Exploring the Dynamics of Building Supply: A Duration Model of the

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Abstract

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A noticeable omission in the existing body of applied real estate research is the lack of empirical analysis of the commercial development process. We address this shortcoming by utilizing a large panel database of individual building projects that in principle allows us to follow individual projects through various stages of their development life cycle. We begin by examining the basic distributional and time series characteristics of the development cycle, and then examine how these results vary by stage of construction, property sector and geography. We then estimate unconditional transition probabilities and finally, present preliminary results from a formal, nonparametric duration model.

Introduction

Though fundamentally important to both the theory and practice of real estate, remarkably little empirical work has been conducted on the nature and dynamics of the commercial property development cycle, and by extension, its implications for the broader building supply cycle. While theoretical models are plentiful, researchers arguably have a tenuous grasp on even the most basic empirical characteristics of the commercial development process, particularly at the microeconomic level. This shortfall of "stylized facts" has important implications for our ability to model real estate market dynamics, predict new supply, and more broadly, understand the macroeconomic relationship between aggregate building activity and the general business cycle. This paucity of existing research stems directly from the lack of relevant data, particularly at the individual project level, where the discrete decisions to develop and build are ultimately made.

The systematic analysis of the supply side response to changes in commercial real estate market conditions is a comparatively recent undertaking. As mentioned, the addition of new commercial space to an existing market is usually treated in an abstract manner, rather than an empirical one. The most common empirical treatment—the stock adjustment model—embeds new construction in a supply-demand system where building activity is the result of a lagged response to tight markets for space. The classic contributions to this literature include studies of rental housing (Rosen and Smith, 1983), offices (Wheaton and Torto, 1988) and industrial space (Wheaton and Torto, 1990). Fischer (1992) also presents a general treatment. Depending on the specification, these models are capable of reproducing long periods of aggregate over-supply in commercial property markets, leading in effect to noticeable cycles. More recently, there has been work in the amplitude and duration of real estate cycles. For example, Kaiser (1997) concludes that the key to a jump in aggregate construction activity and the eventual oversupply in commercial real estate is a sharp increase in rents that "attracts an unusually large amount of investment capital, resulting in a disastrously large over development boom." Capozza and Li (1994) employ an options pricing model to investigate the timing of a real estate investment decision, showing that the timing and intensity of investment are inter-related, supplying as well an optimal stopping rule.

These perspectives, however, remain largely macroeconomic in nature; empirical descriptions of the microeconomic factors driving new construction are somewhat scarce. Bridging the gap between macro and micro factors is recent work on how additional supply is added to real estate. For instance, Somerville (1999:251) discusses the industrial organization of housing supply in different geographic areas, noting that "there is a rich variation in market structure across metropolitan areas." He suggests that market concentration should be useful in explaining the level and duration of construction activity over the business cycle. Benjamin, Judd and Winkler (1998) explicitly examine the supply side response in markets for retail space, estimating the short and long run supply elasticities for more than fifty metropolitan areas. Their results indicate a surprisingly long mean adjustment period of 8.1 years, but with significant variation between cities. They hypothesize that differences across metropolitan areas are due to local factors like zoning, land availability, etc.

In a series of recent papers, Gentile, Gallagher, Choate and Weiss (1997) and Gentile and Gallagher (1999) approach the question of additions to commercial supply using a different conceptual framework. They examine the development process, focusing on its regularities and using data from F. W. Dodge to estimate the transition probabilities and time lags between pre-defined stages of individual building lifecycles. The authors find that the development process is often quite different from the logical and sequential progression from preplanning to construction start. Individual projects can advance at very different rates, apparently jump stages and even revert to logically prior stages. But there are important regularities documented as well. For instance, the probability a project will start (break ground) increases rapidly—in a nonlinear fashion—as it moves forward. In addition, statistically and economically important differences in the time lags and transition probabilities are observed and shown to vary by project type and by project valuation.

The current research continues this basic line of inquiry. We utilize a large, comprehensive national panel dataset of individual commercial construction projects. This data, collected by F. W. Dodge, in principle allows us to track individual building projects through the various stages of the development cycle. Our initial aim is to catalog the stylized facts of commercial development at different points in the development pipeline. More precisely, we wish to explore the common or regular empirical and distributional features of development at the microeconomic level across important dimensions of the data, including stage of construction, location, property sector, size and valuation. Our secondary objective is to then incorporate these stylized facts into more formal predictive and behavior models of the development process.

This article is organized as follows. The next section discusses the panel data set, data collection and classification procedures, and presents some basic summary statistics. In the following section, we follow Gentile, Gallagher, Choate and Weiss (1997) and calculate revised estimates of development transition probabilities and lag-to-start distributions. We also include examples of how these estimates can be used to improve the prediction of new supply. A presentation of the formal duration model of the development lifecycle follows, including estimates of survival and baseline hazard functions. The final section is the conclusion.

Data Collection and Classification

Our study of development dynamics relies on the proprietary Project Life Cycle (PLC) database, provided by F. W. Dodge.[1] The development of the PLC database began in 1994 and tracks the complete sequence, or life history, of Dodge Reports issued on each individual construction project tracked by F. W. Dodge.[2] At any point in time, the Dodge pipeline is actively following about 600,000 individual projects across the United States. The typical Dodge Report contains information on project type, location, size, stage of development, expected start date, bidding schedule, owner and architect. In addition, there is usually a textual description of the project, often containing leasing information or other items of interest to bidders, subcontractors, general contractors and manufacturers. A primary goal of the data collection effort is to identify individual projects as early as possible in their development cycle. Further, it is difficult to determine precisely how representative the Dodge data is of aggregate building. The company estimates that it tracks anywhere from 75%–85% of active or planned construction activity at any point in time.

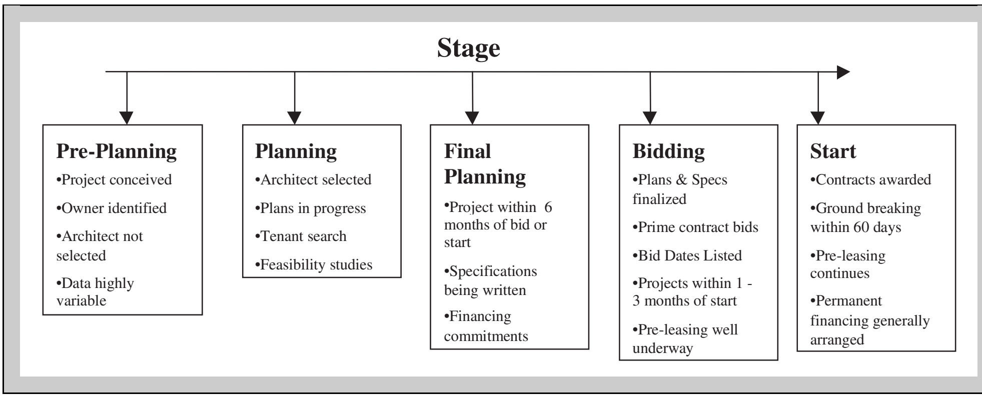
A key to the richness of the PLC database is the ability to observe the evolution of individual projects, or groups of projects, through the various stages of development. To facilitate this, Dodge has established some general data collection guidelines for classifying the status of construction projects. A sketch of the relevant classifications is shown in Exhibits 1 and 2.

Exhibit 1 | F. W. Dodge Project Development Classifications

Stage	Description
Pre-Planning	The earliest part of the development process, generally covering the initial announcement by the developer / owner. At this stage, an architect is usually not selected. This stage is often protracted in length, and encompasses a broad range of elements, including land assembly, entitlement applications, etc. It is a very "uncertain" stage, where investment by the developer in terms of time and money are modest. Historically, a substantial proportion of projects remain in pre-planning for an extended period. Note that any architectural work conducted during this time is often termed "conceptual design."
Planning	At this stage, an architect has been selected and design work is underway. At the same time, the developer will be searching for potential anchor tenants and begin the formal search for financing. It is also a time when more detailed market and feasibility studies are undertaken.
Final Planning	In this stage, specifications are being written, and details of bidding are being determined. At this point, the developer will ideally settle financing issues, including arranging commitments for construction and / or permanent financing. Generally, a project is within six months of bid or start.
Bidding	In this stage, plans and specifications are completed. Bid lists have been developed and the owner is taking bids for the prime contract (the general contractor). Specific bid dates are listed.
Start[a]	At the stage the general contract has been awarded (this stage is also referred to as the Contract Award stage). Physical construction (ground breaking) is scheduled to occur within sixty days.
Deferral	Projects may be temporarily slowed or stopped during the development process. The reasons range from financial stumbling blocks, to zoning and entitlement issues. In these cases, work on the project will often be halted while the developer attempts to address whatever difficulties have arisen.
Abandonment	This stage signals the permanent cessation of development activity. The reasons for abandonment include changes in market conditions, the outcome of lawsuits, etc. A project will typically be marked as deferred before it is defined as abandoned. This is a terminal stage.

[a] Dodge also produces a companion database of building starts, which may be more familiar to real estate researchers. This database is subject to additional levels of quality assurance and fact checking. Though the two databases are drawn from the same "raw" data, the starts database is the one generally preferred for time series estimation and prediction. It contains no "pre-start" information, however.

Exhibit 2 | The Stages of Development



With the exception of the Deferral and Abandonment stages, the classifications given are shown sequentially. Ideally, Dodge tracks each project through each of the first five stages or through at least as many of the stages as possible.[3] Many times, however, a project will not be entered into the database until later (sometimes much later) in its lifecycle, due largely to the practical difficulties of identifying very early stage projects, such as those in the pre-planning. Note also that while these stages are logically sequenced, some projects will experience ''reversions,'' or a return to a logically prior stage.[4] This occurs most often in the earliest stages of development, when precise classification is most difficult and when developers may frequently ''return to the (proverbial) drawing board'' to reassess their efforts. For this study, we will focus on the ''forward'' transitions of projects. In addition, we will not address the abandonment or deferred stages.

To keep our sample as rich as possible, we opted to use the longest possible span on the data; in this case, from 1994–1999. We selected projects corresponding to the following general sectors: offices, hotel, non-manufacturing warehouses, store and shopping centers, and apartments. We include projects of all sizes and dollar values, from anywhere in the U.S. A statistical description of the sample, by project count, contract value and geographic region is shown in Exhibit 3.

As can be seen in Exhibit 3, our sample consists of over 515,000 individual construction projects over the 1994–1999 period. Office and retail projects constitute the lion's share of activity, together accounting for nearly 69% of the sample. On a geographic basis, the South Atlantic region has the largest representation by far, with over 102,000 individual projects, followed by the Pacific Southwest and the East North Central regions, with 88,000 and 85,000 projects, respectively. Thereafter the project counts fall off considerably; the next largest sample is the Middle Atlantic, with about 68,000 projects. One of the most striking characteristics of our sample is the concentrated nature of the contract

Exhibit 3 | Summary Statistics: Project Counts

Property Type	Total Projects	Distribution by Region												
		ENC	ESC	MATL	NENG	PNW	PSW	SATL	WNC	WSC	<5	5–25	25–50	>50
Apartments	84,746	13,795	4,438	19,174	6,287	4,042	9,892	14,188	5,803	6,001	75,409	8,249	698	390
Hotels	16,520	2,248	1,226	1,507	737	725	3,232	3,440	1,113	1,998	13,730	2,240	240	310
Offices	199,009	30,044	11,368	23,877	11,142	8,832	39,447	39,307	12,995	20,493	190,459	7,020	859	671
Retails	155,470	26,931	9,426	17,288	7,851	6,529	27,350	32,667	9,157	17,012	148,736	5,818	476	440
Warehouses	59,921	12,137	4,081	6,112	2,686	3,245	8,967	12,670	3,835	5,758	57,580	2,126	143	72
Total	515,666	85,155	30,539	67,958	28,703	23,373	88,888	102,272	32,903	51,262	485,914	25,453	2,416	1,883

value[5] distribution. About 94% of the sample are projects under $5 million, while less than 0.5% are greater than $50 million.

Next we refined the sample by calculating the distribution of stage occurrences (we denote these "stage-observations"). That is, we count the number of times a project passes through one of the predefined building stages. The resulting distribution provides the empirical foundation for calculating stage-to-stage transition probabilities and estimating duration-based models of the development process. This perspective on the data also highlights some of the practical challenges of collecting data on building projects prior to their actual construction. The results are shown in Exhibit 4.

The full sample represents a total of 736,228 building stages. For each property sector, the highest concentration of stage-observations occurs in the starts stage, followed by the bidding stage. Starts account for over 53% of the data points, while bidding is another 22%. There is some monotinicity to the stage-observations as one traverses from early stages to later ones; the exception is at the planning stage, where a larger percentage of projects appear than at the logically later final planning stage. This general monotinicity is to be expected in that it is far simpler to identify and track projects in the latter stages of development.

One characteristic that is somewhat problematic—at least at first glance—is the apparently low number of stages that each project passes through, on average. The average number of stage-observations for the full sample is about 1.4 stages per project. If Dodge captured each project at "inception" (the pre-planning stage), then the maximum of number of stage-observations would exceed 2.5 million (disregarding the abandoned and deferred stages). By property type, the average number of stages per project ranges from a low of 1.39 for warehouses, to a high of 1.71 for hotels. This (arguably) low average might reduce our ability to reliably estimate multiple stage transitions and durations, especially as we stratify the sample into smaller cells.

The low number of stage observations per project is probably due to many factors, but chief among them is the small size (*i.e.*, contract value) of most projects reported in the PLC database. The median project size for many months during the period 1995–1999 is only about $300,000 in total value and F. W. Dodge guidelines direct reporters to issue these projects only when they reach the bidding stage. In other words, about one-half of all Dodge reports can register a maximum of only two stages, bidding and start. Our subsequent analyses focus on larger projects, raising the average number of stage observations and the inherent interest of the analysis.

Finally, in Exhibit 5, we show sample statistics for stage durations, *i.e.*, the number of months that a project remains in a specific stage. Of interest is the similarity in the means and standard deviations of stage durations across property types. There is little practical difference, at any stage, from one property type to another,

Exhibit 4 | The Distribution of Stage Occurrences

		Distribution of Occurrences in Stages								
Property Type	Total Projects	Pre-Plan.	Planning	Final Plan.	Bidding	Start	Deferred	Abandoned	Totals	Stages per Project
Apartments	84,746	5,130	13,390	8,122	35,878	58,360	1,638	3,775	126,293	1.49
Hotels	16,520	2,188	4,631	2,687	5,341	11,037	737	1,634	28,255	1.71
Offices	199,009	8,550	21,778	15,079	53,332	158,940	2,710	5,771	266,160	1.34
Retails	155,470	9,239	27,555	17,919	47,266	119,872	3,041	7,398	232,290	1.49
Warehouses	59,921	2,530	6,715	5,185	20,824	45,498	738	1,740	83,230	1.39
Total	515,666	27,637	74,069	48,992	162,641	393,707	8,864	20,318	736,228	1.43

Exhibit 5 | Sample Statistics: Stage Duration (in months)

Property Type	Mean	Std. Dev.	Max.	Min.
Offices				
Pre-Planning	8.59	8.10	69	1
Planning	7.28	7.08	69	1
Final Planning	3.44	3.04	54	1
Bidding	2.14	1.98	33	1
Start	4.40	4.34	33	1
Stores				
Pre-Planning	8.92	8.47	70	1
Planning	7.25	7.24	70	1
Final Planning	3.49	3.36	54	1
Bidding	2.19	2.08	43	1
Start	4.54	4.42	24	1
Warehouses				
Pre-Planning	8.09	8.12	65	1
Planning	7.04	6.65	67	1
Final Planning	3.53	3.19	36	1
Bidding	2.29	2.14	31	1
Start	4.33	4.13	18	1
Hotels				
Pre-Planning	9.13	8.09	67	1
Planning	8.26	7.54	62	1
Final Planning	4.04	3.69	39	1
Bidding	2.81	2.92	28	1
Start	6.76	6.63	21	1
Apartments				
Pre-Planning	8.21	7.59	70	1
Planning	8.53	7.48	70	1
Final Planning	4.25	3.64	38	1
Bidding	2.29	2.18	34	1
Start	5.19	5.23	34	1

though hotels have a somewhat larger mean and standard deviation. Note also the consistent pattern of progressively smaller average durations down the sequence of stages, at least until the start stage.[6]

Transition Probabilities and Lags to Start

An analysis of transition probabilities provides both a practical underpinning for using the PLC data and enriches our understanding of the dynamics of the development process. The analysis focuses on the long run, that is the probability that a project will advance *directly* from one stage to another over any *arbitrary* period. The first stipulation means the focus is on direct transitions. An office project in planning, for example, may advance to bidding by a single step or by first advancing to final planning and then moving to bidding.[7] The first possibility is designated as a single transition from planning to bidding. In contrast, the second possibility represents two direct transitions from planning to final planning and from final planning to bidding; the indirect transition from planning to bidding is in effect excluded to prevent double counting.

A second stipulation is that transitions are allowed over any indefinite period. A specific office project, for example, might enter the planning stage in one month and then remain resident in that stage for over a year, while a second project might advance more quickly. The longer the time period in which a project is allowed to advance, the more likely it will transition to a new stage and thus the higher the transition probability. The typical office project for example resides in the planning stage for seven or eight months, but there is wide variation. In calculating transition probabilities for this study, we have not limited the allowed period of time for advancement, *i.e.*, we have given an individual project every opportunity for advancing.[8] Given these somewhat arbitrary decisions about how project transitions are counted, it becomes quickly clear that some of our ‘‘stylized facts’’ about development projects are largely correct, while others are imprecise, if not wrong-headed.

It is hardly a surprise that individual projects first observed in the early planning stages have a low likelihood of advancing. Based on data for the full four years of time, the probability that projects in preplanning will advance to the planning stage range from 15% for stores to 23% for apartments. While a few of these projects will skip the planning stage and advance directly to final planning, bidding or start, over 60% will be formally or informally abandoned. This high attrition rate for preplanning projects reflects a combination of factors, among them the comparatively low investment a developer has in a project in ‘‘conceptual design’’ without any detailed drawings. In many cases, these projects are not even sited and are thus represent a grand scheme in which a developer is trying to excite interest. Conversely, projects that have reached the late stages of planning, *i.e.*, final planning or bidding, are extremely likely to progress to start. A project being put out to bids must have a set of schematic drawings, a promise of financing and probably a substantial amount of pre-leasing as well. Such projects embody a notable investment of time, money and attention on the part of the development team (see Exhibit 6).

Another stylized fact confirmed by the data is the similarity of transition probabilities across property types, suggesting that the basic features of the development process are in a sense robust. The probability office, store, hotel, warehouse and apartment projects that actually attain the planning stage will be formally or informally abandoned are all a bit above 50%. In addition, the probability projects that reach bidding will subsequently advance to start are all 80% or above. In other words, the differences in market conditions by property

Exhibit 6 | Unrestricted Transition Probabilities by Property Type (1994–1999)

Property Type	Pre-Planning	Planning	Final	Bidding	Start	Deferred	Abandoned
Apartments							
Pre-Planning	0.00	0.23	0.04	0.05	0.04	0.04	0.60
Planning		0.00	0.15	0.12	0.15	0.05	0.52
Final Planning			0.00	0.50	0.32	0.02	0.17
Bidding				0.00	0.93	0.01	0.06
Start					1.00	0.00	0.00
Offices							
Pre-Planning	0.00	0.15	0.03	0.03	0.06	0.04	0.68
Planning		0.00	0.16	0.09	0.16	0.04	0.54
Final Planning			0.00	0.35	0.41	0.02	0.21
Bidding				0.00	0.80	0.01	0.09
Start					1.00	0.00	0.00
Hotels							
Pre-Planning	0.00	0.21	0.03	0.03	0.06	0.04	0.63
Planning		0.00	0.16	0.09	0.16	0.06	0.53
Final Planning			0.00	0.35	0.41	0.02	0.22
Bidding				0.00	0.80	0.02	0.17
Start					1.00	0.00	0.00
Retail							
Pre-Planning	0.00	0.15	0.04	0.03	0.06	0.04	0.67
Planning		0.00	0.16	0.09	0.16	0.04	0.55
Final Planning			0.00	0.37	0.35	0.01	0.27
Bidding				0.00	0.84	0.01	0.15
Start					1.00	0.00	0.00
Warehouses							
Pre-Planning	0.00	0.16	0.04	0.04	0.09	0.04	0.62
Planning		0.00	0.16	0.09	0.16	0.04	0.55
Final Planning			0.00	0.46	0.30	0.02	0.23
Bidding				0.00	0.91	0.01	0.08
Start					1.00	0.00	0.00

type have a limited impact on the outcomes of a multi-stage filtering process like commercial construction.

What is surprising about these transition probabilities is the likelihood an individual development project will advance to what appears a logically discontinuous stage. Four percent of office projects in preplanning advance directly to final planning, skipping the planning stage. Three percent of the same projects advance directly to bidding, skipping both planning and final planning; finally, 6% of office projects in preplanning advance directly to start. The simple fact is that the steady and logical progression of individual development projects toward start is belied by the data. It is tempting to attribute all of these "jumps" to difficulties associated with the underlying data collection process. But the reality is likely much more complicated: the development process is episodic and uncertain with individual projects advancing steadily for long periods of time, then languishing for similar periods as local market conditions, political opposition, and national economic cycles disrupt the often carefully crafted schedules of developers.

There are as well some comparative results worth noting, based on stratifying the population of projects by time period and region. The data strongly suggest that projects in the planning pipeline early in an economic expansion have a much better chance of reaching start. Based on the transition probabilities derived for the period 1994–1995, approximately 61% of apartment projects entering the planning stage during that period eventually started or would start given adequate time, compared with only about 42% during the period 1998–1999.[9] There also appears to be substantial regional variation, probably the consequence of differing economic conditions. During the current expansion, office projects in the early planning process were notably more likely to be abandoned in the Middle Atlantic region than in the South Atlantic states: preplanning was 63% vs. 50%, and planning was 36% vs. 31% (see Exhibit 7).

A second measure of the development process is the number of months it takes for the typical project to advance from one stage to another. For each transition probability tabulated, there is a corresponding distribution of the time lags (in months) it takes for the individual projects to advance. There is for example a distribution of lags for the transition from preplanning to planning for all the office properties in the dataset. The most interesting of these distributions are those that describe the monthly lags between the time when a project enters a given stage and the time it starts. How long does it take for an office project that has just entered planning to advance to start, given that it does start? How much do these lags vary by project type? These are important questions for both the real estate professional assessing the risk of new supply and the researcher trying to understand the regularities of the development process.[10]

In general, the most notable characteristic of the lag distributions is their similarity across property type. The average number of months required for an office project to move from the final planning stage directly to the start stage is 3.57, about the same as the retail and warehouse categories and only a bit more quickly than apartments or hotels (see Exhibit 8). A second feature of the lags distributions is the very similar number of months needed to move a project from the early planning stages (preplanning and planning) to the later stages (final planning and bidding). One possible interpretation is that advancing a project in an early planning stage will require about six months. If the developer is lucky, the pieces will fall into place and the project will move to final planning or bidding. If the developer is on the other hand unlucky, the project will remain stuck in planning.[11]

Perhaps the final point about these distributions is the similarity in their shapes across property types and between different stages; they tend to resemble the

Exhibit 7 | Selected Transition Probabilities

Property Type	Pre-Planning	Planning	Final	Bidding	Start	Deferred	Abandoned
Apartments 1994–1995							
Pre-Planning	0.00	0.35	0.06	0.07	0.06	0.06	0.39
Planning		0.00	0.23	0.19	0.23	0.08	0.28
Final Planning			0.00	0.55	0.35	0.02	0.09
Bidding				0.00	0.96	0.01	0.03
Start					1.00	0.00	0.00
Apartments 1998–1999							
Pre-Planning	0.00	0.30	0.03	0.03	0.07	0.03	0.54
Planning		0.00	0.20	0.08	0.20	0.06	0.46
Final Planning			0.00	0.36	0.47	0.03	0.15
Bidding				0.00	0.92	0.01	0.06
Start					1.00	0.00	0.00
Offices—Mid Atlantic							
Pre-Planning	0.00	0.20	0.03	0.03	0.08	0.03	0.63
Planning		0.00	0.26	0.07	0.26	0.05	0.36
Final Planning			0.00	0.41	0.43	0.02	0.13
Bidding				0.00	0.93	0.01	0.05
Start					1.00	0.00	0.00
Offices—South Atlantic							
Pre-Planning	0.00	0.27	0.04	0.04	0.09	0.06	0.50
Planning		0.00	0.26	0.12	0.26	0.06	0.31
Final Planning			0.00	0.45	0.93	0.02	0.12
Bidding				0.00	0.84	0.02	0.05
Start					1.00	0.00	0.00

Poisson, although they do not fit it. They are positive and positively skewed with a standard deviation that varies substantially; it is often nearly as large as the mean (cf. Exhibit 9). An interesting feature of these distributions is that for short transitions, *i.e.,* jumps of one or two stages, the probability of advancing declines monotonically as the time lags increase. For more extended jumps, the transition probabilities initially rise as the number of months increases, quickly reach a peak, then begin to descend.

Duration Model

We extend our analysis of the PLC data by estimating a formal duration model of the transition time between stages. In particular, we statistically link project

Exhibit 8 | Average Lag between Stages (in months, all projects)

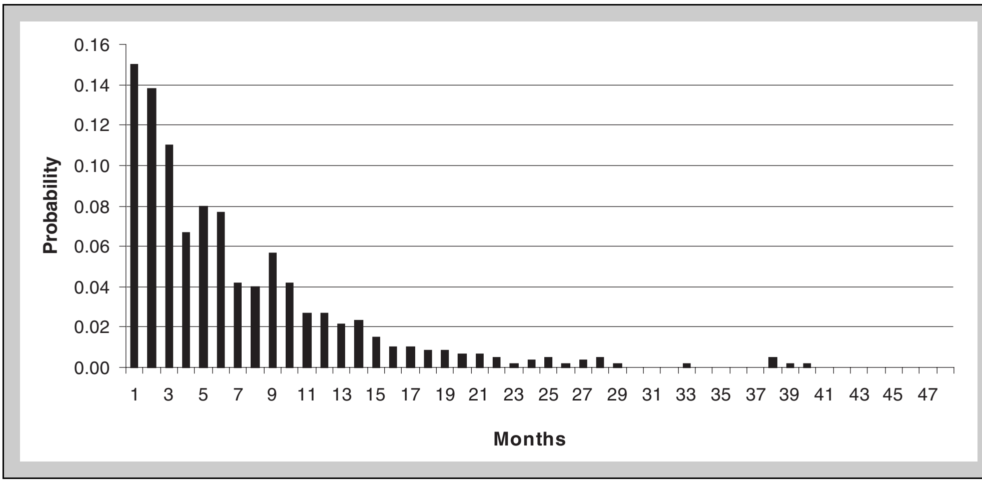
Property Type	Planning	Final	Bidding	Start
Apartments				
Pre-Planning	6.18	6.70	7.67	8.22
Planning		6.74	6.92	8.74
Final Planning			3.43	4.73
Bidding				2.20
Offices				
Pre-Planning	6.51	7.03	7.14	7.74
Planning		5.80	5.75	6.50
Final Planning			2.86	3.57
Bidding				2.06
Hotels				
Pre-Planning	6.89	5.42	6.01	8.19
Planning		5.77	5.62	8.02
Final Planning			2.95	4.17
Bidding				2.58
Retail				
Pre-Planning	6.99	6.70	6.07	7.34
Planning		5.19	4.96	6.73
Final Planning			2.70	3.66
Bidding				2.09
Warehouses				
Pre-Planning	6.04	6.40	6.58	7.19
Planning		5.67	5.94	6.22
Final Planning			2.88	3.67
Bidding				2.21

transitions times between two stages to a set of project-level and market-level covariates, using the familiar proportional hazards framework. This choice is motivated by its relative simplicity and general ease of estimation. Again, we intend our analysis at this stage to be illustrative, not definitive. Nonetheless, even this relatively restrictive model manages to highlight the potential rich inferences about the development process that this data supports.

To simplify the analysis, we begin by defining a subsample of the full data set. The large number of dimensions of the dataset (including property type, location, size, stage of development, time, etc.), while permitting a potentially rich parameterization of survival models, introduces significant practical difficulties, particularly since many interesting classes of duration models are computation-intensive and quite sensitive to the underlying distributional assumptions. The principal limiting factors used to define our subsample include property sector, the selection of a specific sequence of stages and geography. Specifically, we focus

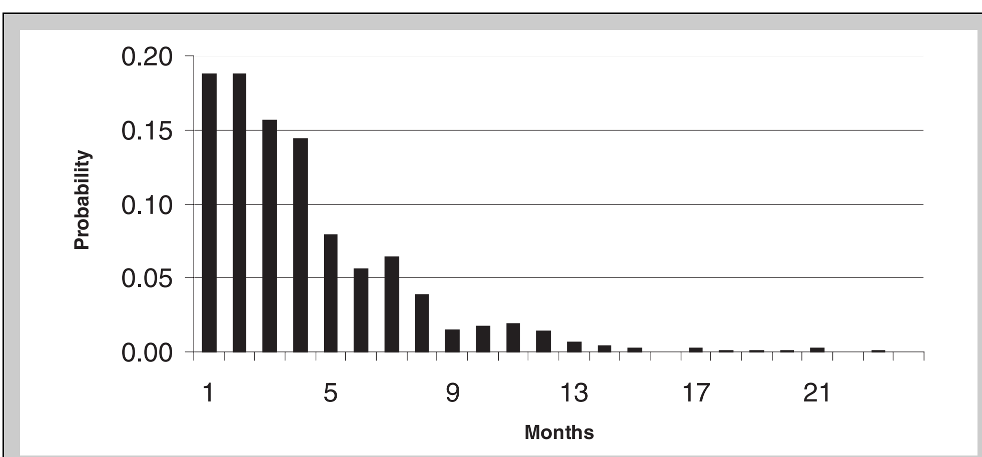
Exhibit 9 | Selected Lag Distributions

A. Pre-Planning to Planning for Hotels (in months)



$N = 601$, $\mu = 6.89$, $\sigma = 28.45$

B. Final Planning to Start for Hotels (in months)

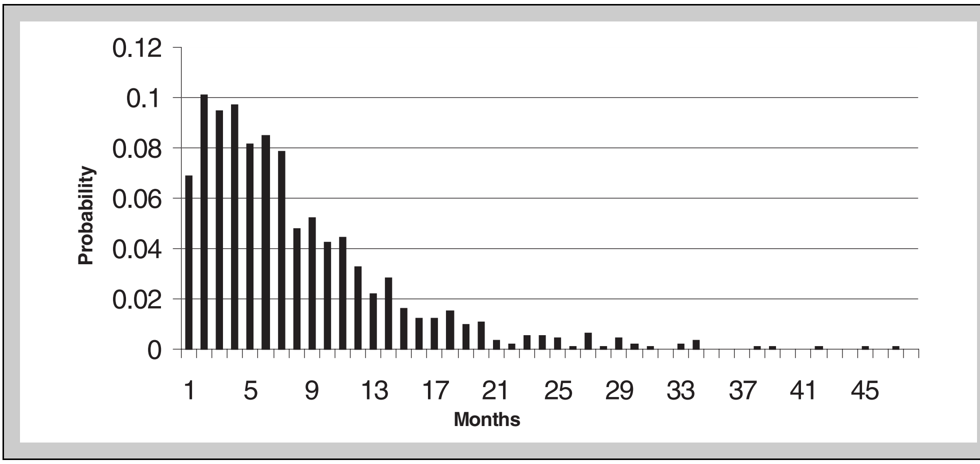


$N = 933$, $\mu = 4.17$, $\sigma = 3.20$

on the office sector, which accounts for the largest proportion of stage-observations. We then limit ourselves to projects within the fifty-eight largest metropolitan areas that F. W. Dodge actively forecasts for its commercial real estate forecasting service, REAPS. Finally, we opt to concentrate on the transition between the planning stage and the start stage, two particularly important stages of the development cycle that are well represented in the Dodge data. We placed no limitations on the specific dates at which projects entered or exited the sample;

Exhibit 9 | (continued)

C. Planning to Start for Hotels (in months)



$N = 919$, $\mu = 8.02$, $\sigma = 5.62$

thus, any project for which both a planning and start stage 'flag' exists were considered. To simplify estimation, however, we do remove censored observations, *i.e.*, those projects for which a planning date exists but there is no corresponding start date. Note that this has the practical effect of removing proportionally more recent projects from the sample. After applying these criteria, the resulting sample consists of 6,568 individual building projects. Sample statistics for project characteristics are shown in Exhibit 10. The 'duration' variable is defined as the number of months between the more recently recorded dates that the project entered the planning stage and the start stage.

We begin by estimating the nonparametric life tables of the sample. Life tables depict the unconditional distribution of survival (or in our case transition) times, as well as the cumulative probability of exit rates. The tabular results are shown in Exhibit 11, while the corresponding estimated survival and hazard functions

Exhibit 10 | Project Characteristics Sample Statistics

Variable	Mean	Std. Dev.	Min.	Max.
Duration (months)	6.82	6.18	0.0	63
Area (000s sq. ft.)	300.56	1,383.96	0.0	9,967
Value ($000)	5,066.57	14,910.39	8.0	800,000

Exhibit 11 | Life Table Results

				Survival		Hazard	
Survival Range	Entered	At Risk	Exited	Rate	S. E.	Rate	S. E.
0.0–3.2	6,568	6,568	2,243	1.0000	0.0000	0.1307	−0.0030
3.2–6.3	4,325	4,325	1,674	0.6585	−0.0060	0.1524	−0.0040
6.3–9.5	2,651	2,651	1,124	0.4036	−0.0060	0.1708	−0.0050
9.5–12.6	1,527	1,527	643	0.2325	−0.0040	0.1693	−0.0060
12.6–15.8	884	884	348	0.1346	−0.0030	0.1556	−0.0080
15.8–18.9	536	536	182	0.0816	−0.0030	0.1298	−0.0090
18.9–22.1	354	354	161	0.0539	−0.0020	0.1869	−0.0140
22.1–25.2	193	193	65	0.0294	−0.0020	0.1286	−0.0160
25.2–28.4	128	128	53	0.0195	−0.0010	0.1658	−0.0220
28.4–31.5	75	75	29	0.0114	−0.0010	0.1522	−0.0270
31.5–34.7	46	46	17	0.0070	−0.0010	0.1439	−0.0340
34.7–37.8	29	29	7	0.0044	−0.0010	0.0871	−0.0330
37.8–41.0	22	22	7	0.0033	−0.0010	0.1201	−0.0450
41.0–44.1	15	15	9	0.0023	0.0000	0.2721	−0.0820
44.1–47.3	6	6	2	0.0009	0.0000	0.1270	−0.0880
47.3–50.4	4	4	0	0.0006	0.0000	0.0000	0.0000
50.4–53.6	4	4	2	0.0006	0.0000	0.2116	−0.1410
53.6–56.7	2	2	1	0.0003	0.0000	0.2116	−0.2000
56.7–59.9	1	1	0	0.0002	0.0000	0.0000	0.0000
59.9–63.0	1	1	1	0.0002	0.0000	0.6349	0.0000

are shown in Exhibits 12 and 13, respectively. The survival curve drops off rapidly as the duration approaches twelve months. Indeed, as can be seen from the life table, over 76% of the projects have moved from planning to start within about one year. In fact, nearly one-third of all projects within our sample exit within about three months.

Next, we utilize a simple proportional hazards model that relates planning-start duration to a number of basic project characteristics, including size (area in thousands of square feet) and contract value. Sample results are shown in Exhibit 14. Based on testing a number of specifications, we determined that, in an informal sense, a quadratic function for project size best 'fits' the sample. The area coefficients have the expected signs, though we remain puzzled by the significant negative sign on contract value—a result that persists through virtually of all our competing specifications. One possible interpretation is that contract value relates to duration in a more complex or subtle nonlinear way; for instance, a sufficiently

Exhibit 12 | Estimated Survival Function

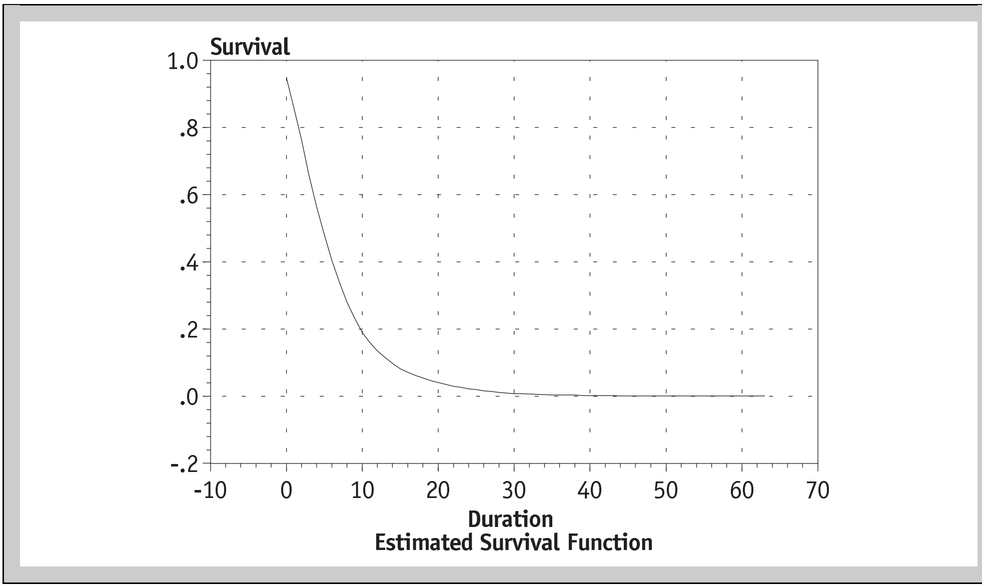


Exhibit 13 | Estimated Hazard Function

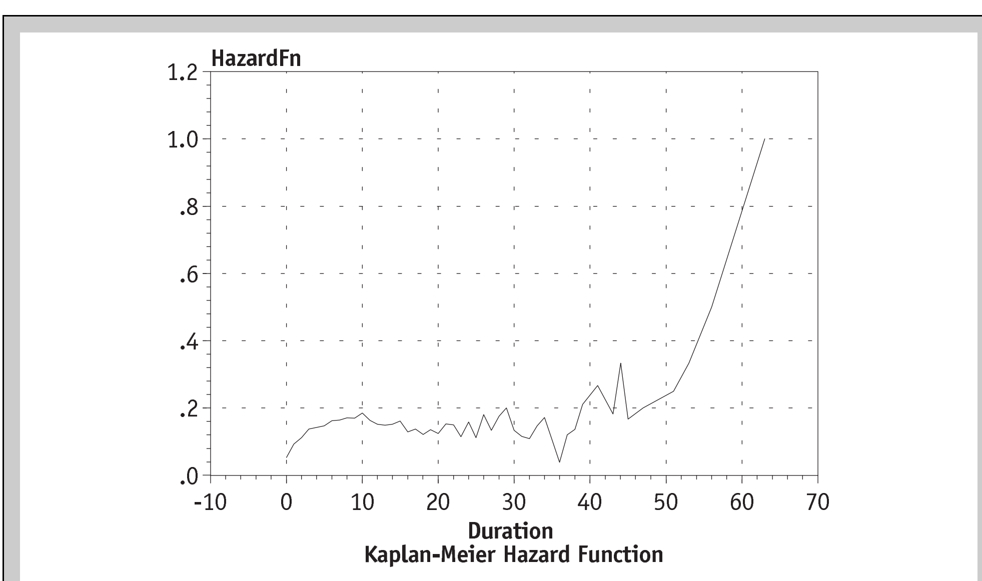


Exhibit 14 | Proportional Hazards Results

Variable	Coefficient	Std. Err.	b/Std. Err.	P[|Z| > z]	Mean of X
AREA	−.167E-03	.706E-04	−2.360	.0183	300.563
AREASQ	.213E-07	.832E-08	2.562	.0104	2,005,394.8
VALUE	−.105E-04	.138E-05	−7.590	.0000	5,066.577

Notes: This table follows a Cox Proportional Hazard Model and uses Maximum Likelihood Estimates.
Dependent variable = *LAGST*
Weighting variable = *ONE*
Number of observations = 6,568
Iterations completed = 6
Log likelihood function = −51,583.00
Restricted log likelihood = −51,647.39
Chi-squared = 128.766
Degrees of freedom = 3
Significance level = .0000
Log-rank test with 3 degrees of freedom: Chi-squared = 71.850, Prob. = .0000

Exhibit 15 | Proportional Hazards Results

Variable	Coefficient	Std. Err.	b/Std. Err.	P[|Z| > z]	Mean of X
AREA	−0.747E-04	.723E-04	−1.033	.3014	300.563
AREASQ	0.884E-08	.862E-08	1.025	.3052	2,005,394.8
VALUE	−0.793E-05	.131E-05	−6.048	.0000	5,066.577
VACPLN	−0.108	.756E-02	−14.348	.0000	12.474
VACST	0.901E-01	.793E-02	11.363	.0000	11.974
EOFFGR	−41.436	.861	−48.148	.0000	0.017
T-10YR	0.927E-03	.175E-01	0.053	.9577	6.211

Notes: This table follows a Cox Proportional Hazard Model and uses Maximum Likelihood Estimates.
Dependent variable = *LAGST*
Weighting variable = *ONE*
Number of observations = 6,568
Iterations completed = 6
Log likelihood function = −49,864.00
Restricted log likelihood = −51,647.39
Chi-squared = 3,566.766
Degrees of freedom = 7
Significance level = .0000
Log-rank test with 7 degrees of freedom: Chi-squared = 2,396.092, Prob. = .0000

convex relationship would appear as negatively related under a simple linear specification.

We then extend these results by introducing several market-specific covariates. Our aim is to determine the extent to which economic conditions that prevailed during the project's transition may influence the duration of the transition. Such relationships might provide a powerful probability-based means for predicting future supply over a wide range of real estate business cycles, on a market and property sector basis. One such specification is shown in Exhibit 15. For this specification, we include vacancy rates at the onset of each stage, growth in office employment over the transition and the ten-year Treasury rate at the project start date. To reflect the geographic mix of our sample, we mapped average market vacancy rates and office employment levels for each project's MSA identifier at the quarter corresponding to the date that Dodge reported the project entering the planning and starts stages. The results point strongly to the inference that market conditions, much more so than static project characteristics, determine transition times. Market factors—particularly those specific to commercial real estate—appear to play a major role in explaining the evolution of projects through the development process. This conclusion was confirmed across a wide range of model specifications and across property sectors.

Conclusion

This study utilizes a unique panel dataset of individual building projects to begin the process of empirically cataloging the "stylized facts" of the development process at a microeconomic level. We begin by stratifying the sample across standardized, pre-defined stages of the development cycle, ranging from conceptual design up through the onset of actual construction. From this, we calculate basic summary statistics, including the mean transition time between stages, the corresponding transition probabilities and lag-to-start distributions. We conclude by estimating a survival/duration model, which models transition times to static project characteristics and underlying real estate market factors. The results, though highly preliminary, suggest that underling real estate factors play a dominant role in determining the speed at which projects move through the development process.

Endnotes

1 F. W. Dodge is a division of the McGraw-Hill Companies, Inc. We are indebted to the Dodge Analytics Group in Lexington, MA for providing us access to this unique database.

2 Dodge defines in project universe as all new construction, additions to existing construction and significant renovations, over $50,000 in reported construction value ("hard costs"). Dodge does not include "soft costs" such as architectural or engineering fees. In addition, land costs are not included.

[3] As a practical matter, Dodge may miss a project's transition though some stages. Dodge reporters are typically required to call on their information sources at least once every six months (or more often if necessary), even when progress is slow or the project is deferred. If this window is missed, or if a project is progressing rapidly, the reporter may not be able to record it as reaching a logically prior stage before it proceeds to the next one. In addition, there are cases where the development process itself permits a project to skip certain stages, as in the case of so-called "fast track" construction. As a general rule, the accuracy of information on projects improves greatly as they advance towards the start stage.

[4] These reversions happen to a relatively small proportion of projects, as reported in Gentile, Gallagher, Choate and Weiss (1997).

[5] Dodge updates its estimate of contract value as the project moves throughout its life cycle. The value used for our calculation is the most recent figure associated with each project.

[6] Recall that by definition, Dodge allows for a window of up to sixty days for starts, implying an upward bias in duration.

[7] A direct transition in which a project appears to skip a stage raises questions about what happened to the tasks usually associated with the omitted stage. One answer is that the omitted stage occurred, was temporally distinct, but the Dodge reporter missed it. A second possibility is that the tasks associated with the omitted stage, say a financing arrangement with a commercial bank, did not occur or were merged into a temporally prior stage.

[8] In an earlier study, transitions were limited to a six-month period. In that case, transition probabilities were often quite low. For example, the probability an office project would advance from pre-planning within a time period of six months was only 11% (Gentile, Gallagher, Choate and Weiss, 1997).

[9] These total transition probabilities are computed by adding together the probability a project in planning advances directly to start, the probability it advances to start via bidding, and the probability it advances to start via final planning and bidding.

[10] Please note that this is a slightly different approach than we have taken heretofore. We are calculating the lags that correspond to the transition probabilities above, requiring that there are no intermediate moves between the two stages. In previous examinations, we have simply asked, What is the lag between each pre-start stage and start?

[11] It appears that a project that proceeds through each phase will take far longer than one that is able to jump. Note that an apartment project that jumps directly from preplanning to start takes on average 8.22 months., but one which moves through each stage (preplanning to planning, planning to final planning, final planning to bidding and bidding to start) would average 18.55 months.

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