919)**	**0**	**455,053**	**294,633**	**219,973**	**32,042**
Cumulative			(872,204)	(876,984)	(935,952)	(935,952)	(935,952)	(1,027,871)	(1,027,871)	(572,818)	(278,185)	(58,211)	(26,169)
Levered IRR			**-0.35%**										

Exhibit 12 (continued)

CAPITAL FLOWS		
Bank Line Drawn		1,541,806
Max Capital In (Ceiling)		7,500,000
Total Capital Required		1,027,871
Acumen	51.00%	524,214
Golden City	49.00%	503,657
Total	100.00%	1,027,871

		Totals	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Levered Net Cash Flow Before Distributions		(26,169)	(872,204)	(4,780)	(58,968)	0	0	(91,919)	0	455,053	294,633	219,973	32,042
Capital Contributions													
Acumen	51.00%	524,214	444,824	2,438	30,074	0	0	46,879	0	0	0	0	0
Golden City	49.00%	503,657	427,380	2,342	28,894	0	0	45,040	0	0	0	0	0
Project	100.00%	1,027,871	872,204	4,780	58,968	0	0	91,919	0	0	0	0	0
Project Distributions													
Distribution to First Hurdle	18.00%	(26,169)	(872,204)	(4,780)	(58,968)	0	0	(91,919)	0	455,053	294,633	219,973	32,042
Distribution to Second Hurdle	21.00%	0	0	0	0	0	0	0	0	0	0	0	0
Distribution to Final Hurdle		0	0	0	0	0	0	0	0	0	0	0	0
Partner Distributions													
Acumen CF to First Hurdle	51.00%	(13,346)	(444,824)	(2,438)	(30,074)	0	0	(46,879)	0	232,077	150,263	112,186	16,341
Golden City CF to First Hurdle	49.00%	(12,823)	(427,380)	(2,342)	(28,894)	0	0	(45,040)	0	222,976	144,370	107,787	15,701
Acumen CF to Second Hurdle	60.00%	0	0	0	0	0	0	0	0	0	0	0	0
Golden City CF to Second Hurdle	40.00%	0	0	0	0	0	0	0	0	0	0	0	0
Acumen CF to Final Hurdle	70.00%	0	0	0	0	0	0	0	0	0	0	0	0
Golden City CF to Final Hurdle	30.00%	0	0	0	0	0	0	0	0	0	0	0	0
Overall Net Cash Flows													
Acumen		(13,346)	(444,824)	(2,438)	(30,074)	0	0	(46,879)	0	232,077	150,263	112,186	16,341
Golden City		(12,823)	(427,380)	(2,342)	(28,894)	0	0	(45,040)	0	222,976	144,370	107,787	15,701
Project		**(26,169)**	**(872,204)**	**(4,780)**	**(58,968)**	**0**	**0**	**(91,919)**	**0**	**455,053**	**294,633**	**219,973**	**32,042**

JV & PROJECT RETURN METRICS	IRR	NPV	Gross Payback Ratio
Acumen	-0.35%	($362,483)	0.97
Golden City	-0.35%	($348,268)	0.97
Project	-0.35%	($628,811)	0.97

Source: Created by case authors from company documents. Some figures have been disguised.

Exercise 1: Monte Carlo Simulation in Excel Applied to the Dushi Huayuan Case

Learning Objectives:

1. Familiarize yourself with the Dushi Huayuan project case.
2. Familiarize yourself with a typical investment and financial analysis pro forma for a real estate development project.
3. Practice building a Monte Carlo simulation model in Excel using the Data Table utility.

Background on Case:

The case is about a mixed-use—but primarily residential—project in close proximity to a newly developed Central Business District (CBD) of a second-tier city in China. It is an ongoing development with a total floor area of roughly 212,000 square meters. Dushi Huayuan was designed to house approximately 2,600 people, or 819 households, in modern townhouses and high-rise apartments. Service retail and social amenities were planned in the ground floor podium space of the high-rise buildings.

Fa Ping of Acumen Properties ("General Partner," also referred to as "GP" or "Managing Partner") has teamed up with Golden City Capital ("Limited Partner," also referred to as "LP" or "Money Partner") who will contribute 49% of the total equity.

Acumen bought the land in December of 2009, launched the project in 2010, and broke ground in 2011. They projected the construction and sales period to span nearly an entire decade. When Acumen and Golden City began evaluating the project, they estimated that the total cost (including land cost) would total ¥2.34 billion CNY (about $360 million USD in 2015) with a maximum equity draw of ¥1.2 billion CNY (about $185 million USD in 2015).

Role of Case in Course:

In the past several decades, the real estate market in China exhibited significant sustained growth. Residential developers in China typically made decisions based on their experience and intuition rather than using careful and detailed quantitative analysis. But beginning in 2011, the housing market in China cooled, dropping real estate development margins. And as China's economic growth matured, construction costs slowly escalated. In this riskier economic environment, executing investment decisions without careful quantitative analyses could put developers in a more vulnerable position when the housing market fluctuates. The Dushi Huayuan case and its corresponding exercises provide a framework to conduct a detailed quantitative analysis of a typical Chinese large-scale, master-planned project. We will use this project as a platform for developing a better understanding of the tools presented in this course. It's our belief that these tools will help push the frontier of analyzing real estate development opportunities. Evaluating projects like Dushi Huayuan through the lens of a rigorous quantitative analysis will not only change our perspective on real estate development in China, but also provide guidance on obtaining greater expected returns over the lifetime of the project. There are two major elements of the sophisticated quantitative analysis. First, beyond simply evaluating a base case pro forma projection about the future, we explicitly recognize that the future is uncertain, and we model the effect such uncertainty can have on the project's ex post performance. Second (in later assignments), we recognize that large-scale multi-building projects usually have flexibility, at least potentially, in exactly when, or even how much, buildout will ultimately be realized.

The process begins in the present assignment with modeling a 10-year financial pro forma. From there, a simulation process (referred to as the "ex ante inflexible model") is built to take into account crucial exogenous dynamic economic variables—uncertainties in the real world—that largely affect project outcomes. Then we will analyze the simulated investment performance of the project focusing on the range of possible net present values (NPV) achieved ex post, initially using the ex ante inflexible model. The analysis is referred to as "ex ante" because it is undertaken before the project actually is built. The ex ante inflexible model is limited in nature by its inability to evaluate the impact of flexibility (call options) on real estate projects because it assumes the original pro forma plan will be carried out exactly as planned ex ante, no matter what happens in the real estate market ex post. The analysis without flexibility may in some instances be realistic, if institutional constraints prevent the developer from altering the original plan or program. But more generally, the inflexible analysis provides a benchmark against which we can compare and evaluate possible types of flexibility that the project may have, such as phasing and the ability to delay or abandon later phases. (As noted, such flexibility will not be modeled in this first assignment.) When we introduce flexibility into the ex ante model, we'll be able to play around with different market factors to see what affect flexibility has on expected net present value (ENPV). Finally, in Exercise 3, a "waterfall analysis" will be modeled for the two Joint Venture (JV) partners—Acumen and Golden City—to illustrate the financial structure of the deal and help us determine if each partner's incentives are correctly aligned to ensure the project's success.

The Assignment:

1. **Create DCF Model.** The purpose of the first exercise is to introduce the Dushi Huayuan case by getting you familiar with modeling uncertainty about the future in the Excel model of the project's DCF (Discounted Cash Flow) and NPV (Net Present Value). Your first analytic task is to create the ex ante DCF projection model of Dushi Huayuan from the case pro forma, which reflects Acumen's initial assumptions and the project's projected value.

2. **Monte Carlo Simulation.** The second analytic task is to create a simulation model (also known as Monte Carlo). Monte Carlo simulation runs numerous future scenarios about the real estate market and applies them to a DCF analysis assuming the base case pro forma execution of the project program. It thereby calculates a *range* of ex ante return metrics (e.g. NPVs, IRRs, etc.); the characteristics of the range's distribution is important in drawing conclusions about how specific market conditions, and the uncertainty surrounding the future, affect the projected returns in the DCF model. The uncertainty of future scenarios are simulated in the Monte Carlo analysis with randomly generated numbers. In this model, you will run 2,000 random "trials" or "futures" (each may be thought of as a "scenario") and tabulate the ex ante distribution of the simulated ex post return metrics across all of these trials. We can then examine various aspects of this ex ante distribution of possible outcomes: its mean, its median, various percentiles, standard deviation, indeed, the entire "shape" of the outcome possibility distribution. As noted, here in Exercise 1 you will ignore any flexibility (buildout delay option and expansion options) and assume Acumen will completely execute the project as it was projected in the base case pro forma, regardless of what you simulate

for China's future real estate market in the model. You will introduce flexibility into the model in Exercise 2.

Exercise 1 Consists of the Following Tasks:

1. **Case Material.** Read the Dushi Huayuan case carefully and study the cash flows in **Exhibits 10** and **11** of the Dushi Huayuan case.

2. **Excel Template.** Download the Exercise 1 Excel template from the course Stellar website. First, save your copy as "Lastname_Firstname_DushiHuayuanEx1" and work from this copy. Go to the **Intro** worksheet (first tab at far left side of the workbook), which explains the several sheets of the template. Read the chart very carefully before you proceed to the following analytic tasks.

3. **Complete the Dushi Huayuan DCF Model.** To make sure that you understand the DCF model, complete the blank ("Fill in") rows of the DCF spreadsheet in the **ExAnteInflex** worksheet. Insert the projected costs and prices for the project. Fill these cells in with the appropriate formulas, not "hardwired" numbers. You can use the completed DCF model from the pro forma (**ProForma** worksheet) as a model. (Essentially, explore the formulas in the **ProForma** sheet, understand why those formulas are used there, and then create the corresponding formulas in the **ExAnteInflex** sheet.) Verify that with the pro forma base case assumptions, the outcomes of **ExAnteInflex** are exactly the same as the pro forma when both (1) the uncertainties all zeroed out on the **OptionAnalysisDashboard** sheet and (2) trend is also zeroed out on the **MktDynamicsInputs** sheet (cell D35). Note that on the **OptionAnalysisDashboard** sheet, you should not zero out the cycle periods (cells C24:C25). Now all the "Price Factors" located in the blue panel above the red "Cash Flow" panel in the cash flow worksheets (red tabs) should be equal to "1.0000."

4. **Create the Simulation Mechanism.** Construct a 2,000-trial Monte Carlo simulation model of the ex ante NPV results under uncertainty for this project in the **Simulation** sheet. Recalculate (by hitting the "Calculate Now" button in the "Formulas" tab or by hitting F9) to run the simulation. Make sure that you get the same ex ante NPV for all 2,000 scenarios and this number equals the NPV projected on the base case pro forma in the **ProForma** sheet.

The NPVs should all be the same because at this point there is no uncertainty in the Excel model. All the uncertainty and price dynamics input parameters such as pricing cycles and volatility have been "zeroed out" in the **MktDynamicsInputs**, **ProjectDynamicsInputs**, and **OptionAnalysisDashboard** sheets. In other words, you have set up the mechanism to conduct a Monte Carlo simulation, but haven't actually executed the simulation yet. As the model currently stands, you're looking at what the world would be like if there was no uncertainty, if everything really were deterministic and the future would for sure equal the pro forma base case projection.

5. **Add Uncertainty by Manipulating Future Price Dynamics.** Now we will add a little uncertainty into the model. Let's start off by simply giving the real estate market pricing some volatility. In the **OptionAnalysisDashboard** sheet, insert 15.00% in the Volatility/Year input (cell C18) and run the simulation. After a few seconds, you will see a nice S-shaped curve emerge in the NPV Cumulative Distribution Function graph directly to the right of the inputs. (S-shaped cumulative distribution corresponds to bell-shaped frequency distribution.) This graph displays the distribution of the ex ante NPV outcomes across the 2,000 simulated future scenarios. You should also take note that the Price Factors located in the **BLUE** panel above the red Cash Flow panel in the **ExAnteInflex** and **ExAnteFlex** worksheets have all changed from "1.0000" except for the "Construction Costs" row, which remains constant in our model so long as uncertainty in the long-run trend growth rate equals 0.00% (cell D32 on the **MktDynamicsInputs** sheet). These changes in the price factors are how the model represents and reflects the random future scenarios in the real estate markets. They are the result of random number generation by Excel, and in this case they now reflect the 15.00% market volatility that you have entered into the model. Consequently, the change in the Price Factors will now vary the return metrics in the ex ante scenarios from the static pro forma and ex post DCF models. The ex ante DCF sheets now display one possible future outcome (the last one generated out of the 2,000 trials that correspond to the 2,000 rows in the **DataTable** sheet) given the new uncertainty and future price dynamic assumptions that are now taken into account in the model.

6. **Change Other Inputs.** Next we will change a "first moment," that is, a "central tendency" parameter. Go to the **MktDynamicsInputs** sheet and change the Trend/Year input from 0.00% to 1.00% (cell D35). Press F9 to recalculate. Flip over to the **OptionAnalysisDashboard** sheet and you should notice that the shapes of the ex ante NPV probability distribution curves look the same, but they have shifted to the right. This market change, *ceteris paribus*, increases the expected net present value (ENPV) as illustrated by the right curve shifts. A central tendency of 1.00%/year growth in real estate prices adds about ¥50 million CNY to the ex ante NPV.

Submit Assignment on Stellar:

1. Paste screenshots of the first five years of your DCF and of your final (after Task 6) target curves from the NPV Cumulative Distribution Function graph in the **OptionAnalysisDashboard** sheet into a Word document. Please fit all of this content into a one-page Word document.
2. Name your document "Lastname_Firstname_DushiHuayuanEx1" and submit the assignment on Stellar.

All students should hand in their own individual solution. However, you are free to consult with and help each other in studying and doing the exercises. Assignments will not be "graded" as such, only checked to see if you are keeping up with course and/or might need some help.

Exercise 2: Using Monte Carlo to Value Flexibility in the Dushi Huayuan Case

Learning Objectives:

1. To become familiar with how you can model project flexibility in an Excel simulation model of a realistic development project.
2. To create and use a multidimensional table of outcomes to provide a basis for choice.
3. To identify in what circumstances and how "put" forms of flexibility can reduce project exposure to downside risk, and in what circumstances it cannot.
4. To identify in what circumstances and how "call" forms of flexibility can increase upside opportunities and project performance, and in what circumstances it cannot.
5. To combine "put" and "call" forms of flexibility to achieve good planning/design portfolios.

Exercise 2 Model Includes Flexibility:

The previous Excel workbook in Exercise 1 is a good working simulation model of the performance of Dushi Huayuan without flexibility. It uses the Monte Carlo simulation to reflect uncertainty regarding the crucial exogenous dynamic economic variables that largely determine the project outcome (e.g. rents, prices, costs). It considers that:

1. The project operates within a *market.*
2. Demand and supply *quantities* can be largely represented by their *price* effects for purposes of economic analysis of the project (Revenue = Price × Quantity, so when demand changes, this can be reflected in either price or quantity and the revenue effect is the same).

The model also provides some limited ability to specify the physical and economic parameters of a "base case" for analyzing project designs.

The Dushi Huayuan Exercise 2 model extends the Exercise 1 model by introducing several basic types of flexibility that could exist in such a project. We suspect the model build-up process reflected in Exercises 1 and 2 might often be useful in real applications:

- Start from the traditional deterministic DCF pro forma that is widely used in current practice (represented here by the case **Exhibit 11**).

- Model just the uncertainty (the Monte Carlo simulation) as in Exercise 1.
- Add some relevant types of flexibility that could (or perhaps should) exist in the project.

Here we introduce three basic types of flexibility that could exist in this type of project:

1. The first type of flexibility mitigates downside losses by providing the ability to delay any or all phases, and indeed to abandon (never build) one or more of the phases. This option thereby defers or even avoids the associated construction costs. If the real estate market turns so bad that it prevents the sale of enough units at an acceptable price, then such defensive options can be very useful. In fact developers often use them in practice, though they rarely model them explicitly in DCF analysis and evaluation of the project before they make investment decisions.
2. Another type of flexibility takes advantage of upside opportunities through fully building out any of the phases. For example, Dushi Huayuan was designed to accommodate this type of flexibility with a vertical expansion option via the construction of a podium that is structurally capable of supporting high-rise residential units above. Acumen has the option to leave the high-rises unbuilt until favorable market conditions make it economically rational to execute the vertical expansion option. We model this vertical expansion option such that we can only exercise it after the initial phase has broken ground.
3. The final type of flexibility that can add value is a hybrid of the flexibilities mentioned above. The delay and buildout options can work in tandem. For example, by using the delay flexibility in the Townhouse Expansion Phase but then fully building out that phase in an up market, we can increase the upside tail of its performance outcome distribution. Improving the upside (right-hand) tail is similar to what a call option does ("offensive" flexibility). But delay is a type of "defensive" flexibility, so we're actually using them both together to create the value. This could happen because the base case profitability is so great. Delay doesn't really save much on the downside (losses in cash flow) because more of our costs are sunk immediately up front (predominately, the land cost). But delay can enable us to avoid selling into a down market by waiting for the market to turn favorable, then exercising the call option to build into the favorable market.

When the initial phase is triggered ("GoBO"), the expansion phases will not necessarily also be triggered. The expansion phases are independent of each other, which means each expansion option can be executed at any time after the initial phase depending on the trigger values set for each expansion phase. In other words, when the market is healthy enough to absorb newly built high-rise condominiums, Acumen can start the High-Rise Expansion Phase. Alternatively, if the market softens for the same product or Acumen expects prices of high-rise condominiums to rise in the future, they have the option to leave the High-Rise Expansion Phase unbuilt. The same applies for the Townhouse Expansion Phase.

Reference the **ProjectFlexInputs** sheet Decisions panel (cells K11:M34) to understand how the flexibility options have been programmed. To implement each of these types of flexibility in the Excel model we inserted two different elements: (1) "Decisions" using IF statements and (2) "Decision Triggers." First, the Decisions panel determines what to do as a result of a test. For example, if the IF statement indicates that the market is developing poorly enough, the "Decision" for the Delay Buildout option triggers the option to delay implementation of the phase in question (cells K11:K34). (Once a phase is started it must be completed.) The Decision Triggers are defined on the **OptionsAnalysisDashboard** sheet in the Project Flexibility Decision Triggers panel (cells C34:C36). These triggers should reflect typical or realistic thresholds of decision makers in Dushi Huayuan's development stage. The flags in the **ProjectFlexInputs** sheet Decisions panel are transposed into the **ExAnteFlex** sheet in the **BLUE** Decision Status panel directly above the **RED** dynamic Cash Flow panel. In general, the **BLUE** region in rows 11-14 at the top of the **ExAnteFlex** sheet indicates the status of each option decision in each future year of the project. IF statements for the timing of the three phases (rows 18, 51, and 61) reflect whether the trial history has triggered a flexibility option, and thus changes the value displayed in each year's cell depending on the flag directly above in the Decision Status panel. As noted, once a phase is triggered, it must be completed.

The following paragraphs explain the flexibility mechanics in more detail.

Consider the formulas in row 51 in the **ExAnteFlex** worksheet. This row determines the timing for the High-Rise Expansion Phase. After Year 0, they contain an IF statement that checks row 13 to see if the high-rise expansion flag indicates the triggering condition for vertical expansion. If the flag reads "HRHold," then the High-Rise Expansion Phase has not been triggered while if it reads "HRGo," then the high-rise expansion option has been executed. In other words, if row 51 displays

"Year 0," then the High-Rise Expansion Phase hasn't commenced while if row 51 displays a year number other than zero, then the high-rise expansion option has been executed. Once triggered, that phase's buildout follows as per the original pro forma base case program, which is indicated by the "Year" designations in row 51.

Now reference row 53, which computes the floor area of high-rise units completed during the High-Rise Expansion Phase for each period. It calculates this by utilizing Excel's HLOOKUP function. The HLOOKUP references the static ex ante cash flows below the dynamic model shaded in **RED**, specifically, the total floor area of high-rises delivered (and sold) in row 142. The formulas in row 53 multiply the total floor areas in each year by a percentage of high-rises delivered (and sold) in the High-Rise Expansion Phase, as defined by in the **Assumptions** sheet (cell K8, Defined Name: Phase_HRExpansion_Highrise). As an example, Year 4 of the static ex ante cash flow specifies that 85,800 square meters of high-rises are sold (cell I142). The floor area sold in Year 4 of the high-rise expansion phase in the dynamic cash flow (row 53) is calculated as follows: 85,800 $m^2 \times 54.0\% \approx$ 46,302 m^2 ($\pm$ rounding error). All sales and construction costs are programmed in the same way.

To see if the history of the project in any trial of the Monte Carlo simulation warrants the exercise of any option, IF statements check the realized random profitability per square meter for the project against the trigger values in each year in which the options could possibly be triggered. These IF statements are in the Decisions panel of the **ProjectFlexInputs** sheet (columns K to M). In the case of the high-rise vertical expansion option, its IF statement (in column L) checks whether the average profitability over the two previous years (the current and previous year) exceeded or fell below the trigger value input. If the reference profitability exceeded the trigger value, this triggers the vertical expansion option (and inserts the "HRGo" flag). Otherwise, the indicator is the "HRHold" flag, which signifies we will hold the development of the High-Rise Expansion Phase until a more opportune time. The spreadsheet transposes the decision trigger flag in column L on the **ProjectFlexInputs** sheet to the corresponding period in row 13 on the **ExAnteFlex** sheet (by means of a TRANSPOSE() Excel array function) where it governs the implementation of the option, in each 24-year future history (each "trial" of the Monte Carlo simulation). The simulation model assumes that any phase that has not been completed within 24 years will be permanently abandoned.

As in Exercise 1, the **RED** DCF sheets compute the NPV and IRR of the project for one future history (one Monte Carlo trial). In a classical DCF pro forma (as on the **ProForma** worksheet), such an NPV or IRR would represent an ex ante expectation, looking into the future, interpreting the cash flows in the pro forma as being the expected cash flows ex ante. However, in what we're labeling the **ExAnte** worksheets, the cash flows in the **RED** section represent ex post realized cash flows, within the one particular future "history" (or "trial" or "scenario") that is reflected by the randomly generated pricing factors displayed in rows 5-9 in the **BLUE** section at the top. Thus, the NPV and IRR computed on the **ExAnte** sheets are actually ex post results. However, across the 2,000 trials of the Monte Carlo analysis there will be 2,000 possible such future realizations, and those will reflect a distribution of possible future outcomes, from the ex ante perspective of an analyst standing in the present before the implementation of the project and before the realization of the (one actual) future.

The way we implement the 2,000-trial Monte Carlo simulation is by calculating a new random future history reflected in each of the 2,000 rows of the Data Table (as you saw in Exercise 1). For the Exercise 2 model, in addition to the Levered IRR and NPV computed in cells D105 & D106 (in the **ExAnteFlex** sheet), we also compute the levered maximum capital draw, that is, the capital requirement or investment cost of the project (inclusive of any debt draw from the construction revolving loan), as this is another metric that is of interest to investors.

To make it easy to use the Exercise 2 workbook for analysis, we have programmed it so that inputs made on the **OptionsAnalysisDashboard** sheet govern a number of the inputs on the **BLUE Inputs** sheets. This allows you to change key inputs and see resulting outputs on the same sheet after recalculation.

The Exercise 2 Model Details:

The Exercise 2 model you download presents a more complete model of the Dushi Huayuan case than you had in Exercise 1. The Exercise 2 model comes with a set of default uncertainty inputs which reflect not only the volatility and drift or trend rate that you examined in Exercise 1, but also other types or sources of uncertainty and pricing dynamics that can be typical in real estate markets and projects. These include uncertainty in the:

- Price-change long-term trend rate.
- Momentum or "memory" in the volatility (an autoregressive process).
- Cycles, separately, in both the space market (rents) and the asset market (cap rate).
- Random pricing noise (dispersion in prices).
- The possibility (fairly small) of a "black swan" event (a one-time negative "jump" in the asset market).

The uncertainty parameter inputs also allow separate price dynamics across the different real estate products (high-rise condominiums, townhouses, retail, and parking), as well as a specified degree of positive cross-correlation among the four products. (Construction cost uncertainty and price dynamics can also be input.) We will review these uncertainty characteristics in class and you can peruse them at will on the two **BLUE DynamicsInputs** sheets. **To simplify Exercise 2, leave all these uncertainty and dynamics assumptions as is throughout Exercise 2.**

Exercise 2 also expands the possible future horizon. It allows up to 24 years to implement the Dushi Huayuan project, compared to 10 years in the base case. This allows the project to experience a considerable amount of delay flexibility, and ultimately even abandonment at the end of the 24-year horizon. The way the delay flexibility works in the Exercise 2 model is that we maintain the relative temporal pattern of the infrastructure costs, sales, and construction costs as in the base case, but then allow the possibility of delaying the commencement of any given phase depending on the outcome of the decision rules. However, mid-phase delays cannot occur. Once a phase has begun construction, its cash flows will follow the temporal pattern defined in the base case. We apply this method of preserving a base plan or exogenously specified "model" temporal pattern to the buildout and resulting cash flows. While this assumption is clearly a simplification of reality, it makes sense as an approximation, because there is usually some design and planning logic in the relative temporal pattern of the cost outlays.

The Exercise 2 model also has a technical difference from Exercise 1, regarding the mechanics of the Monte Carlo simulation in Excel. In Exercise 1 you computed a separate Data Table for the case. In Exercise 2 we have only one Data Table that serves for any number of model outputs (on the **DataTable** sheet). This streamlines and speeds the simulation computations compared to Exercise 1. It halves the number of simulation "trials" that Excel has to run to compare alternatives.

It also causes all of the results for comparison to derive from the same set of realized random numbers within each trial (equivalent to setting the random number generators with the same "seed" value). This also enables us to observe trial-by-trial differences between the alternatives we are comparing (i.e. differences holding constant the actual random realizations in the future "histories"). We have inserted a **Differences** sheet and scatterplots of some of the trial-by-trial outcome differences on the **OptionAnalysisDashboard** sheet.

Note that the posted Exercise 2 model sets the decision rule triggers at starting values that effectively eliminate any flexibility. That is, we have set all the option triggers to equal ¥0 CNY so that the delay buildout option will never be exercised and both expansion options will always occur concurrently with the initial phase. Also, we have not entered the appropriate IF statement for the townhouse horizontal expansion option. Your job in this assignment will be, first, to input a correct IF statement formula into column M (in the **ProjectFlexInputs** sheet) to implement the horizontal expansion; and then to explore how different decision triggers implement each option, keeping track of multi-dimensional metrics of how good (or bad) the project looks, with the options.

Exercise 2 Consists of the Following Tasks:

1. Program the decision rule for the townhouse expansion option.
    - Download the Exercise 2 Excel template from the course Stellar website.
    - First, save your copy as "Lastname_Firstname_DushiHuayuanEx2" and work from this copy.
    - In the **ProjectFlexInputs** worksheet, in the cells M11:M34, enter a formula similar to the vertical expansion option decision formula in the corresponding cells in column L, only applying to the horizontal expansion option whose trigger is displayed in cell D6.
    - Make the flags "THGo" and "THHold," respectively, to either trigger, or not trigger, the horizontal expansion option. (Note that the results in column M will be transposed into Row 14 in the **ExAnteFlex** sheet.

2. Program the expansion option trigger IF statement on the **ExAnteFlex** sheet.

- Go to **ExAnteFlex** sheet. Understand the formula in cell F51 (and propagated across row 51) which calculates the timing that corresponds with the high-rise expansion trigger above, in row 13.
- Beginning in cell F61 (and propagated across row 61), fill in the missing townhouse expansion option years using the same logic used for the high-rise expansion timing in row 51.
- After you've correctly programmed the formulas in row 61, recalculate the spreadsheet either by pressing "F9" or clicking the "Calculate Now" button in the "Calculation" panel of the "Formulas" tab. With the trigger values set as their default values from when you downloaded the Excel template, the model will run the no-flexibility base for the **ExAnteFlex** results, assuming you have programmed in the valid decision rule.
- Verify that you have the no-flexibility base case by checking on the **OptionAnalysisDashboard** sheet that the simulation results are exactly the same for the ex ante inflexible as for the ex ante flexible case (this means that the model is effectively set to allow no flexibility). The simulation results statistics appear in the Monte Carle Model Simulation Results – NPV Statistics panel of the **OptionAnalysisDashboard** sheet (cells B4:D13), with the NPV Cumulative Distribution target curves shown in the chart directly to the right of the panel. The **RED** flexible curve should lie right on top of the **BLUE** inflexible curve.

3. Understand the effects of certain trigger values on the NPV Cumulative Distribution curves for each option.
    - Test different triggers to tease out "tipping points" or crucial moments where the NPV distribution curves have a significant relationship with each other.
    - First, let's test the Delay Buildout Option Only scenario. Try a few trigger values less than ¥10,000 CNY using intervals of ¥1,000 CNY. Notice the Mean (ENPV) for both Inflexible and Flexible curves are equal. Also take note of the 2,000 simulations run in the model; the ratio of trials of the Flexible model's NPV greater than the Inflexible model's NPV should be 1.00, meaning both the Flexible and Inflexible models' NPVs are equal to each other. What does this imply? It tells us that the Flexible project plan

(given our current assumptions) does not provide any additional value to the owners and investors of the project over the Inflexible model. Now, try ¥25,000 CNY as the trigger value for the Delay Buildout Option Only. What changed? Explain the shape of the Flexible NPV Distribution curve's low tail and make a hypothesis as to why Flexibility with this type of triggering actually causes worse outcomes on average and in more cases than not.

Solution: When trying out a large trigger value like ¥25,000 CNY, the Flexibility curve's low tail will rise from roughly 0% probability to well above 70% probability and flatten out, indicating a higher probability overall for downside scenarios. Delay flexibility in our case actually causes worse outcomes on average and in more cases than not because so much of the costs of the project are sunk upfront in the land purchase and marginal construction costs for buildout are minimal in comparison to the revenues generated from buildout. Delaying buildout of the project as a whole (because delaying the initial phase subsequently delays the other two expansion phases) delays Acumen from collecting large marginal profits from buildout. Due to the high sunk costs upfront, it almost always makes sense for Acumen to build immediately (and quickly!) to recoup those initial costs.

- Zero out the Delay Buildout Option Only scenario. Moving down to the next scenario—Highrise Expansion Option Only—try trigger values less than ¥10,000 CNY using intervals of ¥1,000 CNY and then try ¥25,000 CNY again (having reset the Delay Buildout trigger back to zero). How do these results compare with the Delay Buildout Option Only scenario?

  Solution: Results should be almost identical to the Delay Buildout Option scenario.
- Zero out the Highrise Expansion Option Only scenario. Now let's test the Townhouse Expansion Option Only trigger values. What happens for trigger values less than ¥10,000 CNY using intervals of ¥1,000 CNY and a trigger value of ¥15,000 CNY? You'll notice at this point that the ¥15,000 CNY trigger value for this option *sometimes* results in a higher number of trials where the Flexible model's NPV is greater than the Inflexible model's NPV, as shown by a ratio of the number of trials in which Flexible NPV is greater than the Inflexible NPV divided by the number of trials in which Inflexible NPV is greater than Flexible NPV. In this case, *sometimes* the ratio is greater

than 1.00 (cell C13). Still, it's difficult to conclude the Flexible model provides value overall when this metric is so close to the 1.00 ratio and isn't consistently above 1.00.

4. Increase construction costs.
    - In an attempt to find scenarios where the Flexible model provides value, we are going to try increasing construction costs. Since construction costs in China (during the time of writing this case) are so low relative to sales prices, it almost always makes more sense to build the entire project immediately, as shown by testing the last set of triggers in Task 3. Due to the wide delta between construction costs and sales prices, flexibility didn't provide much value in current market conditions. (In options terminology, the options are so "deep in the money" that it doesn't make sense not to exercise them as soon as possible, and by giving decision makers some flexibility to delay, they will sometimes take that suboptimal decision, unless the decision trigger is set so low that the delay circumstance never arises.) However, if we decrease profitability by increasing construction costs, perhaps we'll find that the Flexible model has some value to add.
    - In the **Assumptions** sheet, increase all costs (**BLUE** cells D24:D33) by ¥5,000 CNY.

5. Test triggers with increased construction costs.
    - Repeat task 3 with the following trigger values:

Scenarios	Test Trigger Range (Intervals)	Test Trigger (Maximizing "Trials Flex > Inflex NPV Ratio")
Delay Buildout Option Only	¥0 – ¥10,000 CNY (¥1,000 CNY)	¥0 CNY
Highrise Expansion Option Only	¥0 – ¥10,000 CNY (¥1,000 CNY)	¥0 CNY
Townhouse Expansion Option Only	¥0 – ¥10,000 CNY (¥1,000 CNY)	¥14,000 CNY

- What do you notice? Are there any scenarios where there is trigger that yields a "Trials Flex > Inflex NPV Ratio" ratio greater than 1.00? Explain your findings.

  Solution: The only scenario that should yield a trigger that yields a ratio > 1.00 is ¥14,000 CNY as the trigger for the Townhouse Expansion Option Only scenario (while all other triggers are zeroed out). This trigger should generate a ratio around 1.50 or greater. Increasing triggers for the other two options only make a stronger case for the Inflexible model producing a greater NPV than the Flexible model.

6. Record results in a multidimensional table.
   Background: Now we want you to gain familiarity with the multi-dimensional nature of the "engineering perspective" on how to judge or evaluate project plans. This differs from the "economic perspective" in the following way. Microeconomic normative and equilibrium models rely heavily on the concept of opportunity cost (or value), being defined by market equilibrium prices, what you can sell things for, or what you have to pay to obtain them. (Under certain assumptions about competitive and efficient markets, this value also coincides with what it costs society to produce the good or product in question, on the margin.) What we're calling the engineering perspective does not completely ignore this notion of opportunity cost, but it takes more of the perspective of a single decision-maker without so much focus on opportunity cost. The decision-maker might be an individual or an organization or an institution. The idea is that the decision maker has "preferences," considerations that are important in valuing and making decisions about the investment or the project at hand.

   From the engineering perspective the analysis and evaluation of the project may be interested in several metrics. In addition to average or expected NPV (labeled "ENPV"), there may be concern for the:

   - *entire shape of the "target curve"* (for example, the ex ante NPV probability distribution). We characterize the shape using statistics about the "tails" of the outcome probability curve, for example, the 5th and 95th percentiles of the ex ante NPV distribution. The 5th percentile reflects the downside tail, how much exposure to loss the project entails. The 95th percentile reflects the upside tail, how big a gain the project might conceivably achieve (though probably not, as there is only a five percent chance it will achieve an outcome equal or greater than the 95th percentile). Technical terms for these tails are the 5% Value at Risk (VAR) and Value at Gain.

- *probability that the flexibility programmed into the project will pay off* in the sense that the project will do better with, than without, the flexibility options, under the given decision rules (trigger values).

With this in mind, it is useful with the engineering model to set up a multidimensional table to compare the various plans on several figures of merit. We have set up a template for such a table in cells B38:K44 on the **OptionAnalysisDashboard** sheet, as depicted here:

TYPICAL SIMULATION RESULTS	Trigger Value Used	ENPV	ENPV Differ Flex Minus Inflex	P5 (5%ile)	5%ile Differ Flex Minus Inflex	P95 (95%ile)	95%ile Differ Flex Minus Inflex	Trials Flex > Inflex NPV Ratio
No Flexibility	N/A	¥0	N/A	¥0	N/A	¥0	N/A	0.00
Delay Buildout Option Only	¥0	¥0	¥0	¥0	¥0	¥0	¥0	0.00
Highrise Expansion Option Only	¥0	¥0	¥0	¥0	¥0	¥0	¥0	0.00
Townhouse Expansion Option Only	¥0	¥0	¥0	¥0	¥0	¥0	¥0	0.00
All Options Together	N/A	¥0	¥0	¥0	¥0	¥0	¥0	0.00

The overall task is to fill in the five rows and eight columns of this table. You will obtain the numbers needed by running your Monte Carlo simulation with inputs set to represent each of the five cases of flexibility listed (as each row in the table). In detail:

- The first alternative is the No Flexibility base case. Find its simulation results statistics in the Monte Carle Model Simulation Results – NPV Statistics panel of the **OptionAnalysisDashboard** sheet (cells B4:D13). Manually fill in these statistics into appropriate columns of the outputs table (when copy and pasting, paste "As Values" so the numbers remain as you change the inputs and recalculate the simulation results for the next scenario). The "Differ" columns require that you compute the difference between the value of the No Flexibility case and the other scenarios with flexibility for the respective value dimensions (ENPV, P5, P95). These columns will be blank or N/A in this case because the top row of the Typical Simulation Results table *is* the No Flexibility case.
- Investigate the Delay Buildout Option Only separately. To do this you change only the decision trigger values (cells C34:C36 on the **OptionAnalysisDashboard** sheet) which implement the option in that row of the outputs table. For example, to test the Delay Buildout Option Only, only change the trigger value in cell C34. Raise this trigger value above the ¥0 CNY level the template comes with. Try to find

something like the "best" values for these triggers (hint: they will likely be similar to values in the "Test Trigger" column in Task 5's table), those that maximize the value of each respective option. Record your simulation results into the Delay Buildout Option Only row in the multidimensional table.

- Then, move to the third row of the table and investigate the Highrise Expansion Option Only scenario. To do this, reset the Delay Buildout trigger back to its original ¥0 CNY value (to disable this option) and now set the Highrise Expansion trigger (in cell C35) to a value that maximizes the value of the option. Record your simulation results into the Highrise Expansion Option Only row in the multidimensional table.
- Repeat the same process now for the Townhouse Expansion Option Only in the fourth row of the Typical Simulation Results table.
- Finally, combine All Options Together to see their joint effect. To do this, reset all the trigger values for all three options (C34:C36) to their best trigger value levels. You are likely to find that the combination of All Options Together leads to better overall results, as it combines the distinct effects of the puts and calls. However, these results are unlikely to be additive! Again, record your simulation results into the All Options Together row in the multidimensional table.

Sample Solution for Typical Simulation Results Table:

TYPICAL SIMULATION RESULTS	Trigger Value Used	ENPV	ENPV Differ Flex Minus Inflex	P5 (5%ile)	5%ile Differ Flex Minus Inflex	P95 (95%ile)	95%ile Differ Flex Minus Inflex	Trials Flex > Inflex NPV Ratio
No Flexibility	N/A	¥1,204,501	N/A	-¥231,345	N/A	¥2,994,020	N/A	1.00
Delay Buildout Option Only	¥0	¥1,204,501	¥0	-¥231,345	¥0	¥2,994,020	¥0	1.00
Highrise Expansion Option Only	¥0	¥1,204,501	¥0	-¥231,345	¥0	¥2,994,020	¥0	1.00
Townhouse Expansion Option Only	¥14,000	¥1,189,810	-¥14,691	-¥184,368	¥46,976	¥2,930,414	-¥63,606	2.00
All Options Together	N/A	¥1,189,810	-¥14,691	-¥184,368	¥46,976	¥2,930,414	-¥63,606	2.00

7. Draw conclusions.

- What are some of your observations and what can you determine about the Flexible model given the default market conditions (typical of China at the time of this writing)? Is there one specific scenario that mostly determines whether or not value can be produced from the Flexible model? If yes, why do you think that is? If not, discuss your thoughts on whether flexibility provides any value in the case of Dushi Huayuan.

Solution: There should only be one scenario that shows there is any value produced from the Flexible model: Townhouse Expansion Option Only. When this trigger is set to ¥14,000 CNY (after the construction costs have been increased), and depending on the recalculation, sometimes there is a ratio well above 1.50 indicating the Flexible ex ante NPV is greater than the Inflexible ex ante NPV. Townhouse Expansion requires more infrastructure cost, hence, some scenarios it pays to delay or abandon, in order to avoid those costs. Townhouse Expansion has less marginal profitability than Highrise Expansion. Because Townhouse Expansion must wait for triggering of the Initial Phase, there is time for the market to get worse and jeopardize profitability, more so than with the Initial Phase alone. Delay of the Townhouse Expansion can improve the NPV in either of two ways: (1) Either it avoids losses if/while the market prices are very low (left-hand tail effect, "defensive" put option); or (2) it gains extra-large profits if the market turns sharply upwards after having been depressed causing the delay to enable buildout during an exceptionally profitable period (right-hand tail effect, optimal exercise of "offensive" call option).

- You were asked to observe some of the outputs before and after increasing construction costs in the tasks above. Discuss your thoughts on how escalated construction costs relative to sales prices have changed the value provided by modeling Flexibility in specific scenarios and in general. With labor costs growing rapidly in China, what are some implications for Chinese residential development in the future, using observations from this case?

  Solution: One of the primary lessons we can learn from observations before and after increasing construction costs is that the decreased profitability, that is the decreased delta between construction costs and sales prices, actually creates more value for the Flexible model. Alternatively, when using the default assumptions, the Flexible model was practically worthless because the greater marginal profitability (in particular, the difference between the market value of the condos and the lower construction costs representing the marginal cost of producing the condos) justified Acumen building out the project in its entirety as quickly as possible no matter what.

Any delay in the buildout of the project would generate lower NPVs across most, if not all 2,000 trials because there were always profits to be made once construction began and the quicker those profits were earned, the greater the NPV when considering the time value of money. An important thing to note is that in both cases (Flexible and Inflexible), it's assumed that the land has already been purchased at the onset of the project, meaning the land cost is sunk and therefore isn't included in the *marginal* cost of producing the condos.

8. Compare the ex post results[1] to the pro forma results.
    - The ex post cash flow illustrates the actual outcome of Dushi Huayuan. As you can see on the **ExPost** sheet, Acumen lost over ¥625 million CNY (levered NPV based on a discount rate of 15%) due to a dramatic, unexpected downturn in the market after they sold about 40% of the townhouses in 2012. Reference the NPV Cumulative Distribution Function graph in the **OptionAnalysisDashboard** sheet. Where along the **BLUE** curve (Inflexible NPV Distribution) does the ex post levered NPV fall? (Is it in the downside tail, upside tail, or somewhere in between?) Solution: The ex post levered NPV would fall in the downside tail, well under the 5th percentile of the Inflexible NPV Distribution.
    - Hindsight is 20/20. Thinking conceptually, what are some things Acumen could have done strategically to minimize its losses when the market took a negative turn? Solution: Acumen could have emulated its Loyal Gardens project (referenced in the case) in forgoing construction of such elaborate basement space for the townhouses. Toning down the extravagance of the townhouse basements would have reduced the time to deliver and sell the townhomes before the market downturn. Quicker speed to market would decrease exposure to possible unfavorable changes in the market, in turn, giving the developer more flexibility in their ability to control timing of sales. In a similar way, Acumen could have negotiated with the local government to allow presales for the entire project (or a certain percentage of the project) before breaking ground on the townhouses to also reduce exposure to any changes in the market.

[1] While the case project is fictional, it is patterned after a real project that was actually built in China, and so we can examine the actual historical results of that project. The numbers are slightly changed to mask identity, but the essence of the project's actual results are described in the **ExPost** sheet.

Such a policy change would provide even more flexibility to Acumen than only scrapping the lavish basements, effectively pushing the sales date from completion of the townhouses rising one meter above the ground to before even breaking ground on the townhouses.

Submit Assignment on Stellar:

1. Paste a screenshot (or copy and paste "As Picture") of your multidimensional output table in the **OptionAnalysisDashboard** sheet into a one-page Word document that also includes your (brief) discussion/answers to Tasks 1-9 above.
2. Name your document "Lastname_Firstname_DushiHuayuanEx2" and submit the assignment on Stellar.

All students should hand in their own individual solution. However, you are free to consult with and help each other in studying and doing the exercises. Assignments will not be "graded" as such, only checked to see if you are keeping up with course and/or might need some help.

Exercise 3: Analyzing the Dushi Huayuan Joint Venture Deal

Learning Objectives:

1. Introduce you to the concept of "waterfall" analysis – the examination of the terms of a project financing joint venture (JV) arrangement to see how the profits and losses of a project accrue to each partner.
2. Introduce you to some possible arrangements for allocating the profits and losses of a project.
3. Introduce you to the distribution of net cash flow based on IRR threshold.
4. Acquaint you with the use and limitations of the IRR (Internal Rate of Return) target metric (in addition to the NPV) in waterfall analysis and Monte Carlo analysis.
5. Develop a basic intuition of possible effects of specific terms of the allocation arrangements.
6. Familiarize you with the nuts and bolts for the application of Monte Carlo simulation to waterfall analysis of projects (including treatment of the IRR metric).

References:

- Re Waterfalls: Geltner-Miller Ch.15 (15.3)
- Re IRR: Geltner-Miller Ch.8 (8.2.14), Ch.9 (9.1, 9.3.2), Ch.10 (10.6.3)

Preface:

After completing Exercise 2, you should have a good feel for evaluating the Dushi Huayuan project under uncertainty. Hopefully, you also have a better intuition for the factors that generate value in different types of flexibility, often contained in many large-scale development projects. It would be possible to use this model as a template, although to apply it to other projects, extensive customization and reprogramming would be necessary. Nevertheless, this Excel workbook can serve as a useful guide, perhaps as a starting point in some cases.

Exercise 3 focuses on using the Monte Carlo model to do a waterfall analysis, which is to analyze financing terms of a joint venture (JV). This is a vital step in actually carrying out a project in the real world. You can't build a project without financing it, and large-scale projects typically require joint ventures that involve complex and subtle or tricky financial agreements. In China, this method of financing a project is becoming more and more popular.

Exercise 3 also gives you the opportunity to learn about the technical details of doing a simulation analysis in Excel focusing on the IRR (Internal Rate of Return). Investors often prefer this measure to the NPV as the target objective metric of interest. However, one should also consider the JV terms using the NPV metric, as there can be circumstances in which the IRR does not exist or is ambiguous (multiple IRRs can exist for the same cash flow stream).

Background for this Assignment:

Waterfall Concept: The "waterfall" concept refers to how the money ("water") flows from the investment project to each of the parties in a JV contract. Usually the parties do not share the profits on a completely equal basis.

The key to making JV deals work is to align not only the business and investment risks and rewards, but also the incentive structure among the parties to the JV agreement. They should be done in a manner that will be robust to the variations the project is likely to experience (i.e. the deal terms need to work not just under the expected pro forma base case scenario). The type of Monte Carlo model you have after Exercise 2 can be a useful tool for analyzing deal terms. In particular, it can be especially useful to help understand the risk/reward prospects that each party to the deal faces and thereby to help understand the "fairness" of the deal terms (in some sense) from an investment perspective. From your knowledge now about Monte Carlo simulation, you can see how such analysis can help to identify outcomes and contingencies that might not have been expected or planned for if one didn't run through such an exercise.

Waterfall Arrangements in Exercise: The JV arrangements in the Dushi Huayuan case are realistic, but they are just one example. JV arrangements come in great variety. Dushi Huayuan is a large-scale "merchant building" project (one that derives all of its revenue from the sale of assets immediately upon their construction, blurring the distinction between "operating" and "reversion" cash flow), in an emerging market country where money is relatively plentiful and development opportunities are relatively scarce (skewing the negotiating leverage of the two parties in arriving at the JV agreement terms).

The Dushi Huayuan case describes the business partnership for the project. The JV partners set up a special purpose entity called Acumen-GoldenCity to carry out the project. Acumen-GoldenCity is funded in part with a construction revolving loan equal to 60% of total costs with an annual interest rate of 6% (reference page 5 of the case). Essentially, for each period where there is negative cash flow, 60% of the required capital will be funded by this revolving loan at an annual interest rate of 6% and when cash flow turns positive, the revolving loan would be entitled to the first claim on any project-level free cash flow for return of its invested capital. To fund the remaining 40% of total costs, Acumen and Golden City will act as equity partners for Dushi Huayuan. Splits for the JV partnership have Acumen contributing 51% of the equity as the general partner (GP) and Golden City contributing 49% of the equity as the limited partner (LP). After the construction revolving loan has been paid off in full, any residual income will be distributed to the equity partners *pro rata pari passu* up to the first hurdle of 18% IRR (*pro rata* meaning "in proportion" to each partner's contribution of equity). Beyond 18% and up to 21% IRR, the promote structure gives Acumen 60% of the income and Golden City 40% of the income. Beyond the final hurdle of 21% IRR, Acumen will receive 70% of the income and Golden City 30% of the income. All distributions to Acumen and Golden City in this promote structure will be paid *pari passu* (the GP and LP have equal priority clam on and responsibility for any cash flows; there is no seniority between the equity partners). As described in the case, the IRRs will be calculated on a contemporary "look-back" basis (reference page 6 of the case).

The Exercise 3 model outlines the specific terms for the JV Dushi Huayuan on the **JVTermsDashboard** sheet. The Exercise 3 Excel model is the Exercise 2 engineering model with the output refocused on the separate investment performance experienced by each of the two equity partners, Acumen and Golden City.

The bottom-most part of the **RED** DCF computation sheets computes the waterfall of the cash flows, that is, the allocation of the project's overall net cash flows between Acumen and Golden City in each period. Note that this allocation (starting from row 155 in the **ProForma**, **ExAnteInflex**, and **ExPost** sheets, or row 196 in the **ExAnteFlex** sheet) may differ across the two partners. The split depends on whether the net cash flow is negative or positive in a given period, on how much return the project has already by then provided, and on what year into the project we are. The distribution of net proceeds generated from the project will be based on IRR thresholds (or hurdles).

Here are the basic rules that you can see implemented in the Excel formulas in the Exercise 3 Dushi Huayuan model:

1. If the net cash flow in a period is negative (indicating it is mostly construction costs), Acumen has to distribute 51% and Golden City 49% of the equity, which constitutes 40% of the net cash flow (with the remaining 60% coming from the construction revolving loan).
2. In any instance, the cumulative net capital contribution (outstanding unreturned capital balance) cannot exceed the joint venture's agreed maximum capital draw amount. When you download the model, this maximum is set (on the **JVTermsDashboard** sheet) to ¥1.2 billion CNY (cell C31). If the project requires more than this limit, then the model assumes that the project is abandoned. It is likely that in such circumstances the JV would face a major financial crisis, possibly resulting in bankruptcy.
3. If the net cash flow is positive in any period, the money is allocated based on IRR threshold:
    a. When the levered IRR is less than 18% inclusive, the excess profit shall be distributed *pro rata pari passu.*
    b. When the levered IRR is greater than 18% and less than 21% inclusive, 60% of the excess profit shall be distributed to Acumen and 40% to Golden City, *pari passu.*
    c. When the levered IRR is greater than 21%, 70% of the excess profit shall be distributed to Acumen and 30% to Golden City, *pari passu.*

Use and Limitation of IRR: As the parties to the financing of the project are essentially investors, and investors typically focus on returns, decision makers usually like to focus their analysis of deal terms onto a different target objective function than we used in previous assignments. In particular, they like to focus on the IRR rather than the NPV. From a rigorous financial economic perspective, the NPV is generally the better measure of the merit of the project. But that's not really what the waterfall analysis examines. At this stage the evaluation has presumably already shown that the project is a good investment from an economic perspective. So, at this point we are just trying to finance that investment, to set up how the two partners will share the financial capital provision responsibilities, risks, and rewards. For this purpose the parties typically prefer to focus on what their going-in IRR prospects look like. We can model those going-in prospects by looking at the probability distribution (simulation results distribution) of the possible ex ante realized IRRs the project might generate.

Note however that the IRR can be a problematical metric to compute. This is particularly true in merchant building projects such as Dushi Huayuan that produce assets for sale spanning over a range of time, that experience possible cyclicality in the real estate markets, and that have the flexibility to stop and restart the project. These features can result in alternate changes of sign of the net cash flow, for example from negative to positive to negative again, and so forth. Each time this happens it may become mathematically possible to find an additional IRR. We may thus end up with multiple different IRR rates all of which mathematically solve the IRR-defining equation. The IRR as an investment performance metric becomes ambiguous and can lose meaning.

Circumstances may also occur in which the IRR literally does not exist; no discount rate equates the net cash flow stream to a zero present value. In this case Excel will return an error message. This messes up Monte Carlo analysis in which we want to compile and display histograms and cumulative distribution functions (CDFs) of IRR results across all the random outcome trials (2,000 of them in our model). We find that when Excel returns an error message for the IRR, it usually corresponds to the project having turned out badly from an investment performance perspective. (There is so much negative future cash flow that no discount rate can equate them to the value of the investment capital draws.) Accordingly, the formulas in the IRR computation cells in the Dushi Huayuan JV model arbitrarily assign a value of negative 50% to the IRR when Excel returns an error in the IRR function.

Similarly, our Excel implementation of the waterfall analysis assigns an IRR value of negative 100% if either (1) the JV breaches its capital constraint, as described previously in Rule 2 of the JV or (2) the entire project (all three phases) hasn't been completed in the 24-year period (meaning it has been abandoned). As noted, it would be likely that the JV would go bankrupt in such cases. Thus, an IRR of exactly -100% is effectively a signal of "likely bankruptcy or severe financial distress" for the JV or abandonment of the project. It doesn't actually literally mean an IRR of -100%.

Because of these quirks and problems with the IRR, it is a good idea not to rely solely on the IRR as the metric for judging the investment performance realized by JV partners. It is a good idea also to look at their NPVs. In so doing, one might adjust the discount rate for each partner so as to reflect their risk. However, the ex ante NPV metric that the engineering model uses is not exactly the same as an economic ex ante NPV for which the discount rate should equal the opportunity cost of capital (OCC). The Exercise 3 model retains our previous construction and usage of the ex ante NPV, based on an ad hoc but reasonable discount rate, which we retain at 15% equally for both partners in the Exercise 3 model, though this can be modified on the **JVTermsDashboard** sheet (cells F26 and F27).

The Exercise 3 JV Template:

The Exercise 3 JV model downloads from Stellar with all option triggers set to zero.

The "bottom lines" for the JV analysis are the separate IRR and NPV computations for each partner (as well as for the project or JV as a whole), located at the bottom of the **RED** DCF computation sheets. (In the case of the **ExAnteFlex** sheet, this can be found in cells C226:D228.)

The Exercise 3 JV model has four **ORANGE** "outputs" sheets. The leftmost of the four, labeled **DataTable**, computes the ex ante NPVs and IRRs for the project as a whole, and separately for each of the two JV partners under both the inflexible and flexible plans. It runs the Monte Carlo simulation and computes (in one gigantic 30-column Data Table) the 2,000-trials random simulation of the Dushi Huayuan project's possible futures. The sheet includes a third metric, the gross payback ratio (cumulative net cash flow divided by the cumulative total capital contribution, undiscounted). This metric lacks theoretical justification and we won't focus on it in this assignment. However, it is often considered in industry practice regarding development project investments.

The next **ORANGE** tab to the right, labeled **Differences**, tabulates the trial-by-trial differences most relevant to the analysis. These include the differences in the investment results (both IRR and NPV) between the partners and the Acumen result minus the Golden City result within each of the 2,000 trials. For this latter set of differences, oriented toward analysis of the JV partnership terms, we consider only the flexible plan, as that is most realistic.

The next **ORANGE** tab to right is the **OptionAnalysisDashboard** sheet for the options analysis. It is the same as in Exercise 2.

The final rightmost **ORANGE** tab is the **JVTermsDashboard** for the JV partnership terms analysis. This dashboard contains two panels where you can change some of the major parameters of the JV partnership terms agreement: (1) Capital Structure panel (cells B23:F31) and (2) IRR Hurdles and Promote Structure panel (cells B33:D37). Then once you recalculate (either by pressing F9 or clicking the "Calculate Now" button in the "Calculation" panel of the "Formulas" tab) the **JVTermsDashboard** sheet will show the resulting impact on the two partners' probabilistic expectations of investment performance. It displays a number of statistical and risk-adjusted return metrics, our usual histograms and CDF ("target") curves, and a couple of scatterplots relating the Acumen minus Golden City NPV and IRR differences as a function of overall project (JV entity) NPV or IRR.

Study these outputs for a while. With the default JV term inputs as the model downloads from Stellar, note the following:

1. The ex ante NPV CDF curve for Acumen is strongly rightward-shifted favorably for Acumen compared to Golden City. Acumen has a higher ENPV and better upside (right-hand) tail. This is because Acumen stands to gain high returns when IRR is greater than 18%, and much more when IRR is greater than 21%. However, on the downside tail, Acumen loses slightly more than Golden City. This is because NPV is measured in absolute money amounts (CNY), and Acumen is on the hook to invest slightly more (51% of the money cost). Hence Acumen stands to lose a little bit more if the project goes badly (i.e. if Acumen cannot fully recoup its capital).
2. The ex ante IRR curve for Acumen is strongly rightward-shifted favorably for Acumen compared to Golden City. Acumen has the potential for greater upside on the IRR CDF curve for the same reasons stated above in regards to the NPV CDF curve. However, they both face exactly the same downside tails of the IRR outcome (when IRR is lower than 18%), because distributions from the cash flow of the project is distributed ***pro rata pari passu*** when IRR is less than the first hurdle of 18%.
3. The extreme downside outcomes (dominated by the "-100% bankruptcy" and the "-50% IRR error" cases) have the essentially same frequency or probability for both partners. These are characteristically total loss or "wipe-out" scenarios in which there isn't enough project cash flow.

4. The strong upside outcomes (which make up the bulk of the probability; typically some 80-90% of the outcomes give IRRs > 18%) give Acumen a greater IRR than Golden City, and the marginal difference between Acumen's IRR and Golden City's IRR increases the greater the project IRR. These are the outcomes where Acumen's promote (greater-than-pro-rata share in the residual cash flow) gives it a greater return on its capital investment.
5. The JV seems to experience extreme downside outcomes (flagged by our -50% IRR convention) less than 0.5% of the time, as indicated by the "Extreme Downside %" result in row 13 of the Simulation Results Statistics panel on the **JVTermsDashboard** sheet. This reflects cases when the project suffers through terrible market conditions causing negative net cash flows for many years and thus making it impossible to calculate an IRR.

Exercise 3 Consists of the Following Tasks:

On one sheet, answer the following questions using the model:

1. Under the default JV inputs as given, about how much greater is Acumen's ENPV than Golden City's? (Exact numbers will vary each time you recalculate the simulation.) How much greater is Acumen's mean IRR expectation?
   Solution: Acumen's ENPV is about ¥400 million CNY greater than Golden City's. Acumen's mean IRR expectation is roughly 8-10% higher than Golden City's.

2. As you know, the mean outcome in the probabilistic future is not the whole story. Look at the ratio metrics in rows 18-21 of the Simulation Results Statistics panel on the **JVTermsDashboard** sheet. How do these compare between the two partners? Does it still look like Acumen is getting the better deal from an investment risk and return perspective? Is it different depending on whether you consider two-sided risk (standard deviation) versus one-sided risk (left-hand tail downside risk only)?
   Solution: It does indeed still look like Acumen is getting the better deal from a risk and return perspective. When considering two-sided risk, both partners have very similar risk and return profiles but when considering one-sided risk (left-hand tail downside risk only), it would appear that Acumen is much better off than Golden City.

3. Considering your previous answer, what do you think about the fairness of the joint venture terms between Acumen and Golden City, from an investment perspective? What can you think of that could justify the apparent discrepancy?
   Solution: From an investment perspective, the JV terms seem to favor Acumen. When the Dushi Huayuan project began, residential development in China was so profitable to the point general partners had plenty of negotiating power over their limited partners simply because there was more capital available in the real estate investment market than real estate projects to invest in. Since the real estate industry was relatively new to China, the capability of developing innovative and profitable real estate products was highly valued, giving Acumen an even stronger competitive advantage in negotiating JV terms.

4. Now play around with the JV waterfall terms. Suppose that the cash flow sharing is *pro rata* all the way through. In other words, in the IRR Hurdles and Promote Structure panel, set the percentages after the two IRR hurdles (cells C36:D37) equal to the splits in row 35 for both equity partners. Recalculate and see what this does to the outcome statistics and distributions. Does it correct the disparity in investment ex ante risk/return between the partners that you noted in Questions 2 and 3?
   Solution: Yes, the disparity in investment ex ante risk/return we saw in Questions 2 and 3 has now been eliminated and both JV partners have more equal risk/return profiles.

5. Recently in China, some real estate developers have adopted a new type of JV structure where the money partner (or LP) has a senior position over the managing partner (or GP). A sample of this new JV structure can be seen in the following terms:
   - LP contributes 49% to the equity and the GP contributes 51%.
   - When the project cash flow is positive, distributions go to the LP first until the LP hits an IRR of 10%; then distributions go to the GP until the GP hits an IRR of 10%.
   - After both partners receive distributions up to an IRR of 10%, the residual cash flow is distributed *pro rata pari passu* until both of them reach an IRR of 18%.

- After both partners receive distributions up to an IRR of 18%, 60% of the residual cash flow is distributed to the GP and 40% to the LP, *pari passu*, until both of them reach an IRR of 21%.
- After both partners receive distributions up to an IRR of 21%, 70% of the residual cash flow is distributed to the GP and 30% to the LP indefinitely, *pari passu*.

Conceptually (no need to update the model), using this new JV agreement, is Acumen in a better position than Golden City compared to the previous partnership structure? Who is now protected on the downside? Why? What do you think would cause this recent change in the structure of JV terms?

Solution: Now Acumen is in a worse position than Golden City compared to the previous partnership structure. Golden City is protected on the downside because it's getting paid first (has seniority) until the first IRR hurdle of 10%. The new structure of JV terms could be caused by the reversal of the real estate market conditions in the Question 3: now it's likely that there are more real estate projects to invest in than capital available in the real estate investment market.

Submit Assignment on Stellar:

1. Name your document "Lastname_Firstname_DushiHuayuanEx3" and submit the assignment on Stellar.

All students should hand in their own individual solution. However, you are free to consult with and help each other in studying and doing the exercises. Assignments will not be "graded" as such, only checked to see if you are keeping up with course and/or might need some help.

CONCLUSION

"To phase or not to phase?" was the question we sought to answer at Dushi Huayuan. After working through the exercises, it becomes clear that **there is limited value for introducing flexibility into the Dushi Huayuan project** when programming realistic market conditions into the Monte Carlo simulation model. We learned this was in large part due to a high delta between sales prices and construction costs, specific to China's real estate market. When the marginal cost of production is so low, greater marginal profitability justified Acumen building out the project in its entirety as quickly as possible no matter what. Any delay in the buildout of the project would generate lower NPVs across most, if not all 2,000 trials because there were always profits to be made once construction began and the quicker those profits were earned, the greater the NPV when considering the time value of money. An important thing to note is that in both cases (Flexible and Inflexible), it's assumed that the land has already been purchased at the onset of the project, meaning the land cost is "sunk" and therefore isn't included in the *marginal* cost of producing the condos. Additionally, high upfront land costs—to the tune of roughly 60 percent of total project costs—meant that delaying buildout of profit-generating housing units would be detrimental to Dushi Huayuan's expected NPV.

That said, we observed that flexibility did indeed provide some value to the Townhouse Expansion Phase because this phase in particular required greater infrastructure costs than the High-Rise Expansion Phase, which also meant townhouse expansion exhibited less marginal profitability than high-rise expansion. (The same decreased marginal profitability effect took place after increasing construction costs by ¥5,000 CNY while holding sales prices constant in Exercise 2.) Delaying the townhouse expansion could improve the NPV in either of two ways: (1) either it avoids losses if/while the market prices are very low (left-hand tail effect, "defensive" put option); or (2) it gains extra-large profits if the market turns sharply upwards after having been depressed causing the delay to enable buildout during an exceptionally profitable period (right-hand tail effect, optimal exercise of "offensive" call option).

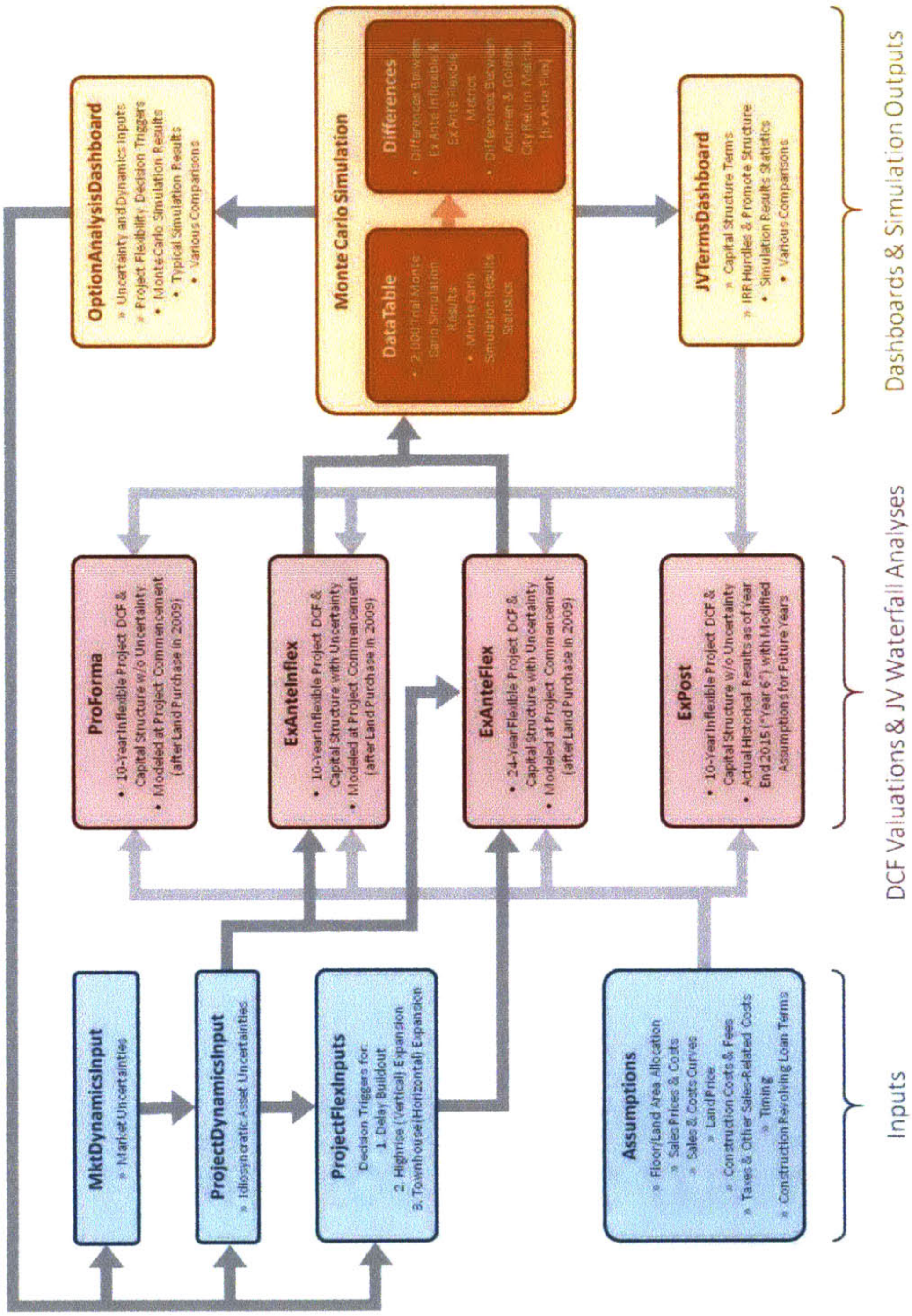
The flexibility also provided value in a greater number of trials as volatility in the market increased. As we calibrated exogenous market conditions to use in the default model, we noticed increasing volatility per year also contributed additional value to the flexible model. Large, unpredictable swings in the market can be protected with flexibility in both downside and upside scenarios.

One final breakthrough came to light when we compared Dushi Huayuan to Loyal Gardens, Acumen's preceding project to Dushi Huayuan as mentioned in the case. Since Acumen was able to build townhouses in less time at Loyal Gardens than Dushi Huayuan, the developer was able to take advantage of selling units in a booming market. Townhouse units at Dushi Huayuan, unfortunately, weren't able to capitalize on those same market conditions because of longer construction times. The takeaway here was quicker speed to market decreases exposure to possible unfavorable changes in the market, in turn, giving developers more flexibility in their ability to control timing of sales.

There were many lessons learned going through the process of building out the simulation model and applying it to a very typical project located in an increasingly important market, globally. We hope this case study and accompanying exercises provide meaningful insight into recognizing appropriate market conditions to employ the use of flexibility in real estate development.

EXHIBITS

Exhibit 1 Dushi Huayuan Monte Carlo Simulation Model Flowchart



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