UCF College of Business Administration

Dr. P. Phillips School of Real Estate

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Henry J. Munneke
University of Georgia

Joseph T. L. Ooi
National University of Singapore

C. F. Sirmans
Florida State University

Geoffrey K. Turnbull
University of Central Florida

Working Paper 1503

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Henry J. Munneke†
Department of Ins/LS/RE
University of Georgia
hmunneke@terry.uga.edu

Joseph T.L. Ooi
Department of Real Estate
National University of Singapore
rstooitl@nus.edu.sg

C.F. Sirmans
Department of Risk Management/Insurance, Real Estate, and Business Law
Florida State University
sirmanscf@gmail.com

Geoffrey K. Turnbull
Dr. P. Phillips School of Real Estate
University of Central Florida
Geoffrey.Turnbull@ucf.edu

March 2015

† (communicating author)

We thank, without implicating, Paul Anglin, Norm Miller, and participants in the Real Estate Investments session at the January 2013 ASSA meetings for their comments and suggestions.

Abstract. This paper examines how firm, project and market characteristics influence real estate developers' decisions to outsource sales activities. Work incentives theory shows that neither inside nor outsourced sales are first-best, although the ability to use pure commissions with no base salary or employee benefits makes outsourcing more efficient but more costly on the margin. The empirical evidence shows that publicly traded companies and the most active developers in Singapore favor outsourcing. But firms tend to use inside staff in stronger property markets, a result consistent with incentives theory but not the established rationale that firms outsource to avoid long term cost obligations during booms. Internal staff generate faster sales and higher prices, evidence either they are more skilled or that outside agents spread their efforts across too many competing firms for any one firm to fully realize the greater efficiency of outsource sales.

1. Introduction

The prevailing view is that firms domestically outsource operations to reduce costs, retain flexibility, or control risk. First, outside suppliers may enjoy cost advantages over internal provision because of their unique expertise, ability to exploit economies of scale in their narrow specialized activity, or perhaps because they have access to lower cost inputs than are available to non-specializing firms (Anderson and Weitz, 1986; Roodhoft and Warlop, 1999). Second, firms can retain capital flexibility by outsourcing key activities to satisfy rapidly growing demand; outsourcing reduces the need to take on long run cost obligations to exploit what may be short run booms (Quinn, 1999). Third, outsourcing may offer the opportunity to shift risk to others with greater ability to control such risks or willingness to absorb them. Against these potential benefits, outsourcing introduces costs and uncertainty associated with contract management and enforcement issues (Jiang and Qureshi, 2006). This is one inescapable aspect of the general principal-agent problem inherent in contracting for external services.

The real estate development industry represents an opportunity to take a closer look at the relationship between firms' outsourcing decisions and their consequences. Like other industries, it is not unusual to find individual firms outsourcing only some of a particular activity; real estate developers often outsource their sales activities for some development projects while relying on internal sales staff at others. This suggests that at least some of the advantages of outsourcing accrue at the development project level rather than the firm level. While suggestive, the literature offers no clear explanation for why some of these firms outsource all of their sales activities while others outsource none and some firms outsource marketing for only some of their development projects while keeping the marketing activities of other projects in house. This paper provides empirical evidence that begins to fill this gap. It examines the extent to which development firm characteristics, project characteristics, and market conditions affect the net advantages of outsourcing selling activities to individual firms.

Work incentives theory offers a unified approach for examining rationales for outsourcing. In order to gain access to greater expertise or the benefits of economies of scale by outsourcing, the firm must implement a contract that will create incentives for the external provider to meet the firm's requirements at sufficiently low implementation, monitoring, and enforcement costs. On the other hand, relying on internal employees opens a range of incentive systems within a firm that cannot be effectively implemented across firms when outsourcing. At a minimum, outsourcing introduces one more layer of principal-agent relationships and the attendant incentives issues. From this perspective, it would be reasonable to suppose that the firm's outsourcing decision balances the efficiency loss from introducing another principal-agent relationship against the efficiency gain from specialization (presumably arising from external suppliers' greater skill from wider experience or from their ability to exploit economies of scale in the outsourced activity).

It turns out, however, that this approach to analyzing the sales outsourcing problem identifies trade-offs not yet identified in the outsourcing literature. The theoretical model illustrates that, even in the absence of any skill or inherent productivity advantage for outside agents, the information asymmetry between the firm and sales personnel intimately involved in the sales process (whether internal employees or external third parties) generates more efficient selling effort levels from outside agents than from inside employees. But at the same time, outside agents are more costly to motivate on the margin than inside agents. Therefore, in this context we find that the firm's outsourcing decision hinges on weighing the potential productivity gain from relying on outside agents against the greater marginal cost of incentivizing them.

This paper addresses the outsourcing question for real estate development firms. It uses a stylized model of internal versus external selling methods to identify various economic factors affecting the feasibility and relative profitability of each selling method. The empirical study uses data from 15 years of residential development activity to examine various factors at all levels—market, firm, and development project—that influence the decision to outsource sales. It also examines the consequences of outsourcing in terms of sales performance; revenues, prices, and the pace of sales.

Section 2 presents a simple outsourcing model that views the decision to outsource as another dimension of the firm's work incentives problem. The sales process is an asymmetric information environment in which selling agents, whether internal employees or external third parties, enjoy an information advantage regarding how difficult it will be to find buyers and complete transactions. In this environment, neither inside nor outside sales agents are first best. Surprisingly, outside agents are more efficient than inside agents, primarily because the firm is restricted to offer at least some nonwage benefits to internal employees which weakens the marginal incentive effects of sales commissions or performance bonuses. The development firm's decision to outsource therefore balances the greater efficiency that can be obtained from external agents against the greater commission rate needed to ensure the third party agent's participation constraint is met regardless of how difficult the sales environment turns out to be.

Section 3 describes the data and the empirical models. The data draw from 15 years of residential development activity in Singapore, a compact island city-state with well-functioning property and financial markets. One advantage of using Singapore as the study area is that it's relatively small size and thorough record keeping makes it possible to capture all of the new residential development undertaken during the sample period in the data set, offering a more complete picture of the entire market and development industry than is possible for the U.S.

Sections 4 and 5 present the empirical analysis. The first stage analysis focuses on firms' choices of whether to rely on in-house sales staff or outside independent agents, paying particular attention to how market level, firm level, and development project level attributes relate to these outsourcing decisions. The estimates show that boom markets stimulate property developers to rely more heavily on internal sales, a result that contradicts Quinn's (1999) argument that firms outsource to temporarily increase capacity during boom periods. Other market variables provide reinforcing evidence on this point, indicating that outsourcing is more attractive when sales are expected to be more difficult due to greater neighboring or broader market competition from properties being offered for sale by other developers. Turning to firm level effects, publicly held development firms and firms that are highly active in the Singapore market both tend to outsource sales. Finally, market conditions associated with greater revenue risk tend to favor outsourcing, an outcome consistent with risk averse property development firms attempting to shift risk onto external agents.

The second stage of the empirical study examines the effect of marketing mode on performance in terms of revenue as well as price and liquidity for each individual development project. For total revenues, the results indicate no stable relationship between relying on inside sales and realized revenues in fixed effects and probit models of the sales method. But the results also show that the greater the predicted likelihood that the development project would benefit from internal sales, the greater the incremental revenue from actually adopting that selling regime. Overall, the revenue analysis yields some support for the notion that internal sales generate greater expected revenues than outsourcing while providing absolutely no evidence of outsourcing being more productive than internal sales.

Separating revenue into its components, selling price and liquidity, reveals new sales performance results. While relying on internal agents has no significant direct effect on selling price, it does lead to faster sales. The results show a subtle effect on sales performance primarily through liquidity changes, an effect not evident in the total revenue approach. The faster pace of sales in turn indirectly leads to higher selling prices.

2. Incentives and Outsourcing

Consider a real estate development firm with an inventory of new (or forthcoming) housing units to offer to the market. For an individual development project, the firm chooses to either employ inside sales staff or outsource sales to independent agents rewarded with traditional commissions. What drives this decision? At least part of the decision to outsource sales appears to be project or development-specific since firms do not use the same marketing scheme for all of their development projects. Some firms outsource sales for one project while relying on internal sales staff for another project.

This section offers a simple incentives model to examine factors likely to affect the firm's choice of internal or outsource selling regimes. Principal-agent relationships exist in both arrangements, but their implications for relative cost and sales performance differ. Our goal is to identify how firm, development project, and market factors can affect outsourcing decisions.

The model focuses on the development firm's marketing decision and ignores production decisions. The firm has an inventory of new housing units to sell. The total number does not matter for this discussion, so we leave it unspecified without loss of generality. The firm is concerned with expected revenue per period. Sales revenues per period are a stochastic function of agent sales effort e; realized revenue per period can be expressed as

$$R = wf(e) + v \quad (1)$$

The function f is nonstochastic, increasing in effort, and strictly concave in agent sales effort, e ($f_e > 0$, $f_{ee} < 0$). The parameter $w > 0$ is the stochastic sales productivity parameter mediating how difficult it is to translate effort e into sales outcomes. The greater the realized w, the greater the expected sales revenue from a given amount of sales effort. The realized w therefore includes the influences of market-wide or neighborhood factors on buyers' willingness-to-pay for the subject property that may vary over the total time needed to sell the developer's inventory of housing units. The additive stochastic term v in the revenue function captures sales outcome effects that are unrelated to sales effort level, including luck. The stochastic terms w and v have continuous distributions W and V, respectively, with finite means and variances VAR(w) > 0, VAR(v) > 0. Assume E[v] = 0 without loss of generality.

All parties are assumed to be risk neutral; risk considerations are addressed informally later. The decision sequence is as follows. At the contracting stage, the developer and sales agent agree to the incentive structure before observing the stochastic terms w and v. In the selling stage, the sales agent, whether internal employee or independent third party, observes w and sets its own sales effort e before v is known. In the final stage the stochastic term v is realized so that the revenue output is observed and compensation awarded following the previously established agreement between the firm and sales agent. The presence of the stochastic productivity w and the additive effect v ensure that the developer cannot infer agent sales effort from observations of realized sales revenue R; observed revenue is not a sufficient statistic for worker effort (Nalebuff and Stigliz 1983).

Outsource sales. First consider the case in which the developer hires an outside or independent agent (or firm) to sell the inventory of housing units in the development project. At the outset, the developer and sales agent agree to the commission rate c_o, where the subscript pertains to the outsource case. The commission rate is feasible in that it ensures the broker's participation constraint (explained below) is satisfied. The developer observes realized revenues but cannot observe the realized sales productivity *w*. The agent, however, is intimately involved in the selling process and observes *w* before choosing its own sales effort *e*.

Conditional on the realized state *w*, the outside agent chooses effort to maximize expected utility (where the expectation is over *v*), which is the expected agent gross income less the cost of effort (the unit cost of which is normalized to unity). Since E[*v*] = 0, the worker's expected utility is simply

$$U(w) = c_o w f(e) - e \tag{2}$$

The outside agent's optimal effort is $e^o(w)$ satisfying the marginal condition at each *w*

$$c_o w f_e(e) - 1 = 0 \tag{3}$$

Substituting $e^o(w)$ into $U(w)$ yields the state-dependent expected utility $U^*(w) = c_o w f(e^o(w)) - e^o(w)$. Since $dU^*/dw = cf(e^o(w)) > 0$, equilibrium expected utility is increasing in *w*. Let α denote the agent's opportunity cost of engaging in sales for this developer. It follows that the agent's ex post participation constraint is fulfilled for all *w* at minimum cost to the developer when the commission rate $c_o < 1$ satisfies the condition

$$\alpha = c_o w' f(e^o(w')) - e^o(w') \tag{4}$$

at the lower bound *w'*. This condition is used in later comparisons.

Sales by internal staff. Suppose the developer instead relies on internal sales employees. There is a wide range of incentive schemes available to the developer, the relative efficiency and economic feasibility of each depending upon the nature of the transactions technology, hence the cost of monitoring and managing internal sales production by employees. At one extreme of the information spectrum the firm can observe both worker effort and state of the world at sufficiently low cost. In this case the employment relation (Simon, 1951; Turnbull, 1993) stipulates the state-dependent work rules specifying required effort for sales employees for all w in return for a specified salary or fixed wage. It bears emphasis that the Simon employment relation is economically feasible only when the developer can observe w by incurring a sufficiently low expenditure on market research, employee monitoring and management, including enforcement costs. But the firms in our data set instead rely on performance bonuses, a scheme at the other extreme of the information spectrum; it only requires that firm be able to observe realized output. This incentive system requires little investment in monitoring and sales management. Its popularity among developers relying on internal sales staff suggests that the resource cost of trying to measure sales effort directly is prohibitive. Whatever efficiency gains it garners are outweighed by the lower monitoring cost of relying on observed performance rather than effort. In any case, given its empirical relevance, the discussion here focuses on such a performance-based bonus scheme.

Even though the developer cannot observe realized sales productivity w with sufficient accuracy to infer worker effort from realized sales R, it can nonetheless structure an incentive scheme for its sales staff using measurable outcomes. A commission scheme with base income $b > 0$ (which includes the value of nonwage benefits) and commission rate c_i provides a stylized model of the performance bonus scheme popular in this industry. In this case, since E[v] = 0, the worker's expected utility in state w is

$$U(w) = b + c_i w f(e) - e \tag{5}$$

Maximizing with respect to sales effort conditional on w, the internal worker's effort $e^i(w)$ satisfies the marginal condition

$$c_i w f_e(e) - 1 = 0 \tag{6}$$

It worthwhile to note at this point that one consequence of the firm's inability to directly observe productivity w and accurately infer worker effort is that it cannot set efficient work rules requiring effort $r(w)$, as in Simon's employment relation (Simon, 1951; Turnbull, 1993). The problem considered here therefore differs from previous studies of real estate property sales outsourcing in which inside agents behave efficiently because in those applications sellers and agents are the same individuals (Hendel et al., 2009; Levitt and Syverson, 2008; Rutherford et al., 2005).

In order to find the reward structure that satisfies the worker's participation constraint for all w, substitute $e^i(w)$ into the expected utility to find $U(w) = b + c_i w f(e^i(w)) - e^i(w)$. As in the outside sales agent case, the envelope theorem reveals that the maximized expected utility is increasing in w so that the cost-minimizing bonus scheme that satisfies the worker's participation constraint is that which allows the worker to attain its opportunity cost α at the lower bound w', satisfying

$$\alpha = b + c_i w' f(e^i(w')) - e^i(w') \tag{7}$$

Assuming the opportunity cost is the same for all agents, whether third party or employee, the participation constraints for the outside (4) and inside (7) agents require

$$b + c_i w' f(e^i(w')) - e^i(w') = c_o w' f(e^o(w')) - e^o(w') \tag{8}$$

To compare outsource and employee rewards, first note that $b = 0$ implies $c_i = c_o$. But $b > 0$ for internal sales staff as employees of the development firm (since b includes nonwage benefits required for internal employment). Differentiating the left hand side of (8) with respect to the employee base income and applying the envelope theorem yields

$$dc_i/db = -1/w'f(e^i(w')) < 0 \qquad (9)$$

It follows that $b > 0$ requires $c_i < c_o$ which, with agent optimality conditions (3) and (6), further implies $e^i(w) < e^o(w)$ for all states w. *Therefore, outsource agents work harder and generate greater expected sales revenue per period than equal ability employees of the developer.* And while neither sales scheme is first best, it nonetheless turns out that *outside independent agents provide more efficient effort because the labor market constraint embodied in the participation constraint forces the developer to offer outside agents a higher commission rate than under the bonus scheme offered to its own sales employees.* This conclusion contrasts with Hendel et al. (2009), Levitt and Syverson (2008), and Rutherford et al. (2005), all of which focus on situations in which the seller is the agent, so there is no principal-agent relationship for inside selling. In this analysis, however, the more efficient sales performance under outsourcing comes at a higher marginal cost to the developer, so outsourcing need not be more profitable than internal sales. Hence, outsourcing may not be chosen by the developer even though it is more efficient than keeping sales activities inside the firm. Nonetheless, the relationship between sales method and revenue predicted by the model is empirically relevant because revenues can be reconstructed from market transaction data whereas developer profits cannot.[1]

Other factors also influence the observed revenues (outcomes) of the two sales methods. For example, greater inherent ability or selling skills can be introduced as a spread-preserving

[1] The only other real estate related outsourcing studies examine outsourcing property management. These studies, Glascock et al. (1993) and Sirmans et al. (1999), similarly focus on revenue relationships because profits cannot be calculated from observed market data.

increase in the mean of the *w* distribution; doing so for the independent outsource agent, for example, (3) implies an even greater performance premium for the outside agent when compared with the internal employee counterpart. At the same time, it can also be shown that greater selling ability for independent agents lowers the market commission rate c_o, which in turn reduces the cost to the developer of relying on outside sales. While we do not attempt to formally model any agent sorting by ability as employees or independent agents, this conclusion nonetheless implies that *outsourcing sales will be more attractive to the developer the greater the advantage in selling ability of outside agents relative to potential employee agents while outsourcing sales will be less attractive the greater the advantage in selling ability of potential employee agents relative to outside agents.*

There is, however, a complicating factor. It may be that outside independent agents (or the specialized brokerage firm) may be more interested in selling a property, any property, to a particular buyer than selling a specific property to any buyer (Turnbull and Dombrow 2007). In contrast, the employee sales agent is only interested in selling a particular property (the employer's product) to any potential buyer. In the context of our model, the freedom that an independent broker has to match buyers with properties from a number of developers may lead to greater opportunity cost of any sales effort allocated to a single developer's product.[2] Introducing a higher unit cost of effort into the outside agent effort condition (3) clearly dampens the effort expended by the outside agent on behalf of the subject property, and may even do so enough to yield $e^i(w) > e^o(w)$ for some or all *w*. *The developer may realize lower expected sales revenues for outsource agents than employee agents when the independent contractor effect is sufficiently strong.*

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[2] An independent outside agent selling units from *n* different developers will, in symmetric equilibrium, generate greater total expected revenues from greater sales effort, but only (1/*n*)th of the brokerage's revenues will accrue to each developer on average.

Finally, we briefly consider the differences in income risk (for the agent) and revenue risk (for the firm) across internal and outsource sales approaches. For each realized state *w* the variance in sales agent income unrelated to selling effort is c^2VAR(v) and the corresponding variance in developer net revenue unrelated to agent selling effort is $(1\text{-}c)^2$VAR(v). Clearly, the lower commission rate for internal agents generally leads to lower income risk for employee-agents and greater profit risk for the developer than when outsourcing sales. This suggests that introducing developer risk aversion increases the attractiveness of outsourcing to the extent that it shifts some of the risk to external agents. Similarly, introducing agent risk aversion increases the cost of incentivizing outside agents more than inside agents, decreasing the attractiveness of outsourcing to the developer. In the context of this model, if the data show that greater unpredictability of revenue increases the likelihood of outsourcing by the firm, then the firm is more risk averse than the outside sales agent. On the other hand, if greater unpredictability of revenue decreases the likelihood of outsourcing, then the firm is less risk averse than the outside agent. The effect of greater unpredictability in the sales effort-sales revenue relationship (i.e., larger VAR(v)) on the firm's decision to outsource or rely on inside employees therefore remains an empirical question.

3. Data

We use data for new residential developments in Singapore to examine the factors affecting a developer's choice of whether to outsource sales or retain an internal sales staff. Singapore is an independent city-nation with residential districts entirely self-contained on one island. Singapore has a long tradition of the rule of law and well-established private property markets. The main source of project level information for our study is the Urban Redevelopment Authority (URA)

Property Market Information, which is available quarterly. This is an objective data source due to the fact that developers are required by law to provide accurate information to the governing authority.[3] The URA publication contains the dates of written permission, building approval, grant of sale license, marketing launch, and completion of the individual developments. Statistics on the total number of uncompleted units launched and sold for every residential development are also reported together with the aggregate figures for the entire market. This data, when coupled with sales data on individual unit sales, provide a useful benchmark for a property's initial launch date, as well as important milestones including when the particular project is physically completed. The sample used to estimate the empirical models is compiled from new residential condominium and apartment developments launched between 1999 (1st Quarter) and 2005 (4th Quarter) in Singapore and the subsequent sale of their individual units. In an effort to obtain a more homogenous sample of developments, we concentrate on newly developed residential projects with at least 100 dwelling units.

Table 1 presents the summary statistics for 129 developments launched within the study period. The table provides summary statistics for the full sample and for the sub-samples of developments sold using internal verses outsource agents. Of the 129 developments, 31 (or 24%) of the developers chose to market the development with internal agents. Developments with internal agents tend to contain more units; however, the average unit size and unit size variation for developments with external agents tends to be lower than developments with internal agents.

There also appears to be some variation in the developer's characteristics between developments with internal verses external agents. The developments in the sample are

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[3] Press reports on property launches offer another source of information on how fast units are selling. This source, however, is not reliable because developers have an incentive to manipulate their sales figures to enhance the image of their projects. Projects that are not selling well may not even be reported.

predominantly (67%) undertaken by publicly listed companies and developments using external agents have a higher frequency of being a publicly listed company. Overall, 94% of developers have prior experience in the market. While only 14% of the overall projects are undertaken as joint ventures, nearly 16% of the developments marketed by external agents are joint ventures. Of the development projects in the sample, 85% are condominium complexes.[4] Approximately 52% of the developments in the full sample have freehold or leasehold tenure of 999 years; however, only 42% of the developments with internal agents have freehold or leasehold tenure of 999 years.

The location attributes of the projects reflect the relatively small physical area of the Singapore market. On average, the distance of a development to the nearest metro station ($UMRT_i$) is less than 1 km and the average distance to the city center ($UCBD_i$) is 7.7 km. Approximately 29% of the developments are in residential districts informally considered prime districts by buyers and sellers in Singapore's real estate market. Interestingly, the locational attributes do not appear to vary significantly between the sub-samples with the exception of developments located near water. Nearly 19% of the developments with internal agents are located near water, while only 9% of developments with external agents are located near water.

As explained earlier, unpredictable variation in transaction outcomes (liquidity, or speed of sales, and price), corresponding to VAR(v) in the incentives model, may influence the developer's decision to outsource sales for a particular development. We use the standard deviations of the price (*STD_DEV_PRICING*) and liquidity (*STD_DEV_LIQUIDITY*) regression errors for all units sold in the market within 30 days of the launch of each development as measures of the portion of the liquidity and pricing processes not explained by the market and

[4] In this market, "condominium" indicates specific additional amenities not present in "apartment" developments. Note that all condominium and apartment units are sold to buyers as individual units.

property characteristics.[5] As reported in table 1, the level of unexplained variation is consistent across the internal and external sub-samples for the price process. This relationship is also true for the one period lag of this variable. And while we observe no statistical difference in the average level of unexplained variation in the liquidity process in the development launch period, the average of the lag of the liquidity variable is significantly greater for the external sub-sample than for the internal subsample.

Table 2 reports summary statistics for variables constructed from individual unit transactions, aggregated to the project or development level. Information on individual transactions is drawn from the Real Estate Information System (REALIS), a database maintained by Singapore's national land use planning authority, the Urban Redevelopment Authority (URA), provides information related to the individual unit's selling price, date of sale, and size. This transaction database is based on legal documents or caveats filed by buyers to protect their interest soon after an option to purchase a property is exercised. Caveats typically are lodged two to three weeks after a purchaser signs an option to purchase at the model unit. Since it is not mandatory to lodge a caveat, it is possible that the transaction database does not include all of the units sold directly by the developers. However, such omissions are few in practice since most home purchases involve mortgage loans, in which case the solicitors acting on behalf of the banks insist on lodging a caveat to protect their client's interest in the property.

In table 2 Revenues (*REV*) are measured at the development level by aggregating individual unit sales that occur within each 30 day period (where the first 30 day period begins

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[5] The price and liquidity risk measures are constructed from the regression error terms of the simultaneous estimation of the price and liquidity equations for individual unit transactions. The system estimation follows the general approach suggested by Zahirovic-Herbert and Turnbull (2008). Both equations are functions of the typical exogenous unit, project, transaction and time variables usually found in hedonic house price functions. They show that including such neighborhood market conditions in the empirical model leads to parametric restrictions that identify the simultaneous system. We also use this approach for some of the performance analysis undertaken later in this paper, where a more complete explanation can be found. The individual unit level hedonic estimates used to construct the price and liquidity risk measures used in this paper are available upon request.

on the date of the first unit is sold). Selling prices (*PRICE*) and *LIQUIDITY* are the averages for all individual units sold in the development during a 30 day period. The total revenue for developments marketed with external agents is on average greater, by over S$2 million, than that found in developments marketed with internal agents. The average selling price per unit is also higher for the external agent sample. The liquidity measure, the time between sales, is higher in the outsource sample indicating external agents sell units at a slower pace on average. The variable $SOLD_i$ is the proportion of total units sold in the project at the end of each 30 day interval.

Recent housing market research emphasizes the role of surrounding properties with units for sale as potential competition for units that are for sale in the subject development project. Following Turnbull and Dombrow (2006) and a growing literature, we construct total competition ($TOTCOMP_i$) and competition density ($COMPDENS_i$) variables to measure the extent of local competition from surrounding developments. The total competition measure takes into account the total number of units in other developments outside of the subject property's development that have overlapping days on the market (the empirical models include separate direct controls for the number of units on the market in the subject development, so they are excluded from the measure of surrounding competition). Let $L(i)$ and $S(i)$ denote the initial date the ith unit is exposed to the market and the sales date, respectively. The overlapping days on the market for units j and i is defined as:

$$O(i, j) = \min\,[S(i), S(j)] - \max\,[L(i), L(j)] + 1$$

where units j are found in developments J not in development I (the development in which the ith unit is contained). Competing units are determined by their distance from the subject property. Calculate $D(i, j)$ as the straight-line distance between the subject unit i and other overlapping units j for sale; competing units are defined as units found in the developments J that fall within λ km of the ith unit's development. More formally, the set of competing units is defined as $K \equiv \{ j \mid D(i, j) \leq \lambda \text{ and } I \neq J\}$. The variable measuring total competition is defined as:

$$TOTCOMP_i^{\lambda} = \sum_{j \epsilon K} \left(1 - \left(\frac{D(i,j)}{\lambda}\right)^2\right) O(i,j).$$

Combining the total competition and liquidity measures yields a measure of competition per day on the market for the subject property, or competition density:

$$COMPDENS_i^{\lambda} = TOTCOMP_i^{\lambda} / LIQUIDITY_i.$$

This measure represents the average intensity of the competition from other units for sale in terms of competing units per day.

To calculate the measure of total competition from surrounding units on the market, the REALIS first sale data set is extended to include developments launched two years prior to the first development in the study period. In other words, we expand the sample to calculate the competition measure so that the measures for the early development in the study period will reflect the competition of developments launched prior to the study period and still have competing units on the market. Most new condominiums in Singapore are sold before project completion, which is a common practice in many of the Asian markets such as China, Hong Kong, Taiwan, South Korea, and Malaysia (Chang and Ward, 1993; Ong, 1997; Lai, et al., 2004). Therefore, to make the calculation of the competition measure tractable, we only use the pre-completion transactions when calculating the competition measures. Finally, separate competition measures are calculated using properties for sale within a 2 km radius that fall within the same governmentally designated planning area as the subject development and properties for sale within a 2 km radius that fall outside the planning area. This approach allows units inside and outside the same planning district to exhibit different competition effects. In table 2, the calculated total competition and competition density are on average, over the 30 day intervals, greater for the internal agent sample within the planning area than for the external sample.

4. Empirical Analysis of Outsourcing Choice

The developer's choice of whether to outsource sales activities may be influenced by developer characteristics, development characteristics that may make sales easier or more difficult under various market conditions, and the broad and local market conditions themselves. Table 3 reports the probit estimates for choosing the *INTERNAL* sales method as a function of variables measuring different aspects of these determinants. Whether or not the development project has been undertaken by a joint venture of two or more developers (*JOINT*) does not appear to matter; the coefficient is not significant. Other developer characteristics, however, do affect the choice of sales method. The significant negative coefficient estimates on *LISTED* and *LAUNCHED* indicate that publicly held developers and highly active developers both tend to rely on outsourcing. Developers with a history of offering higher quality construction to the market, however, show no significant pattern.

Looking at the market conditions variables, greater increases in residential prices before project launch increase the probability that the developer will rely on internal sales. This result runs counter to Quinn's (1999) notion that firms outsource to retain flexibility, expanding capacity to accommodate booms without taking on long run cost obligations. This estimate suggests the opposite; developers rely more on internal sales staff in booming markets.

The market level residential vacancy rate is not significant, but other market conditions variables are. The greater the supply of units for sale in the broad market (*UNIT_SUPPLY*), the lower the probability of relying on internal sales staff. Similarly, the greater the number of other units being offered for sale in other developments in the same planning area (*COMPETITION*), the less like the development will be marketed internally. These two results dovetail with the residential price index result. It appears that outsourcing becomes more attractive to developers the more difficult sales are expected to be. In terms of the underlying theory, these estimates imply that the transaction technology embodied in the sales production process is such that increasing the mean sales productivity parameter (a spread-preserving increase in E[w]) increases the performance or cost advantage of outside agents over inside agents.

The next set of variables relate to development project characteristics. Of these, the average unit size (*AREA_AVE*) increases the probability of outsourcing while proximity to water (*NEAR_WATER*) increases the probability of inside sales. The other development characteristics, including the overall size of the project, *DEV*_SZ, are insignificant. The insignificance of the project size, in particular, is an important result. It indicates that even the largest individual developments in Singapore are not large enough for developers to realize meaningful economies of scale in internal marketing.

Finally, the unexplained variation in sales prices and liquidity, our proxies for the stochastic influences in v that are unrelated to sales effort, do influence the sales regime as we argued earlier. The net effect of the liquidity risk at the time of project launch and the lagged liquidity risk is not significant, but the price risk at the time of project launch is significantly negative at the 5% level. The latter result indicates that greater revenue risk from this source (that is, greater VAR(v)) makes outsourcing more attractive to developers, a relationship consistent with risk averse firms using outsourcing to shift revenue risk onto external agents.

5. Empirical Analysis of Outsourcing Effects

The developer's choice of sales method appears to be systematically influenced by several developer and development characteristics as well as market conditions in terms of competition and unpredictability of prices and liquidity. We now consider how the different selling regimes are reflected in measurable outcomes. Looking first at revenues, Table 3 reports the effects of development characteristics, market conditions and sales regime on the log of revenues in a fixed effects model for internal sales. Many of the development characteristics and market conditions affect expected sales revenues (recall that revenues are measured over 30 day periods). The size of units, location of the development in the prime area, quality of construction, freehold title, and the size of the development all have significant positive effects on expected revenue. And not surprisingly, the negative coefficient on *UCBD* indicates the greater the distance from the central business district, the lower the sales revenue. Competition from nearby units for sale in the same planning area (*TOTCOMP_IN*) tends to reduce revenue, an intuitively appealing result. Competition from nearby units outside the planning area (*TOTCOMP_OUT*), however, has no significant effect on revenue. In sum, these aspects of the revenue function appear to be consistent with what one would expect.

Turning to the sales method, however, the coefficient on *INTERNAL* is not significantly different from zero. There appears to be no stable relationship between the sales method and overall sales outcomes, as measured by total revenues.

Of course, the results reported in table 4 treat the sales regime as exogenous. The theory and the previous sales regime choice analysis both indicate that the method of selling is systematically influenced by a variety of factors. Table 5 reports the total revenue function estimates using the predicted probability of internal sales for each development (*PROB*), based on the choice function in table 3. The revenue function is robust across specifications for the other variables. The model using *PROB* in the first column yields the same conclusion as the fixed effect model in table 3; the choice of selling regime has no significant effect on expected revenue performance. The model reported in the second column adds an interaction term, *PROB*INTERNAL*. In this model the *PROB* variable coefficient by itself captures the revenue of effect of being a high internal sales probability development that instead ends up outsourcing sales. The coefficient is negative, but not significant. The interaction term *PROB*INTERNAL* coefficient captures the revenue effect of being a high internal sales probability development that actually does rely on internal sales. The interaction coefficient is positive and significant, indicating that the greater the predicted probability of being a suitable internal sales development, the greater the incremental revenue from actually adopting that selling regime. In summary, while the evidence is not robust, it provides some support for the notion that internal sales generate greater expected revenues than outsourcing while providing absolutely no support for outsourcing as more productive in this regard than internal sales. This pattern is consistent with internal sales agents enjoying sufficiently greater inherent ability or productivity over outside sales agents to overcome the incentives efficiency advantage of the latter.

In order to probe more deeply into how the selling regime affects transactions outcomes at the development level, we break the revenue function into its separate components: selling price and pace of sales or liquidity. Housing is a search market, and price and liquidity are jointly determined in search markets (Krainer, 2001). This means that price and liquidity must be evaluated using a simultaneous system comprising an hedonic price equation and a liquidity equation. The further complication of the joint determination conclusion of search theory, however, is that it implies that both price and liquidity are functions of the same set of variables.

Specifically, they are functions of development characteristics *X,* the total amount of competition from surrounding competing listings, *TOTCOMP* (comprising *TOTCOMP_IN* and *TOTCOMP_OUT* in this application)*,* and selling regime, *INTERNAL.* For observation *i*, the system of equations can be written

$$\ln\left(PRICE_i\right) = P\left(\widehat{LIQUIDITY}_i, X_i, TOTCOMP_i, INTERNAL_i\right) \qquad (10)$$

$$LIQUIDITY_i = L\left(\ln\left(\widehat{PRICE}_i\right), X_i, TOTCOMP_i, INTERNAL_i\right) \qquad (11)$$

where X_i summarizes the exogenous development and time variables that impact price and liquidity.

To identify the above set of equations, Zahirovic-Herbert and Turnbull (2008) note that the effect of increasing *TOTCOMP* on ln*PRICE* while holding *LIQUIDITY* constant only reflects the effect of increasing the number of competing listings per day on the market, or increasing the competition density, which is the *COMPDENS* variable defined earlier. Imposing this parametric restriction, the empirical price-liquidity system is identified and becomes (see Zahirovic-Herbert and Turnbull (2008) for additional details)

$$\ln\left(PRICE_i\right) = p\left(\widehat{LIQUIDITY}_i, X_i, COMPDENS_i, INTERNAL_i\right) \qquad (12)$$

$$LIQUIDITY_i = L\left(\ln\left(\widehat{PRICE}_i\right), X_i, TOTCOMP_i, INTERNAL_i\right) \qquad (13)$$

where the change in functional notation in (12) reflects the imposed parametric restriction.

Interpreting the coefficients on the *COMPDENS* and *TOTCOMP* variables is straightforward in this model. Surrounding units for sale may reduce price and/or increase the liquidity measure, indicating greater localized competition for potential buyers, or may increase price and/or reduce the liquidity measure, indicating the presence of a stronger shopping externality effect from nearby sales drawing additional interested buyers to the locale (Turnbull and Drombrow, 2006).

Table 6 reports the 3SLS estimates of the system (12)-(13) for the selling regime fixed effect model, the model using only the probability measure of internal sales, and the interaction model. The non-selling regime variable coefficient estimates are remarkably robust across all specifications; the individual coefficients for these models do not yield any startling results. Looking at the selling regime variables, though, we do find some new patterns not evident in the total revenue approach taking earlier. The use of internal agents has no significant effect on selling price (holding liquidity constant) in either the fixed effect or probability models. The significant negative *INTERNAL* coefficient in the fixed effect liquidity model indicates that using internal agents leads to faster sales. The *PROB* coefficient in the probability model is also negative, but not significant. So, while the total revenue approach considered earlier does not reveal any systematic selling regime effects for the fixed effect or probability models, these results show at least some evidence of an effect through liquidity.

The interaction model in table 6 gives a clearer picture for both price and liquidity. The *PROB* coefficient in the price equation is positive and not significant but the interaction coefficient on *PROB*INTERNAL* is positive and significant. This combination indicates that inside agents generate higher prices (holding liquidity constant) in developments that are both good candidates for internal agents (as indicated by a high *PROB* value) and actually choose to rely on internal agents. The *PROB* coefficient estimate is significantly positive and the interaction coefficient significantly negative in the liquidity equation. This combination indicates that inside agents generate slower unit sales in developments that are good candidates for inside agents (as indicated by a high *PROB* value) but choose to outsource (in which case *INTERNAL* and the interaction variable are zero). The negative significant coefficient on the interaction variable offsets the positive effect of the *PROB* coefficient for developments employing internal sales staff. This means that internal agents generate faster sales than outsourced agents, regardless of the value of the *PROB* variable for the development, a strong conclusion consistent with the other models in Table 6. Finally, it is useful to also note that, in all cases, the negative *LIQUIDITY* coefficient in the price equation indicates that the indirect internal agent effect (through faster sales) is to raise prices. Referring back to the theoretical discussion, this pattern is consistent either with more capable inside agents overcoming the incentives efficiency advantage of outsourcing or outside agents spreading their sales efforts across several development projects.

6. Conclusion

This paper begins examines how developer characteristics, development project characteristics, and market conditions affect selling outsourcing decisions. While some firm characteristics increase the likelihood of outsourcing, the fact that developers may outsource sales for one development while relying on internal agents for another implies that outsourcing decisions are driven by development project level factors. Publicly traded companies in Singapore are more likely to outsource selling activities, as are the most active developers in the market. Stronger property markets, on the other hand, tend to increase reliance on internal sales staff, a result consistent with incentives theory but not with the notion that firms outsource to avoid long term cost obligations while responding to market booms. Development characteristics like freehold tenancy, distance to the CBD or nearest metro station, or being situated in the recognized prime neighborhoods do not appear to influence the outsourcing decisions of developers. These particular features are value-enhancing and likely to affect the difficulty of sale, yet surprisingly, they are not important factors in outsourcing decisions. On the other hand, some development project characteristics influence outsourcing decisions. We find, for example, that developments featuring larger residential units are more likely to outsource sales, as are developments that are not near water.

The decision to outsource or not has some surprising effects on sales performance at the project level. Looking at total revenues, the empirical estimates provide some support for the notion that internal sales generate greater expected revenues than outsourcing while providing absolutely no support for outsourcing as more productive than internal sales. Looking at the individual revenue components, prices and liquidity, the estimates imply that relying on internal staff leads to faster sales and higher prices. It appears that something is offsetting the more efficient effort level expended by outsourced agents under the participation constraint. Our framework suggests that either inside agents in the sample are more skilled than outside agents or outside agents are spreading their sales efforts across multiple competing developments.

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Table 1: Summary statistics of residential development projects launched by developers in Singapore 1999Q1 through 2005Q4 (N = 129)

	Full Sample		Internal Agent		External Agent	
Variables	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
$JOINT_i$	0.155	0.3634	0.129	0.3634	0.1633	0.3634
1, if joint venture; 0, else						
$EXPERIENCE_i$	0.938	0.2421	0.9677	0.1796	0.9286	0.2589
1, if developer has prior experience; 0, else						
$LISTED_i$	0.6667	0.4732	0.3548	0.4864	0.7653	0.426
1, if publically listed company; 0, else						
$LAUNCHED_i$	5.5736	3.695	3.7419	3.1088	6.1531	3.6899
Ranking of developer according to number of units launched in prior two years (1 most active)						
$QUALITY_i$	81.1421	4.1387	81.1839	3.897	81.1289	4.2315
Average the Conquas Score (a construction quality index) for projects in the previous years by the same developer						
$\Delta RPI(t\text{-}1)_i$	-0.0004	0.0338	0.0003	0.0226	-0.0006	0.0367
Change in Residential Price Index (RPI) lagged one period						
$MKT\_VAC(t\text{-}1)_i$	0.0808	0.0061	0.0811	0.0054	0.0807	0.0063
Market vacancy rate lagged one period						
$PRIMERATE_i$	5.5098	0.2446	5.4897	0.2446	5.5161	0.2455
Prime lending rate at launch						
$UNIT\_SUPPLY_i$	1953.67	838.3086	1835.97	739.8923	1990.91	867.3034
Supply of units in the entire Singapore market at launch						
$COMPETITION_i$	0.3721	0.4852	0.4194	0.5016	0.3571	0.4816
Number of residential projects by the ***other*** *developers in the same planning area and year.*						
$AREA\_AVG_i$	122.8702	23.7636	116.0824	21.0952	125.0174	24.2522
Average size of unit (sqm) contained in the development						
$AREA\_STD_i$	36.5677	35.5755	28.2954	15.7643	39.1844	39.5531

Standard deviation of unit size in the development						
$FREEHOLD_i$	0.5194	0.5016	0.4194	0.5016	0.551	0.4999
1, indicating freehold tenure; 0, else						
$PRIME_i$	0.2868	0.454	0.2903	0.4614	0.2857	0.4541
1, if development is located in prime location; 0, else						
$UCBD_i$	7.6715	4.7127	7.7148	5.005	7.6578	4.6432
Distance to CBD (km)						
$UMRT_i$	1.0083	0.7474	1.0825	0.8528	0.9848	0.714
Distance to the nearest metro station (km)						
$NEAR\_WATER_i$	0.1163	0.3218	0.1935	0.4016	0.0918	0.2903
1, if located within 500m of sea/lake/river; 0, else						
DEV_SZ_i	322.0775	217.7552	339.6452	204.8975	316.5204	222.3894
Number of units in development						
$CONDO_i$	0.845	0.3634	0.8387	0.3739	0.8469	0.3619
1, if located within condominium complex; 0, else						
$STD\_LIQUIDITY\_e_i$	36.6113	18.8651	39.4415	18.8819	35.7161	18.8678
St. dev. of unobserved component of the liquidity process.						
$STD\_PRICING\_e_i$	0.1477	0.0278	0.1467	0.0243	0.1481	0.0289
St. dev. of unobserved component of the pricing process.						
$STD\_LIQUIDITY\_e_i(t-1)$	32.4546	23.2152	26.914	16.8583	34.2073	24.7057
One period lag of $STD\_LIQUIDITY\_e_i$						
$STD\_PRICING\_e_i(t-1)$	0.146	0.0342	0.143	0.0288	0.1469	0.0358
One period lag of $STD\_PRICING\_e_i$						
$INTERNAL_i^{(0,1)}$	0.2403	0.4289	1	0	0	0
1, if the project is marketed by an internal agent						
$PROB_i$	0.2402	0.3259	0.6702	0.2981	0.1042	0.1869
Probability project is marketed by an internal agent						
Observations	129		31		98	

Table 2: Summary statistics based on 30 day intervals beginning from development launch date (development level)

	Full Sample		Internal Agent		External Agent	
Variable	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
TOT_REV_i	9717442	24403723	8030501	19277532	10324166	25979620
Total Revenue over interval t						
$PRICE_i$	858147	498170	759432	267752	893650	554036
Average selling price over interval t						
$LIQUIDITY_i$	21.5663	49.3150	17.7668	36.4821	22.9328	53.1214
Average number of days since last sale in project over interval t						
$AREA_i$	122.4179	45.2553	112.5045	24.3901	125.9834	50.2318
Natural logarithm of average unit size (sqm) over interval t						
DEV_HEIGHT_i	16.7794	9.7006	18.0458	8.1567	16.3239	10.1624
Height (in floors) of development						
$PRIME_i$	0.2131	0.4096	0.1959	0.3972	0.2193	0.4139
1, if unit is located in prime location; 0, else						
$UCBD_i$	8.6434	4.7161	8.6225	5.0055	8.6509	4.6090
Distance to CBD (km)						
$UMRT_i$	1.0703	0.7234	1.1653	0.7961	1.0362	0.6924
Distance to the nearest metro station (km)						
$NEAR\_WATER_i$	0.1204	0.3254	0.1864	0.3897	0.0966	0.2955
1, if located within 500m of sea/lake/river; 0, else						
$CONDO_i$	0.8863	0.3175	0.8894	0.3139	0.8852	0.3188
1, if condominium complex; 0, else						
$COMPETITION_i$	0.4041	0.4908	0.4028	0.4909	0.4045	0.4909
Number of residential projects by the ***other*** *developers in the same planning area and year.*						

$QUALITY_i$	80.9617	3.8903	81.4736	3.2704	80.7776	4.0756
Avg. Conquas Score (a construction quality index) for projects in the previous years by the same developer						
$FREEHOLD_i$	0.4275	0.4948	0.3160	0.4653	0.4676	0.4991
1, indicating freehold tenure; 0, else						
DEV_SZ_i	365.7200	215.4216	398.5355	200.2734	353.9176	219.4731
Total number of units in development						
$SOLD_i$	0.5127	0.2662	0.5072	0.2709	0.5147	0.2646
Proportion of total units sold at end of period						
$INTERNAL_i^{(0,1)}$	0.2645	0.4412	1.0000	0.0000	0.0000	0.0000
1, if the project is marketed by an internal agent						
$PROB_i$	0.2559	0.3364	0.6659	0.3006	0.1084	0.1979
Estimated probability project is marketed by an internal agent						
$TOTCOMP\_IN_i$	1857.54	5588.21	2020.54	5181.30	1798.91	5727.77
The average number of units available each day over the liquidity period within 2 km & inside of the development's planning area						
$TOTCOMP\_OUT_i$	715.67	3907.77	601.53	2693.69	756.73	4260.59
The average number of units available each day over the liquidity period within 2 km & outside of the development's planning area						
$COMPDENS\_IN_i$	133.6866	295.6125	161.1389	219.1539	123.8131	318.1335
$TOTCOMP\_IN_i$ divided by the avg. daily liquidity measure						
$COMPDENS\_OUT_i$	45.6321	140.7535	49.1910	112.6010	44.3521	149.5971
$TOTCOMP\_OUT_i$ divided by avg. daily liquidity measure						
Observations	2393		633		1760	

Table 3: OLS estimation of total revenue equations with fixed effects internal agent variable

Variable	(1)
Intercept	9.0911
	(11.39)
ln($AREA_i$)	0.9413
Natural logarithm of average unit size (sqm) over interval t	(9.06)
DEV_HEIGHT_i	0.0036
Height (in floors) of development	(1.10)
$PRIME_i$	0.3390
1, if located in prime location; 0, else	(4.21)
$UCBD_i$	-0.0179
Distance to CBD (km)	(2.58)
$UMRT_i$	-0.0362
Distance to the nearest metro station (km)	(0.94)
$NEAR\_WATER_i$	-0.0559
1, if located within 500m of sea/lake/river; 0, else	(0.68)
$CONDO_i$	0.0967
1, if located within condominium complex; 0, else	(1.19)
$COMPETITION_i$	0.0458
Number of residential projects by ***other*** *developers in the same planning area and year.*	(0.89)
$QUALITY_i$	0.0187
Average the Conquas Score (a construction quality index) for projects in the previous years by the same developer	(2.63)
$FREEHOLD_i$	0.3949
1, indicating freehold tenure; 0, else	(6.50)
DEV_SZ_i	0.0016

Total number of units in development	(9.87)
$SOLD_i$	-0.8699
Proportion of total units sold at the end of interval t	(9.37)
$INTERNAL_i^{(0,1)}$	0.0571
1, if the project is marketed by an internal agent	(1.04)
$TOTCOMP\_IN_i$	-4.1E-05
The average number of units available each day over the liquidity period within 2 km & in the same planning area as subject development	(8.87)
$TOTCOMP\_OUT_i$	-1.2E-05
The average number of units available each day over the liquidity period within 2 km & outside planning area of subject development	(1.78)
Year of Sale Fixed Effects:	Yes
R-sq	0.2193

Notes: Dependent variable is the natural logarithm of total revenue. Each observation represented is determined over each 30 day interval from the property's launch to reaching completion.

Table 4: Probit estimation results for internal/outsourcing choice

Variable	
Intercept	8.0265
	(0.68)
$JOINT_i$	0.4427
1, if joint venture; 0, else	(0.48)
$EXPERIENCE_i$	-0.7643
1, if developer has prior experience; 0, else	(0.57)
$LISTED_i$	-2.3130
1, if publically listed company; 0, else	(<.01)
$LAUNCHED_i$	-0.3474
Ranking of developer according to number of units launched in prior two years (1 most active)	(<.01)
$QUALITY_i$	-0.0122
Average the Conquas Score (a construction quality index) for projects in the previous years by the same developer	(0.88)
$\Delta RPI(t\text{-}1)_i$	24.4283
Change in Residential Price Index (RPI) lagged one period	(0.05)
$MKT\_VAC(t\text{-}1)_i$	83.1308
Market vacancy rate lagged one period	(0.20)
$PRIMERATE_i$	1.0309
Prime lending rate at launch	(0.70)
$UNIT\_SUPPLY_i$	-0.0011
Supply of units in the entire Singapore market at launch	(0.03)
$COMPETITION_i$	-0.1089
Number of residential projects by the **other** *developers in the same planning area and year.*	(0.81)
$AREA\_AVG_i$	-0.0374

Average size of unit (sqm) contained in the development	(0.05)
$AREA\_STD_i$	-0.0068
Standard deviation of unit size in the development	(0.67)
$FREEHOLD_i$	0.6014
1, indicating freehold tenure; 0, else	(0.34)
$PRIME_i$	-0.4292
1, if development is located in prime location; 0, else	(0.53)
$UCBD_i$	-0.0262
Distance to CBD (km)	(0.74)
$UMRT_i$	-0.5756
Distance to the nearest metro station (km)	(0.16)
$NEAR\_WATER_i$	1.7778
1, if located within 500m of sea/lake/river; 0, else	(0.04)
DEV_SZ_i	-0.0010
Number of units in development	(0.47)
$CONDO_i$	-0.8246
1, if located within condominium complex; 0, else	(0.34)
$STD\_LIQUIDITY\_e_i$	0.0589
St. dev. of unobserved component of the liquidity process.	(0.02)
$STD\_PRICING\_e_i$	-36.8813
St. dev. of unobserved component of the pricing process.	(0.05)
$STD\_LIQUIDITY\_e_i(t-1)$	-0.0554
One period lag of $STD\_LIQUIDITY\_e_i$	(<.01)
$STD\_PRICING\_e_i(t-1)$	-16.8154
One period lag of $STD\_PRICING\_e_i$	(0.10)
Likelihood Ratio	79.9094
	(<.01)

Notes: Dependent variable equals 1 if internal agent. Also note that p-values are reported in parentheses.

Table 5: OLS estimation results of total revenue equations

Variable	(1)	(2)
Intercept	9.1035	9.1854
	(11.40)	(11.50)
ln($AREA_i$)	0.9372	0.9419
Natural logarithm of average unit size (sqm) over interval t	(9.03)	(9.07)
DEV_HEIGHT_i	0.0035	0.0034
Height (in floors) of development	(1.08)	(1.03)
$PRIME_i$	0.3386	0.3508
1, if development is located in prime location; 0, else	(4.20)	(4.34)
$UCBD_i$	-0.0180	-0.0172
Distance to CBD (km)	(2.59)	(2.48)
$UMRT_i$	-0.0358	-0.0426
Distance to the nearest metro station (km)	(0.93)	(1.11)
$NEAR\_WATER_i$	-0.0593	-0.0480
1, if located within 500m of sea/lake/river; 0, else	(0.72)	(0.58)
$CONDO_i$	0.0994	0.1085
1, if development is a condominium complex; 0, else	(1.22)	(1.33)
$COMPETITION_i$	0.0427	0.0486
Number of residential projects by the **other** *developers in the same planning area and year.*	(0.82)	(0.94)
$QUALITY_i$	0.0188	0.0174
Average the Conquas Score (a construction quality index) for projects in the previous years by the same developer	(2.64)	(2.45)
$FREEHOLD_i$	0.3966	0.4095
1, indicating freehold tenure; 0, else	(6.45)	(6.63)

DEV_SZ_i	0.0016	0.0016
Total number of units in development	(9.87)	(9.97)
$SOLD_i$	-0.8692	-0.8749
Proportion of total units sold at the end of interval t	(9.36)	(9.42)
$PROB_i$	0.0601	-0.1854
Estimated probability project is marketed by an internal agent	(0.80)	(1.32)
$PROB_i * INTERNAL_i^{(0,1)}$		0.2920
		(2.07)
$TOTCOMP\_IN_i$	-4.1E-05	-4.1E-05
The average number of units available each day over the liquidity period within 2 km & inside planning area of the subject development	(8.85)	(8.89)
$TOTCOMP\_OUT_i$	-1.2E-05	-1.2E-05
The average number of units available each day over the liquidity period within 2 km & outside the planning area of the subject development	(1.77)	(1.78)
Year of Sale Fixed Effects:	Yes	Yes
R-sq	0.2192	0.2202

Notes: Dependent variable is the natural logarithm of total revenue. Each observation represented is determined over each 30 day interval from the property's launch to reaching completion.

Table 6: 3SLS estimation results for price and liquidity equations

Variable	Fixed Effect		Probability Measure		Interaction Effects	
	Price Equation	Liquidity Equation	Price Equation	Liquidity Equation	Price Equation	Liquidity Equation
Intercept	9.5512	-120.647	9.5416	210.658	9.5376	-268.602
	(85.57)	(0.31)	(85.63)	(0.70)	(85.57)	(0.71)
LIQUIDITY$_i$	0.0005		0.0005		0.0005	
Average number of days since last sale in project over interval t	(4.41)		(3.91)		(4.39)	
ln(*PRICE$_i$*)		25.7784		-9.0340		39.9721
Natural logarithm of average selling price over interval t		(0.65)		(0.29)		(1.02)
ln(*AREA$_i$*)	0.9105	-27.9414	0.9163	4.6904	0.9163	-39.9427
Natural logarithm of average unit size (sqm) over interval t	(63.27)	(0.78)	(63.79)	(0.17)	(63.78)	(1.12)
DEV_HEIGHT$_i$	0.0039	-0.2192	0.0038	-0.0957	0.0038	-0.2673
Height (in floors) of development	(8.72)	(1.15)	(8.45)	(0.58)	(8.48)	(1.42)
PRIME$_i$	0.2780	-11.9460	0.2747	-1.9029	0.2788	-17.2878
1, if unit is located in prime location; 0, else	(24.45)	(1.01)	(24.13)	(0.20)	(24.4)	(1.47)
UCBD$_i$	-0.0199	-0.0620	-0.0201	-0.7810	-0.0200	0.1522
Distance to CBD (km)	(20.71)	(0.07)	(20.85)	(1.15)	(20.74)	(0.18)
UMRT$_i$	0.0433	-2.2274	0.0419	-1.0981	0.0402	-2.5807
Distance to the nearest metro station (km)	(8.16)	(1.02)	(7.88)	(0.58)	(7.55)	(1.22)
NEAR_WATER$_i$	0.1322	-0.5093	0.1288	3.9498	0.1301	-3.5868
1, if located within 500m of sea/lake/river; 0, else	(11.68)	(0.08)	(11.3)	(0.77)	(11.38)	(0.58)
CONDO$_i$	0.1376	-9.4321	0.1375	-4.6412	0.1406	-12.1677
1, if condominium complex; 0, else	(12.22)	(1.51)	(12.23)	(0.88)	(12.47)	(1.93)
COMPETITION$_i$	0.0250	-12.8359	0.0215	-12.3520	0.0249	-13.4966
*Number of residential projects by the **other** developers in the same planning area and year.*	(3.50)	(6.48)	(2.99)	(6.36)	(3.45)	(6.75)
QUALITY$_i$	-0.0063	-0.7704	-0.0066	-1.0347	-0.0066	-0.5833
	(6.39)	(1.98)	(6.65)	(2.99)	(6.60)	(1.47)
Avg. Conquas Score (a construction quality index) for						

projects in the previous years by the same developer						
$FREEHOLD_i$	0.1934	-5.7839	0.1959	1.5051	0.1997	-9.1788
1, indicating freehold tenure; 0, else	(22.88)	(0.72)	(22.98)	(0.23)	(23.32)	(1.12)
DEV_SZ_i	0.0001	-0.0149	0.0001	-0.0120	0.0001	-0.0173
Total number of units in development	(3.82)	(2.33)	(3.86)	(1.94)	(4.18)	(2.64)
$SOLD_i$	-0.1572	18.1064	-0.1545	12.8432	-0.1577	20.7817
Proportion of total units sold at end of period	(12.06)	(2.63)	(11.87)	(2.22)	(12.10)	(3.03)
$INTERNAL_i^{(0,1)}$	-0.0048	-5.7652				
1, if the project is marketed by an internal agent	(0.63)	(2.84)				
$PROB_i$			0.0186	-2.0636	-0.0240	16.0727
Estimated probability project is marketed by an internal agent			(1.79)	(0.75)	(1.23)	(3.06)
$PROB_i * INTERNAL_i^{(0,1)}$					0.0511	-22.1413
					(2.61)	(4.03)
$TOTCOMP\_IN_i$		0.0039		0.0039		0.0038
The average number of units available each day over the liquidity period within 2 km & inside the planning area of subject development		(23.03)		(23.00)		(22.88)
$TOTCOMP\_OUT_i$		0.0020		0.0020		0.0019
The average number of units available each day over the liquidity period within 2 km & outside the planning area of subject development		(6.25)		(6.86)		(6.24)
$COMPDENS\_IN_i$	-0.0001		-0.0001		-0.0001	
$TOTCOMP\_IN_i$ divided by the avg. daily liquidity measure	(5.45)		(5.00)		(6.36)	
$COMPDENS\_OUT_i$	0.0002		0.0002		0.0001	
$TOTCOMP\_OUT_i$ divided by avg. daily liquidity measure	(5.81)		(6.44)		(5.54)	
Year of Sale Fixed Effects:	Yes	Yes	Yes	Yes	Yes	Yes
System Weighted R-Square	0.7185		0.7220		0.7290	

Note: t-statistics are reported in parentheses.