# Hospital Competition and Prescribing Behaviors: Empirical Evidence from Taiwan


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# HOSPITAL COMPETITION AND PRESCRIBING BEHAVIORS: EMPIRICAL EVIDENCE FROM TAIWAN

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**ABSTRACT**

This study empirically examines the effect of hospital competition on prescribing behaviors of oral hypoglycemic agents (OHAs) for ambulatory care in a market setting where hospitals are classified into three levels according to the Taiwanese accreditation system. Without distinguishing the types of market structures and hospital levels, there might be no significant relationship between hospital competition and prescribing behavior. However, the relationship between competition and prescribing behaviors may differ among hospitals at various levels under each type of market structure. Our findings suggest that a market mechanism may improve the prescribing quality of regional and district hospitals under a market structure composed of three level hospitals where more medical resources and information are likely allocated.

**JEL Classifications:** L10. I11
**Keywords:** Hospital Competition, Prescribing Behavior
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## INTRODUCTION

In 1995, Taiwan launched a compulsory national health insurance scheme with all payments being made through a single-payer and reimbursed in a cost-based fee scheme. Because of the compulsory feature of universal health insurance, the Bureau of National Health Insurance (NHI) has monopsony power over the health services market, resulting in that most of hospitals and clinics were contracted with the Bureau of NHI. In addition, there is no restriction on choices of medical providers for the insured, implying patient-driven competition among hospitals in Taiwan.

The studies of patient-driven competition is reflected in those based on data prior to the mid-1980s which suggests that competition among hospitals tends to increase costs, prices, or resource capacity (Joskow, 1980; Robinson and Luft, 1985, 1987, 1988; Robinson et al., 1987, 1988; Luft et al., 1986; Noether, 1988; Hughes and Luft, 1991). On the other hand, those studies using more recent data tend to be the results of payer-driven competition. With the exception of Manheim et al. (1994), those studies find prices, costs, or resource capacity likely decrease in more competitive markets. (Zwanziger and

Melnick, 1988; Wooley, 1989; Dranove, Shanley, and Simon, 1992; Melnick et al., 1992; Dranove, Shanley, and White, 1993; Gruber, 1994; Kessler and McClellan, 2000). If the measure of hospital performance is based on quality measures rather than price or cost, results indicate that hospital competition tends to have an ambiguous effect on quality of care, which would seem to stem from different measures of quality of care. Some studies find no significant relationship between competition and quality (Shortell and Hughes, 1988; Ho and Hamilton, 2000), but others find significant and positive results (Kessler and McClellan, 2000; Gowrisankaran and Town (2003). Recently, Propper et al. (2004) shows a small but negative estimated impact of competition on death rates in the UK health care market. Previous studies in Taiwan indicate that there exist "medical arms races" based on hi-tech medical services among hospitals (Tsai and Li, 2002; Lu and Hsieh, 2003). However, there is still little literature to investigate the relationship between hospital competition and prescribing behaviors in a market other than the one in the US.

Currently, most literature with regard to hospital competition is mainly from the US hospital-industry, and results tend to be inconsistent with each other. Below are some possible reasons for the inconsistencies and how the characteristic of Taiwanese market may be different from that of U.S. market: (1) the existence of multiple-payers: hospitals are facing different underwriters, and their payment schemes are different from each other. Besides the traditional FFS system that leads to non-price competition, there is also interference from price competition; for example, managed care plans and selected contracting. In contrast, there is only one payer in Taiwan, i.e., the Bureau of National Health Insurance, with more than 90% of the reimbursement being FFS based and only about 10% being case-based; (2) Most beneficiaries are limited to the aged population in the Medicare Program, and thus, the result is not applicable to the demos; (3) The timeframe of policies and implementation are different in various states, but Taiwan implements a unified system; (4) The relationship between physicians and hospitals is complicated in the US., where a hospital serves as a "workshop" for physicians. Physicians may not comply with hospital managers' objectives, making it difficult to apply classical firm theory to hospitals in the US (Pauly, 1980).

Besides the insurance payment scheme, government regulation is also an important factor that affects the relationship between hospital competition and its performance. One of the major regulations by Taiwan's government on the hospital industry is the hospital accreditation system (Liu and Kinsey, 2005). Since 1987, the Department of Health has implemented a nation-wide accreditation system in order to classify the teaching affiliation and levels of medical services, which also serves as a reference of reimbursement. In the early phase, the classification was based on the facilities provided by each hospital, and all hospitals are classified into medical centers, regional hospitals, or district hospitals. In recent years, the accreditation system has become an implication of hospital quality among Taiwan's citizens, and the reference for choosing a hospital.

Because of the accreditation system, the composition of different hospital levels in each county tends to reflect the characteristic of each market. For example, a county with three hospital levels is likely to be an area with abundant medical resources. In this study, the definition of a hospital market is based on political boundaries, i.e., the administrative regions, dividing Taiwan into 17 hospital markets. Therefore, the hospital markets can be classified into three types of market structures based on the composition of hospitals in each county: 1) the market contains medical centers, regional hospitals and district hospitals; 2) the market contains only regional hospitals and district hospitals; 3) the market contains only district hospitals. Figure 1 shows that after the implementation of

the National Health Insurance program in 1996, considerable variety could be found in the concentration of hospitals among different regions in Taiwan. The concentration of hospitals in all regions is likely to increase, indicating that hospital market structures differ from each other and competition tends to be decreasing over our study period.

In addition, physicians practicing in hospitals are mainly employees of hospitals, and hospitals usually provide fairly extensive outpatient services in Taiwan, contributing to about 66% of the total drug expense incurred from outpatient departments. Furthermore, the treatment expense of diabetes accounts for 11.5% of the total medical expense of the NHI, with 61% being spent on outpatient services. Thus, drug consumption of hospital outpatient services for diabetes, to some extent, could represent outpatient pharmaceutical utilization. Therefore, this study focuses only the prescribing behavior of hospital outpatient departments, assuming that free-standing outpatient clinics and doctor's offices do not compete with hospitals, and selects oral hypoglycemic agents (OHAs) as a proxy variable for the prescribing behaviors.

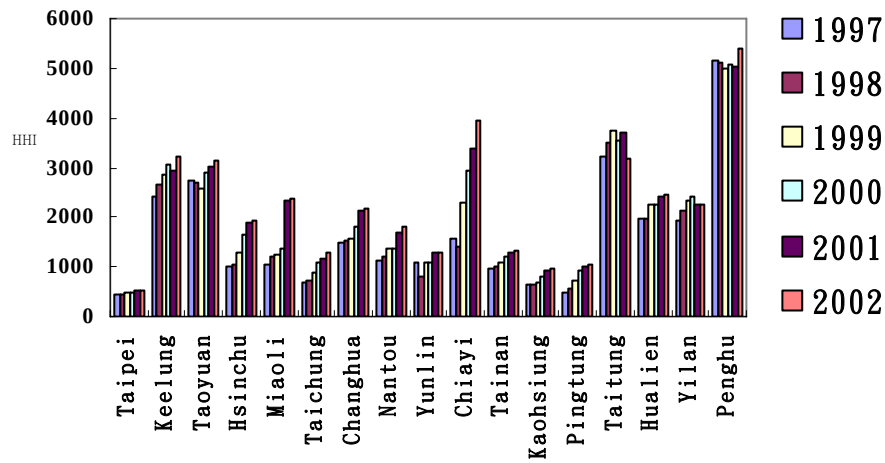
Since the specificity of the Taiwanese market may bring a new light on the issue of hospital competition, the main purpose of this study is to examine the effect of hospital competition on prescribing behaviors of OHAs for ambulatory care in a market setting where hospitals are classified into three levels according to Taiwan's accreditation system (i.e., medical centers, regional hospitals, and district hospitals). The utilization of pharmaceutical products was measured by the Defined Daily Dose (DDD), which is the designated average maintenance dose when a drug is used for its main indication by an adult[1]. Competition was measured by the Herfindahl-Hirschman index based on the market share of outpatient visits for each level of hospitals. The instrumental variable method was employed to identify the endogeneity and measurement error in competition index. The organization of the paper is as follows. Section 2 presents the characteristics of OHAs prescriptions under the regulation of drug formulary. Section 3 provides the study objectives. Section 4 presents the method and data. The results and discussions are in Section 5 and 6 respectively. The final section presents our conclusions.

## PRESCRIBING BEHAVIORS FOR OHAs

The pharmacological therapy of diabetes is mainly based on OHAs. For the patients whose pancreas β cells are absolutely short of insulin secretion, they have to depend on insulin to survive. But for those who are just relatively short of insulin, OHA is a better choice. Since most of the diabetic patients are the latter category, OHAs play an important role in the therapy of diabetes (Inzucchi, 2002).

In 1988, the British National Health Service sets a routine monitoring system called Prescribing Analysis and Cost (PACT). The purpose of this system is to provide a general practitioner (GP) a source for reference in prescribing. Prescription pattern can also be compared among physicians to maintain clinical prescription quality (Campbell et al., 2000). Recently, the European Drug Utilization Research Group (EuroDURG) attempted to classify the prescribing indicators according to their quality indices. The classification includes: (1) Aspects of care: according to the medical quality, with the evaluation based on the structure, process and outcome of medical care. (2) The orientation of the indicators, including drug oriented, disease oriented and patient oriented. For OHAs, EuroDURG suggests the medication uses process indicators for the evaluation of prescribing quality. For example, prescribing traditional long-acting sulfonamides represents an outdated and obsolete prescribing quality (Hoven et al., 2005).

**FIGURE1. THE VARIATION OF HOSPITAL MARKET STRUCTURE (HHI VALUE) IN TAIWAN GROUPED BY YEAR AND COUNTY**




Besides the above pharmacological factors, under the insurance scheme, hospital managers delegate a pharmacy & therapeutic committee to develop a formulary of approved drugs with NHI coverage. Physicians, as employees of hospitals in Taiwan, are usually not free to choose drugs outside the formulary approved by this committee. These restrictive drug formularies may even bring a spillover effect on the prescribing behavior for those patients who are not directly subject to this close-formulary policy of medication (Wang and Pauly, 2005). Therefore, besides physicians, the pharmacy & therapeutic committee may also play an important role in deciding the prescribing quality. If the formulary includes more new and high-priced drugs because of hospital competition, it is expected that physicians would prescribe more new and high-priced drugs. As a result, hospital competition may affect prescribing behaviors of physicians through the formulary policy adopted by the pharmacy & therapeutic committee.

## STUDY OBJECTIVES

This study chose the prescription of OHAs as a proxy to investigate the effect of competition on the prescription behavior. We have the following two goals for analysis:

1. Investigate the relationship between hospital competition and prescribing behavior for all hospitals. The hypothesis is that when a hospital faces competition from other hospitals, the hospital tends to prescribe high-priced OHAs and improve the prescription quality by increasing prescription of new OHAs and reducing prescription of OHAs that may result in hypoglycemia.
2. Analyze the relationships in a market setting where the market was classified into three types of structures according to the composition of hospitals in different levels, in order to investigate the competition among different hospital levels.

## METHODS AND DATA

### Data Sources and Study Design

The data sources were the National Health Insurance Database (NHIRD) for the period 1997-2002. These registration and patient cohort files are samples of outpatient claims randomly sampled from the entire database, where the details of medical diagnosis, interventions and prescriptions dispensed for each visit are included. The counties data are taken from *Social Indicators*, and *Health and Vital Statistics*.

The independent variable is hospital competition, measured by the Herfindahl-Hirschman Index calculated by outpatient visits. The dependent variables are three prescribing behaviors, i.e., the prescription of high-priced OHAs, new OHAs, and OHAs with chlorpropamide or glibenclamide. All of three prescribing behaviors are measured by the proportions of each type OHAs prescription consumption to total OHAs consumption in the Defined Daily Dose (DDD). The selection of high-priced drugs is based on daily cost [= (unit price / strength of product) × DDD], and the top 5% OHAs (daily cost is around NT$34)[2] are included. Furthermore, the prescription quality is measured by the behaviors of prescribing new OHAs (high-quality) and OHAs with chlorpropamide or glibenclamide (low-quality) respectively. In this study, we define new OHAs as those which obtained a license in Taiwan after 1995. The selection of poor-quality OHAs is based on the adverse effect of hypoglycemia. Among OHAs, higher hypoglycemic potential is observed for chlorpropamide and glibenclamide. If chlorpropamide and glibenclamide are used together with other OHAs, it would increase the risk of hypoglycemia, suggesting a poor-quality OHAs prescribing behavior. In this study, we employ the prescription of chlorpropamide or glibenclamide as a poor-quality indicator.

Other control variables include the average age of the diabetic patient (AGE), proportion of male patients (SEX_M), proportion of diabetic patients (CASED), case-mix (MIX), ownership of hospital (OWN_H), accreditation level (LEVEL), number of specialists (DOC), number of beds (BED), service area (MOB) and year (YEAR). Since the pharmacological therapy of diabetes is divided into several phases according to severity, the measurement of patients' severity is based on the types of combination therapy. For those whose symptoms are mild, they may need only one kind of OHA whereas for those with moderate symptoms, combinations of OHAs would be required. If more than two kinds of OHAs fail to achieve glycemic control, the condition is considered to be severe, and the patient may require insulin therapy. Thus, this study uses the classes of combination therapy for OHAs to classify patients' severity and construct the case-mix variable for each hospital.

### Empirical Analysis

The instrumental variables (IV) method is used to identify measurement error from the market division by political boundary and endogeneity bias from the calculation of HHI in order to obtain unbiased and consistent estimates (Keller and McClellan, 2000). Since hospitals and medical centers tend to be located in the metropolitan area, the total population to instrument the HHI of hospitals and medical centers. For regional hospitals which mainly provide supportive health care to patients who have no access to medical centers, the number of clinics was used to instrument the HHI of regional hospitals.

Regarding the IV of district hospitals, more townships within a county implies that there should be more district hospitals to provide health care to people who live in remote areas. Therefore, the IVs selected in this research include: a logarithm of the total population for the HHI of overall hospitals and medical centers, a logarithm of the number of clinics for the HHI of regional hospitals, and a logarithm of the total number of townships for the HHI of district hospitals, since these instruments are likely related to competition of overall hospitals, medical centers, regional hospitals and district hospitals but not to the prescribing behaviors.[3] Other exogenous variables for county level data include: proportion of patients older than 65, proportion of beds to the national total, and average family income.

Separate multiple regressions were estimated as a function of hospital and market structure characteristics. The relationships between hospital competition and prescribing behaviors for the high-priced, new, and poor-quality OHAs were modeled as:

**1. The relationship between hospital competition and OHAs prescribing behavior for overall hospitals:**

$$R_{jkt} = a_0 + a_1 AGE_{jkt} + a_2 SEX\_M_{jkt} + a_3 CASED_{jkt} + a_4 MIX_{jkt} + a_5 OWN\_H_{jkt} + a_6 BED_{jkt} + a_7 DOC_{jkt} + a_8 MOB_{kt} + a_9 pHHI_{kt} + a_{10} LEVEL2_{jkt} + a_{11} LEVEL3_{jkt} + a_{12} YEAR98 + a_{13} YEAR99 + a_{14} YEAR00 + a_{15} YEAR01 + a_{16} YEAR02 + e_{jkt} \quad (1)$$

where j indexes a hospital, k indexes a county, and t indexes a year.

**2. The relationship of different level hospital competition and OHAs prescribing under various market structures:**

$$R'_{jkt} = a_0 + a_1 AGE_{jkt} + a_2 SEX\_M_{jkt} + a_3 CASED_{jkt} + a_4 MIX_{jkt} + a_5 OWN\_H_{jkt} + a_6 BED_{jkt} + a_7 DOC_{jkt} + a_8 MOB_{kt} + a_9 pHHI1_{kt} + a_{10} pHHI2_{kt} + a_{11} pHHI3_{kt} + a_{12} YEAR98 + a_{13} YEAR99 + a_{14} YEAR00 + a_{15} YEAR01 + a_{16} YEAR02 + e_{jkt} \quad (2)$$

where j indexes a hospital, k indexes a county, and t indexes a year.

Variable Definition:

1. Dependent variables: the prescribing behaviors of overall hospitals ($R_{jkt}$) and different levels hospitals ($R'_{jkt}$), including the proportions of high-priced OHAs, new OHAs and poor-quality OHAs consumption to total OHAs prescribed consumption in each hospital by the DDD respectively.
2. Independent variables: The IV predicted concentrations of overall hospitals ($pHHI_0$), medical centers ($pHHI_1$), regional hospitals ($pHHI_2$) and district hospitals ($pHHI_3$).
3. Control variables: for the patient demand side, there are average age (AGE), average proportion of male (SEX_M), proportion of diabetic patients (CASED) and case-mix (MIX); for the hospital supply side, there are ownership (OWN_H), number of specialists (DOC), total beds (BED) and a dummy variable for regional hospital (Level2) and district hospital (Level 3); for regional characteristics, there are, service area (MOB); for years, there are 1998 (YEAR98), 1999 (YEAR99), 2000 (YEAR00), 2001 (YEAR01) and 2002 (YEAR02).

## RESULTS

### Sample Characteristics

2,110 hospitals, including 94 medical centers, 353 regional hospitals and 1,663 district hospitals were observed for 6 years. 158,655 visits of 18,045 diabetic patients' cohort data are also included. For market concentration (Table 1), the average concentration for 6 years was 1935.60, with the highest concentration for medical centers (6628.86) and the lowest for district hospitals (152.92).

Among the three indicators of prescribing behaviors, the high-priced OHAs accounted for 0.97% of total OHAs prescribing consumption on average in each hospital during the 6 years (Table 1). If we compared the hospitals by their levels, the highest proportion occurs in medical centers. In these hospitals, high-priced OHAs account for 8.91% of the prescriptions. Among different market structures (Table 2), for regional hospitals, the proportion of high-priced OHAs is higher in the second market structure (1.94%) than that in the first one. For district hospitals, the proportion of high-priced OHAs is higher in the third structure (0.8291%).

The average consumption of new OHAs accounted for 3.28% of the total during the 6 years (Table 1). From the aspect of different hospital levels, the highest proportion occurred in medical centers, where the new OHAs account for 8.81% (Table 1). Among different market structures (Table 2), the proportion of new OHAs in regional hospitals was relatively higher in the second market structure (7.39%). For district hospitals, the proportion of new OHAs under the first market structure was the highest (2.59%).

The poor-prescription-quality OHAs accounted for an average of 41.97% of the total during the 6 years (Table 1). The highest proportion occurred in the district hospitals, where the low-prescription-quality OHAs accounted for 45.05% (Table 1). Among the different market structures (Table 2), the proportion of poor-prescription-quality OHAs showed its maximum value for regional hospitals under the first market structure, which was 35.65%. For district hospitals, the proportion of low-prescription-quality OHAs under the first market structure was the highest (46.16%).

### Empirical Results

Multiple regression results (Table 3) show that, overall, the market concentration is negatively related to the high-priced and new OHAs prescription without statistical significance. The concentration is also significantly negatively related to the poor-prescription-quality OHAs ($p<0.05$), which does not support the hypothesis of the research.

Furthermore (Table 4A/4B), if we consider the concentration among different levels of hospitals under three market structures, high-priced OHAs in district hospitals are negatively related to the concentration of district hospitals under the second market structure with statistical significance ($p<0.01$), thereby supporting the hypothesis of the research. Similarly, high-priced OHAs in district hospital are also negatively related to the concentration of district hospitals under the third market structure, thus supporting the hypothesis of the research. The prescribing behavior of new OHAs in district hospitals is positively related to the concentration of regional hospitals under the second market structure with statistical significance ($p<0.05$) but does not support the hypothesis of the research.

**TABLE 1. DESCRIPTIVE STATISTICS OF VARIALBES IN EACH LEVEL OF HOSPITALS FROM 1997-2002**

| | **Overall hospitals (*N*= 2,110)** | | **Medical centers (*N*= 98)** | | **Regional hospitals (*N*= 353)** | | **District hospitals (*N*= 1,663)** | |
|---|---|---|---|---|---|---|---|---|
| **Variable** | **Mean** | **S.E.** | **Mean** | **S.E.** | **Mean** | **S.E.** | **Mean** | **S.E.** |
| **Concentrat-ion(PHHI)** | 1935.6 | 1098.6 | 6628.9 | 2885.6 | 4596.7 | 3087.6 | 1752.9 | 1255.5 |
| **Patient char.** | | | | | | | | |
| AGE | 61.58 | 8.65 | 62.08 | 3.33 | 61.21 | 4.96 | 61.64 | 9.45 |
| SEX_M | 48.91 | 35.35 | 46.14 | 11.42 | 46.18 | 19.12 | 49.66 | 38.76 |
| CASED | 6.60 | 4.88 | 7.55 | 2.10 | 6.34 | 2.34 | 6.61 | 5.37 |
| MIX | 1.58 | 0.78 | 1.69 | 0.27 | 1.66 | 1.06 | 1.56 | 0.73 |
| **Hospital char.** | | | | | | | | |
| OWN_H | 0.22 | 0.43 | 0.43 | 0.50 | 0.41 | 0.49 | 0.17 | 0.37 |
| DOC | 34.62 | 64.91 | 225.06 | 171.78 | 145.76 | 99.73 | 26.00 | 50.22 |
| BED | 300.22 | 436.89 | 1666.9 | 841.32 | 623.96 | 289.53 | 151.75 | 180.51 |
| **Area char.** | | | | | | | | |
| MOB | 55.97 | 90.67 | 37.89 | 81.31 | 55.78 | 100.76 | 57.05 | 88.81 |
| **Prescribing behavior for OHAs*** | | | | | | | | |
| High-Priced | 0.97 | 3.29 | 8.91 | 11.42 | 6.86 | 12.25 | 2.37 | 9.72 |
| New | 3.28 | 10.32 | 8.81 | 13.40 | 6.23 | 11.72 | 2.32 | 9.55 |
| Poor-Quality | 41.97 | 34.36 | 26.42 | 16.04 | 31.86 | 22.32 | 45.05 | 36.55 |

* : The proportion of specific type OHAs prescription to total OHAs prescription consumption at each hospital (%)
S.E.: standard error

**TABLE 2. DESCRIPTIVE STATISTICS OF VARIALBES IN EACH LEVEL OF HOSPITALS UNDER DIFFERENT TYPES OF MARKET STRUCTURES***

| **Type of market structure** | | **1st type** | | **2nd type** | | **3rd type** |
|---|---|---|---|---|---|---|
| **Variable** | M. C. (*N*=94) | R. H (*N*=225) | D. H. (*N*=1074) | R. H. (*N*=98) | D. H. (*N*=454) | D. H. (*N*=135) |
| Concentration of M. C. (PHHI1) | 4997.01 (2752.82) | | | | | |
| Concentration for R. H. (PHHI2) | | 2137.62 (1820.65) | | 6364.59 (1840.35) | | |
| Concentration for D. H. (PHHI3) | | | 618.65 (360.07) | | 1760.43 (683.43) | 1864.88 (1143.65) |
| AGE | 62.08 (3.32) | 61.14 (4.83) | 60.90 (9.85) | 61.36 (5.29) | 63.20 (8.59) | 62.12 (8.13) |
| SEX_M | 46.14 (011.42) | 47.25 (19.29) | 50.10 (39.83) | 43.40 (18.49) | 50.60 (37.62) | 42.92 (33.08) |
| CASED | 7.55 (2.10) | 6.40 (2.45) | 6.64 (5.63) | 6.17 (2.02) | 6.77 (5.17) | 5.80 (3.47) |
| MIX | 1.66 (0.27) | 1.63 (0.46) | 1.52 (0.66) | 1.84 (1.86) | 1.59 (0.55) | 1.64 (1.45) |
| OWN | 0.42 (0.49) | 0.45 (0.49) | 0.11 (0.32) | 0.26 (0.44) | 0.25 (0.43) | 0.23 (0.42) |
| DOC | 67.78 (109.12) | 78.27 (155.10) | 21.01 (46.32) | 64.55 (93.97) | 32.38 (66.07) | 25.50 (45.32) |
| BED | 1666.95 (841.31) | 620.17 (276.15) | 122.29 (137.88) | 633.80 (323.06) | 203.04 (235.38) | 212.54 (210.51) |
| MOB | 37.89 (81.30) | 33.13 (70.10) | 26.41 (42.60) | 114.69 (138.28) | 112.37 (127.78) | 113.46 (81.32) |
| High-Priced OHAs | 2.36 (3.24) | 1.87 (4.04) | 0.76 (3.36) | 1.94 (3.12) | 0.48 (2.53) | 0.82 (2.71) |
| New OHAs | 8.81 (13.39) | 5.78 (11.11) | 2.59 (10.42) | 7.39 (13.17) | 2.04 (8.41) | 1.04 (4.25) |
| Poor-Quality OHAs | 26.42 (16.04) | 35.65 (22.42) | 46.16 (36.79) | 21.99 (18.83) | 43.83 (36.13) | 40.22 (35.69) |

*: M.C.= Medical Center, R. H.= Regional Hospital, D. H.= District Hospital
Standard errors are in parentheses.

**TABLE 3. RELATIONSHIPS BETWEEN HOSPITAL COMPETITION AND PRESCRIBING BEHAVIORS FOR OVERALL HOSPITALS（*N*= 2,110）**

| **Concentration and prescribing behavior** | **High-Priced OHAs** | **New OHAs** | **Low-Quality OHAs** |
|---|---|---|---|
| **Hypothesis** | − | − | + |
| **Coefficient** | −0.7823 | −2.7498 | −23.6064* |
| **(Standard errors）** | （0.9887） | （2.9724） | （12.9834） |

+/−: Positive/ negative relationship between hospital concentration and prescribing behavior ＊: adj R-Sq = 0.39, p < 0.05

**TABLE 4A. RELATIONSHIPS BETWEEN HOSPITAL COMPETITION AND PRESCRIBING BEHAVIORS UNDER DIFFERENT TYPES OF MARKET STRUCTURES**

| **Hospital level*** | | **Medical center** | | | **Regional hospital** | | |
|---|---|---|---|---|---|---|---|
| **Prescribing behavior for OHAs** | | **High-Priced** | **New** | **Poor Quality** | **High-Priced** | **New** | **Poor Quality** |
| **Market structure** | | | | | | | |
| **1st** | M. C. | –1.82 | −5.72 | +3.53 | +1.78 | −1.64 | −22.57 |
| **type** | (PHHI1) | (2.45) | （8.86） | （15.00） | （1.85） | （4.38） | （12.52） |
| | R. H. | –3.15 | −8.82 | −23.67 | −1.34 | −0.56 | +40.32** |
| | (PHHI2) | (3.29) | （11.92） | （20.19） | （2.73） | （6.45） | （18.43） |
| | D. H. | –2.34 | −104.85 | +144.87 | −18.07 | −0.76 | +145.13 |
| | (PHHI3) | (14.20) | （51.36） | （86.96） | （14.26） | （33.69） | （96.15） |
| **2nd** | R. H. | | | | −2.67 | +2.41 | −13.69* |
| **type** | (PHHI2) | | | | （2.28） | （8.31） | （12.44） |
| | D. H. | | | | −0.89 | −16.57 | −67.70* |
| | (PHHI3) | | | | （6.30） | （22.91） | （34.32） |

*p< 0.05; **p< 0.01

**TABLE 4B. RELATIONSHIPS BETWEEN HOSPITAL COMPETITION AND PRESCRIBING BEHAVIORS UNDER DIFFERENT TYPES OF MARKET STRUCTURES**

| **Hospital level*** | | **District hospital** | | |
|---|---|---|---|---|
| **Prescribing behavior for OHAs** | | **High-Priced** | **New** | **Poor Quality** |
| **Market structure** | | | | |
| **1st type** | M. C. (PHHI1) | −0.12 | −0.94 | +8.53 |
| | | (0.96) | (2.93) | (10.61) |
| | R. H. | −0.13 | −1.0895 | −29.16 |
| | (PHHI2) | (1.21) | (3.69) | (13.35) |
| | D. H. | +4.78 | −6.06 | +140.13* |
| | (PHHI3) | (6.28) | (19.12) | (69.18) |
| **2nd type** | R. H. | −1.08 | +9.19* | −23.71 |
| | (PHHI2) | (1.12) | (3.68) | (15.76) |
| | D. H. | −9.48** | +20.25 | −67.24 |
| | (PHHI3) | (3.36) | (11.02) | (47.26) |
| **3rd type** | D. H. | −1.36* | +2.89 (4.15) | −15.90 (38.86) |
| | (PHHI3) | (2.90) | | |

*p< 0.05; **p< 0.01

For poor-prescription-quality OHAs, such behaviors in regional hospitals are positively related to the concentration of regional hospitals under the first market structure with statistical significance ($p<0.05$). Under the first market structure, the result is the same for district hospitals ($p<0.05$). The above two results support the hypothesis of the research. On the other hand, the prescribing behaviors of poor-prescription-quality OHAs in regional hospitals are negatively related to the concentration of regional hospitals under the second market structure. This finding is statistically significant ($p<0.05$) and does not support the hypothesis of the research. Furthermore, under the second market structure, the poor-prescription-quality OHAs in regional hospitals are negatively related to the concentration of district hospitals with statistical significance, which is also consistent with our hypothesis.

On the whole, the results from the relationship between the three prescribing behaviors and control variables show that high-priced OHAs are positively related to the number of beds in the hospital, implying that larger hospitals are more likely to offer high-priced drugs.[4] The prescribing behavior of new OHAs shows a significantly positive relationship with the proportion of male patients, number of beds and number of employees, but is negatively related to the dummy variable for private or corporate hospitals, i.e. the prescribing behavior of new OHAs is more likely preferred if there are more male diabetic patients and the hospital's scale is larger. Compared with private and corporate hospitals, since the new medicine purchasing procedure and regulations in the public hospitals are more bureaucratic and time-consuming, prescribing behaviors of new OHAs are more prompt to occur in private or corporate hospitals. For

poor-prescription-quality OHAs, such prescribing behavior is negatively related to the proportion of diabetic patients, severity, number of beds, and number of employees. In the aspect of time, the coefficients of the time variables of high-priced OHAs and new OHAs are significantly positive in 2001 and 2002. The coefficients of the time variable of poor-prescription-quality OHAs are significantly negative from 1999 to 2002. Therefore, compared with the year 1997, OHAs prescribing behavior has apparently changed over the study period, i.e., inclined to use high-priced and new OHAs, while poor-quality prescription OHAs are decreasing gradually.

## DISCUSSION

As for relationships between hospital competition and OHAs prescribing behaviors of each hospital, this study employs high-priced OHAs prescribing behavior as a proxy variable of competition behavior to attract patients in the market, and the results show an insignificant positive relationship between market competition and high-priced OHAs utilization. Under the reimbursement scheme of the NHI in Taiwan, all OHAs are covered by the health plan with little co-payment, and therefore, the patient is insensitive to the price of pharmaceuticals. From the aspect of market mechanism, patients can only grant the privilege of selecting medications (i.e., the prescribing behavior) to physicians due to asymmetric information as it would further hinder the public to assess the prescribing quality as well. Since the public is less likely to choose hospitals by prescribing quality, it is inferred there may be limited space to attract patients by changing prescribing behaviors, which reduces the influence of the market mechanism on prescribing behaviors of a hospital.

Furthermore, the results also show that hospital competition is not significantly related to the new OHAs prescribing behavior. A possible reason for the non-significant relationship may be the unawareness on the part of the public to distinguish between a new medicine and its quality, which provides no incentive for hospitals to use new medicine to attract patients. In addition, besides the market mechanism, there may be other factors that lead to less new medicine being prescribed.

First of all, for the study period, the new OHAs are defined as those licensed after 1995, while the data of this research is from 1997 to 2001. Some drugs are still in their initial stage of market diffusion, and have not been widely accepted by the hospitals.

Secondly, the physicians' prescribing habits of OHAs may be attributable. According to the analysis on the shifts of 5 classes of OHAs' shares in the US drug market during 1990 to 2001 by Wysowski etc (2003), 1995 is a divide. Before 1995, the market was dominated by traditional sulfonylurea, but after that, new ingredient OHAs were introduced gradually into the market. With the affiliation of new ingredient medicine, traditional sulfonylurea still takes the lead in American medicine market, i.e. sulfonylurea is mainly used for OHAs prescription (Wysowski, 2003). Studies on Taiwan's OHAs prescription between 2000 and 2002 found that the sulfonylurea was the most widely used OHAs among the available choices, suggesting that most physicians are still used to traditional sulfonylurea medicine during the initial launch time of new ingredient OHAs (Chuang et al., 2001). New OHAs in this study, including acarbose, repaglinide, glimepiride, rosiglitazone, and piolitazone, in which only glimepiride belongs to sulfonylurea medicine, have been used after obtaining approval of a license in Taiwan in Nov, 1999. Therefore, fewer prescriptions of new OHAs would seem to stem from the clinical habit of physicians during the study period.

Thirdly, intensive glycemic control is paramount and a gold standard for long-term

management of diabetes mellitus. It is suggested that single OHAs should be initiated if lifestyle modification fails to achieve adequate glycemic control. Sulfonylureas or metformin are primarily prescribed for initial control, albeit selection of OHAs depends largely on the individual medical conditions of the patient. Failure of initial therapy should result in addition rather than substitution of another class of drug, i.e. the prescription of OHAs has a characteristic of "*non-complete substitution*". Since prescribing behavior in this study is the proportion of new OHAs to total OHAs consumption by hospitals, it is inferred that the proportion of new ingredient OHAs for this kind of medication may not alter significantly. Thus, the impact of the above factors can not be ignored, which probably reduce the effect of the market mechanism on new OHAs prescribing behaviors in this study.

For poor-quality prescribing OHAs, the result shows a significantly positive relationship between hospital competition and poor-quality prescribing OHAs. However, except market competition, there are still medical factors that apparently affect poor-quality prescribing behavior as mentioned above. Chlorpropamide and glibenclamide are defined as poor-quality OHAs in this study, because their long duration of effect and active metabolites may result in severe and protracted hypoglycemia in high risk individuals, e.g., elderly and those with renal insufficiency or advanced liver disease. Both the OHAs with chlorpropamide and glibenclamide were launched earlier than other OHAs and are available in various generic products. Therefore, physicians tend to be more familiar with their use, which may further affect the prescribing pattern.

For the relationship between competition and OHAs prescribing behaviors of the hospitals at different levels under various market structures, there are two aspects which deserve further discussion:

(1) We find that district hospitals under the second and the third structure tend to compete in high-priced OHAs. This kind of competition increases the cost directly; at the same time, there is a declining trend for prescribing quality over time (i.e., new OHAs prescribing behavior decreases, and poor-quality OHAs prescribing behaviors increases).

(2) For hospitals at the same level, different market structures lead to different prescribing quality. We find that regional and district hospitals may demonstrate different prescribing behaviors according to the type of market structure. Regional and district hospitals may improve their prescribing quality when the competition in the same level increases under the first market structure (i.e., decreasing poor-quality OHAs prescription). But under the second or the third market structure, regional and district hospitals may reduce their prescribing quality when facing competition from the same level hospital. Therefore, the type of market structure may affect the relationship between market competition and prescribing quality.

However, further study is needed to find out why the market mechanism with the first market structure appears to bring a positive effect on the performance of hospitals. In contrast to the second and third market structure, an increase in the market competition for regional or district hospitals under the first market structure, regional or district hospitals tend to have a higher prescribing quality (for instance, an increase in new OHAs prescribing behavior and a decrease in poor-quality OHAs prescribing behavior) or a decrease in high-priced OHAs prescribing behavior. It is inferred that most of the unique properties of the hospital industry exist in these market structures, including the differentiation of product, entry barriers, and so on. But the condition of perfect

information, one of the elements of a perfect competition market, may cause the difference in the three market structures. Market structures in this study are determined by hospital composition at three levels, which likely reflects deficiency and abundance of medical resources in each market. For example, the first market structure contains three levels of hospitals, implying a region with abundant medical resources, whereas in the second and third market structures, only regional and district hospitals are available, suggesting relatively deficient medical resources allocated. Thus, the first market structure with relatively abundant medical resources suggests availability of more additional medical information. For instance, there is more advanced information about medicine, more physicians and channels available to offer related consultation, which leads to relatively better cognition of the medicine quality for consumers. Therefore, compared with the second and third market structures, the problem of asymmetric information in the first market structure is a relatively less important factor, which may facilitate the market mechanism to result in higher quality medication and lower medicine expenditure.

## CONCLUSION

Since there is little literature to discuss the relationship between hospital competition and prescribing behaviors in a health care system other than the one in the US, this study may be an important attempt to show the significance of the issue.[5] Without distinguishing market structures and hospital levels, there might be no significant relationship between hospital competition and prescribing behaviors. However, we could not exclude the effects of other potential factors, such as the launch time of new OHAs and the prescribing habits of physicians, in this relationship. In addition, our findings suggest that market mechanisms may improve the prescribing quality of regional and district hospitals under a market composed of three hospital levels. It appears that a market with three hospital levels may be an area with abundant medical resources, consequently being able to provide more pharmaceutical services and information to patients to improve the transparency of drug information. Therefore, the hospital accreditation system with its implicitly distributive effect on health care resources should also reinforce an effective medical information circulation policy to enhance the cognition of prescribing quality for the public, which may alleviate the asymmetric information problem and lead the market mechanism to bring a positive effect on the hospital industry.

## ENDNOTES

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[1] The ATC/DDD system was established by the WHO Collaborating Center for Drug Statistics Methodology.

[2] Average exchange rate in 2000: US$1 = NT$33.5.

[3] Results regarding the weak instruments show that the F-statistic proposed by Staiger and Stock (1997) for the HHI of all hospitals (HHI) is 112.8 in the first stage regression, suggesting that the employment of IV should reduce the bias. The Hausman test also shows that HHI is endogenous, and the predicted value has additional explanatory power in the estimation of the second stage regression. Since the weak IV and Hausman test can only verify the validity of one instrument

under the assumption of the validity of another instrument in the second stage regression, this test is not applicable for the specification (2) with three endogenous variables (HHI1, HHI2 and HHI3).

[4] Due to space limitations, regression results under different types of market structures for all control variables are contained in an appendix which is available from the authors upon request.

[5] To do a comparative study for the results from different measures of hospital competition, like OLS, 2SLS, or CR4 (Four-Firm Concentration Ratio) would be a good topic to discuss the methodology issue about hospital competition measures in the future. Our results with careful consideration of endegeneity and measurement error problems may provide a reference for further studies regarding hospital competition.

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