# Improved Information Shock and Price Dispersion: A Natural Experiment in the Housing Market

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## Abstract

This research employs data from a natural experiment to assess the effect of improved price information shock on subsequent real estate transaction price dispersion. While transaction data in the Israeli real estate market had never been open to the public, in 2010 an Israeli court ordered the Israel Tax Authority to post all real estate transaction data on its website. We employ all housing transactions in the period prior and subsequent to this event to assess its effect on housing price dispersion. Results provide strong evidence of improved market efficiency as indicated by a significant decrease in the dispersion of quality-adjusted prices. We further find evidence that the information shock effect on price dispersion varies with households' characteristics in the market. Our findings support the market transparency argument for promoting economic efficiency.

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## 1. INTRODUCTION

Economists have long recognized the central role of information in the operation of markets. For example, when information is costly or imperfect, sub-optimal welfare is likely to be attained, and market equilibrium may exhibit price dispersion even for homogenous goods [see, e.g., Stiglitz (1985) and Stigler (1961), respectively].[1] Interestingly, while a great deal of theoretical and empirical research has been devoted to understanding the effect of information on prices, only limited empirical work has been done to date on the specific effect of information shocks on price dispersion of goods.

An exception to this trend is a study by Jensen (2007) on the effect of improved information technology shock on price dispersion and welfare in the fishing industry in Kerala, India. According to Jensen (2007), information shock that was associated with the introduction of mobile phone service to fishermen and wholesalers has led to a reduction in price dispersion in the South Indian fisheries sector.[2]

A recent experience in the Israeli real estate market serves as a natural experiment to further explore the effect of information availability on price dispersion in a market where transactions carry considerable individual economic consequences. Specifically, in 2010 an Israeli court ordered the Israel Tax Authority to open its records to the public on all past and current real estate transactions.[3] For the first time, price and other related real estate transaction

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[1] Studies on the role of information in markets are too numerous too cite. See Stiglitz (1985) for a thorough review of the role of information in economic analysis.

[2] Note that unlike Fama *et al.* (1969) and many others that followed, we do not test the price reaction to new (favorable or unfavorable) information per se; rather, along the lines of Jensen (2007), we focus on the effect of improved information on the price dispersion. Prevailing rational explanations for the price dispersion of a given good include the cost of information collection [e.g., Stigler (1961), Rothschild (1973), and, more recently, Janssen and Moraga-González (2004) and Janssen, Moraga-González, and Wildenbeest (2005)] and consumer heterogeneity in a "clearinghouse" setting [e.g., Salop and Stiglitz (1977), Varian (1980), and, more recently, Baye and Morgan (2001) and Baye, Morgan, and Scholten (2004)]. Empirical studies of price dispersion in particular account for explanations such as the absolute value of the good [e.g., Pratt *et al*. (1979) and, more recently, Gatti and Kattuman (2003) and Eckard (2004)]; purchase frequency [e.g., Sorensen (2000)]; number of competing sellers in the market [Baye, Morgan, Gatti, and Kattuman (2004) and Barron *et al*. (2004)]; and search cost [e.g., Brown and Goolsbee (2002), Brynjolfsson and Smith (2000), Smith and Brynjolfsson (2001), and Dinlersoz and Li (2006)]. Several studies also examine the persistence of price dispersion over time [see, among others, Lach (2002)]. Finally, see the comprehensive review of price dispersion literature in Baye *et al*. (2006).

[3] For proper disclosure, one of the authors of this paper was among the plaintiffs against the Israel Tax Authority on this matter.

information was disclosed to market participants and was freely accessed through the Tax Authority's website.[4]

We study the effect of the public disclosure of housing transaction data on the price dispersion of subsequent transaction prices. In particular, by observing all market transaction prices prior and subsequent to the improved information shock, we estimate the change in the dispersion of quality-adjusted housing prices over time and across locations. Moreover, we examine the sensitivity of the estimated price dispersion effect to such characteristics as household education, income, and socio-economic status in the market. Finally, we examine the robustness of our findings to issues of sampling and test specifications.[5]

The results provide solid evidence of decreased price dispersion that follows the public disclosure of transaction price information. Specifically, the standard deviation of quality-adjusted prices has decreased by about 13% subsequent to the improved information shock. Further, we find that the effect of the improved information shock on price dispersion is sensitive to market participant characteristics. The results are robust to sampling and test design issues.

The key contribution of this research is threefold. First, our natural experiment setting provides us with a precise and clean examination of the effect of information shock on price dispersion. [To the best of our knowledge, Jensen (2007) is the only previous study that provides such evidence.] Further, we extend Jensen's (2007) evidence to a market of non-homogenous goods where each transaction involves significant and long-term individual economic consequences. Finally, we show that the effect of the improved information shock on price dispersion varies with market players' characteristics. In particular, decreased price dispersion inversely correlates with level of income, education, and socio-economic status.

The remainder of the paper proceeds as follows: Section 2 provides further background and describes the data. Section 3 describes the methodology, and Section 4 presents the results. Section 5 presents a series of robustness tests, while Section 6 presents the sensitivity of the

[4] Our study thus further relates to the ambiguous evidence on the effect of online markets on price dispersion of goods [see, among others, Bailey (1998), Brynjolfsson and Smith (2000), Clemons *et al*. (2002), and Baye *et al*. (2006)].

[5] Eerola and Lyytikäinen (2015) use a conceptually similar natural experiment setting in the Finnish housing market to explore the effect of an improved information shock on the price *level* and time-on-the-market of transacted assets. Also, two other studies find that price dispersion in the housing market correlates with market activity [Yiu *et al.* (2009)] and, to a limited extent, with macro-economic variables [Leung *et al.* (2006)].

results to market participant characteristics. Finally, Section 7 provides a summary and concluding remarks.

## 2. BACKGROUND AND SAMPLE DESCRIPTION

In April 2010, following a court order, the Israel Tax Authority publicly disclosed for the first time micro-level information on real estate transactions. All transaction information was provided at no charge through the Tax Authority's website. While the interface was initially "unfriendly" and suffered from technical problems, the website was upgraded some six months later (in October 2010) and allowed for simpler access by non-professional users.[6]

We study the effect of the price information shock on housing price dispersion. Our sample includes the universe of all housing transactions in Israel over the period 2007–2013, a total of 248,145 observations.[7] Specifically, as further described in the next section, we estimate and compare the dispersion of quality-adjusted prices over the three years prior to the price information disclosure in April 2010 (i.e., April 2007–March 2010) and the three years subsequent to the information provision in a simple and friendly manner in October 2010 (i.e., November 2010–October 2013).

The sample of transactions includes closing price and date as well as a series of asset attributes. Table 1 presents summary statistics of the sample of transactions. As indicated in the table, the typical dwelling unit is a 3.6-room, 954-square-foot condominium apartment located on the second floor of a 25-year-old structure. The average unit price is about 278,000 dollars, with a standard deviation of about 197,000 dollars.[8]

[6] See Israel Tax Authority media reports in https://taxes.gov.il/About/SpokesmanAnnouncements/Pages/ConvertAnnPage_613.aspx (April 13, 2010) and https://taxes.gov.il/About/SpokesmanAnnouncements/Pages/ConvertAnnPage_810.aspx (October 17, 2010). It should be further noted that in March 2011, another (private) website was launched providing access to the Tax Authority transaction data at no charge and in a highly accessible and friendly manner. A couple of other private websites followed over the next year.

[7] From the raw sample of 312,341 observations in 58 of the most active city-level housing markets in Israel over the period 2007–2013, we omitted observations in cases where fewer than 30 transactions occurred in a given city in a given period (month). Moreover, we required that each city appear at least in one period both prior and subsequent to the information shock (see further description in Section 3 below). The final sample thus includes 248,145 observations in 42 cities, of which 12 appear in all 72 examined periods and 32 in at least 55 periods.

[8] Condominium apartments are the vast majority of housing assets in Israel. It follows from our data that 87% of the universe of housing transactions over the 1998-2013 period includes condominium apartments.

Table 2 further presents summary statistics for the sample of city panel across all time periods. As shown, the average value of *Treatment*, an indicator variable that equals 1 for post-information shock periods and zero otherwise, is about 0.5. The table also provides information on a set of control variables including $SD\_\hat{P}_{tc}$, the 6-month (ending at *t*) moving standard deviation of quality-adjusted (log of) housing prices in city *c* (more on the derivation of $SD\_\hat{P}_{tc}$ can be found in Appendix A). The average value of $SD\_\hat{P}_{tc}$ is about 0.01. Other controls include the number of transactions per month *t* in city *c* (denoted by $N_{tc}$), the average of which is equal to 101; the 3-month moving standard deviation of daily yields on the Tel Aviv 100 stock index (the Israeli equivalent of the SP500) ($SD\_Stock_t$), the average of which equals 1.2%; and the annual rate of change in the population size in city *c* at time *t* ($\Delta POP_{tc}$), the average of which equals 1.5%. Additional controls include macroeconomic variables: the average quarterly rate of change in gross domestic product ($\Delta GDP_t$) was about 0.9%, and average quarterly number of housing starts ($ConstrStart_{tc}$) and completions ($ConstrEnd_{tc}$) in the district where city *c* is located were about 630 and 550, respectively. Finally, as shown in Table 2, the panel analysis controls for the average of dwelling unit characteristics in city *c* at time *t* (including $Avg\_Area_{tc}$, $Avg\_Rooms_{tc}$, $Avg\_Floor_{tc}$, $Avg\_Age_{tc}$, and $Avg\_SocioEcon_{tc}$) and the variance of dwelling unit characteristics in city *c* at time *t* (including $SD\_Area_{tc}$, $SD\_Rooms_{tc}$, $SD\_Floor_{tc}$, $SD\_Age_{tc}$, and $SD\_SocioEcon_{tc}$).

## 3. METHODOLOGY

Consider the following model consisting of three structural equations:

(1)

$$SD_{tc} = \alpha_0 + \alpha_1\, Treatment_t + \alpha_2 \widehat{N}_{tc} + \alpha_3 SD\_\hat{P}_{tc} + \alpha_4 SD\_Stock_t + \vec{\alpha}_5 Avg\_Attributes_{tc} + \vec{\alpha}_6 SD\_Attributes_{tc} + \vec{\alpha}_7 Dum\_City_c + \varepsilon_{1tc}\,,$$

(2)

$$\ln(P_{itc}) = \beta_{0,tc} + \beta_{1,tc}\ln(Rooms_{itc}) + \beta_{2,tc}\ln(Area_{itc}) + \beta_{3,tc}\ln(Age_{itc}) + \beta_{4,tc}\ln(Floor_{itc}) + \beta_{5,tc} Dum\_New_{itc} + \beta_{6,tc} SocioEcon_{itc} + \vec{\beta}_{7,tc} TYPE_{itc} + \varepsilon_{2itc}$$ for all *t* and *c*,

and

(3)

$$N_{tc} = \gamma_0 + \gamma_1 \Delta\hat{P}_{6_{tc}} + \gamma_2 \Delta Pop_{tc} + \gamma_3 ConstrStart_{tc} + \gamma_4 ConstrEnd_{tc} + \gamma_5 \Delta GDP_t + \vec{\gamma}_6 Dum\_City_c + \varepsilon_{3tc} ,$$

where equation (1) examines the effect of the price information shock on price dispersion and equations (2) and (3) are two auxiliary equations whose objective is to estimate the price dispersion and the number of market transactions, respectively, to be substituted into equation (1) as further described below.

The dependent variable in equation (1), $SD_{tc}$, is the standard deviation of $\varepsilon_{2itc}$ that follows from equation (2) [see further description of (2) below], where subscripts $i$, $t$, and $c$ denote transactions, months, and cities, respectively. The independent variables in equation (1) include $Treatment_t$, indicating post-information shock periods (a dummy variable that equals 1 for post-October 2010 periods and zero for pre-April 2010 periods) and a series of control variables comprised of $\hat{N}_{tc}$, the fitted-value of the number of transactions at time $t$ in city $c$ generated from equation (3) (see details below), reflecting the amount of information that is generated by market depth; $SD\_\hat{P}_{tc}$, the 6-month (ending at $t$) moving standard deviation of quality-adjusted housing prices (under the log operator) in city $c$, controlling for the volatility in the time-series of the price that may affect the time $t$ cross-sectional (across transacted units) quality-adjusted price dispersion (for the derivation of $SD\_\hat{P}_{tc}$, see Appendix A); $SD\_Stock_t$, the 3-month moving average of the standard deviation of daily yields on the Tel Aviv 100 stock index, proxying the current level of uncertainty in the economy; $Avg\_Attributes_{tc}$ and $SD\_Attributes_{tc}$, respective vectors of the average and standard deviation of dwelling attributes (across transacted dwellings at each couplet $t$ and $c$), controlling for potential correlation between $SD_{tc}$ and the distribution of dwelling unit attributes across time and space; and $Dum\_City_c$, a city fixed-effect indicator. Finally, the parameters $\alpha_0 - \alpha_4$ are estimated coefficients, $\vec{\alpha}_5 - \vec{\alpha}_7$ are vectors of estimated coefficients, and $\varepsilon_{1itc}$ is a random disturbance term.

The model further includes auxiliary equations (2) and (3). Equation (2) is a hedonic price equation estimated for each couplet $c$ and $t$ (i.e, for each city at every period). We use the estimation of equation (2) to generate the standard deviation of the residuals $\varepsilon_{2itc}$ for every $t$ and $c$, $SD_{ct}$, to be substituted on the left-hand side of equation (1). The dependent variable in equation (2), ln $(P_{itc})$, is the log of the closing price of transaction $i$ at time $t$ in city $c$, and the independent variables in (2) include a series of asset characteristics: *Rooms*, the number of rooms; *Area*, the floor area (in square feet); *Age*, the structure's age (in years); *Floor*, the floor of the structure on which the asset is located; *Dum_New*, an indicator variable for new units (equals one if *Age* is less than one year; zero otherwise); *SocioEcon*, the score on a socio-economic index of the statistical area where property $i$ is located;[9] and a vector indicating the dwelling type (condominium apartment, garden apartment, duplex, penthouse, townhouse, attached, or single-family unit). Also, $\beta_0 - \beta_6$ are estimated parameters, $\vec{\beta}_7$ is an estimated vector of parameters, and $\varepsilon_{2itc}$ is a disturbance term.[10]

The derivation of $SD_{tc}$ in equation (2) and its substitution in the panel specification of equation (1) are designed to test the effect of improved information shock on price dispersion. We anticipate that the sudden availability of price information is followed by a decreased standard deviation of the residuals in the price equation (2), that is, that $\alpha_1 < 0$ in estimated equation (1).

Finally, equation (3) addresses a possible endogeneity between $SD_{ct}$ and $N_{ct}$ in the estimation of equation (1). Specifically, while an increase in the number of transactions $N$ generates greater market depth and thus increases price information that may, in turn, lead to a decreased *SD*, a decreased *SD* reflects greater price certainty (i.e., decreased price risk), which may, in turn, increase the number of transactions, $N$. Consequently we use a 2SLS procedure, where in the first stage we estimate $N_{ct}$ in equation (3) on a set of exogenous variables, and in the second stage we substitute the fitted value from (3), $\widehat{N}_{ct}$, into the right-hand side of equation (1). The explanatory variables in equation (3) include $\Delta\widehat{P}_{6_{tc}}$, the 6-month (ending at $t$) rate of change in average quality-adjusted housing prices in city $c$ (see Appendix A for more details); $\Delta Pop_{tc}$,

[9] A statistical area—the Israeli equivalent of a census tract—is the smallest geographic area examined by the Israeli Central Bureau of Statistics (see more on this geographical unit in Section 5 below). The socio-economic index (provided by the Israel Central Bureau of Statistics) may range from -3 to 3 and is generated by 16 indicators of the statistical area, clustered into 4 groups: standard of living, employment and welfare, schooling and education, and demography (see Israel Central Bureau of Statistics, 2013).

[10] Note that the log transformation in equation (2) reduces potential heteroskedasticity [see, among many others, Clemons *et al*. (2002)]. We performed a Breusch-Pagan test for heteroskedasticity for all estimations of equation (2). In more than 60% (80%) of the cases, the homoskedasticity hypothesis could not be rejected at the 10% (1%) significance level. It should be noted that the outcomes from equation (1) are robust to (*a*) the omission of $SD_{tc}$ observations for which the homoskedasticity hypothesis in equation (2) is rejected and (*b*) using robust least squares procedure. The outcomes from these robustness checks (not reported) are available from the authors upon request.

the annual rate of change in city population; $ConstrStart_{tc}$ and $ConstrEnd_{tc}$, the respective quarterly number of construction starts and completions in the district in which city $c$ locates; $\Delta GDP_t$, the quarterly rate of change in gross domestic product; and $Dum\_City_c$, a city fixed-effect indictor.[11] Also, $\gamma_0 - \gamma_5$ are estimated coefficients, $\vec{\gamma}_6$ is a vector of estimated coefficients, and $\varepsilon_{3tc}$ is a random disturbance term.

In sum, based on the universe of all housing transactions in city $c$ at period $t$, we estimate a series of hedonic price models in equation (2) for each couplet $c$ and $t$ [total of 42 cities over 72 monthly periods—altogether 2,447 estimations of equation (2)].[12] This first-step estimation generates $SD_{tc}$. We then employ an unbalanced monthly panel data of all cities over the period 2007-2013 (total of 2,447 observations) to estimate equations (1) and (3) using a 2SLS procedure to test the effect of the price information shock on subsequent price dispersion.

## 4. Results

Table 3 presents the results of panel estimation that tests for the effect of the price information disclosure shock on the dispersion of subsequent quality-adjusted transaction closing prices. Column 1 presents the outcomes obtained from the estimation of equation (1) over the period April 2007–March 2010 (pre-information shock) and November 2010–October 2013 (post-information shock).[13] Empirical findings provide solid evidence in support of an information effect on the dispersion of quality-adjusted prices. The coefficient on the *Treatment* variable is negative and significant at the 1% level. In particular, improved information shock associates with a decreased *SD* of about 2.5% of property value. As the average standard deviation of the

[11] Note that the Israel Central Bureau of Statistics publishes data on $\Delta Pop$ by years only and on $\Delta GDP$, $ConstrStarts$, and $ConstrEnds$ by quarters only. As our estimation is organized by months, the time $t$ observation for these variables is the value for the quarter (year) to which month $t$ refers.

[12] We condition the inclusion of city $c$ at month $t$ in the estimation of (2) on experiencing no fewer than 30 transactions for the couplet $c$ and $t$. In total, we thus conduct 2,447 estimations of equation (2). It should be noted that 12 out of the 42 participating cities satisfy the condition in all 72 periods, and 32 cities in no less than 50 periods.

[13] Summary statistics of $SD_{tc}$, the standard error of the residuals from the estimated price equation (2), are presented in Table 2. As one can see, the average and standard deviation of $SD_{tc}$ are 0.18 and 0.05, respectively. Also, note that we use weighted least-squares in the estimation of (1), where weights are determined by the total number of transactions in each city. Finally, the average $R^2$ coefficient from the estimations of equation (2) is equal to 0.81 [outcomes from the estimations of auxiliary equation (2) are not reported but are available upon request; outcomes from the estimation of (3) are presented in Appendix B].

residuals in the period prior to the price disclosure is 0.197, this implies about a 13% decrease in price dispersion due to improved information shock.[14]

Column 2 in Table 3 presents the outcomes from re-estimating the model over the periods April 2009–March 2010 and November 2010–October 2011 (that is, one year prior and subsequent to the information shock). It follows that while price dispersion significantly drops with improved information shock, the short-term (1-year subsequent) effect is smaller in magnitude. The coefficient on the *Treatment* variable implies about a 7% decrease in price dispersion (i.e., relative to the average standard deviation of the residuals in the pre-information shock period).

We further repeat the model estimation for the 2007-2013 and 2009-2011 periods, substituting the *SD* measure of dispersion in Equation (1) with *P*75-*P*25, the difference between the residuals in the 75th and the 25th percentiles (of the residual distribution) that follow from the estimation of equation (2) (summary statistics of *P75-P25* are presented in Table 2). This price dispersion measure is robust to outliers in the price observations. It follows that estimation outcomes are robust to this specification. The improved information shock associates with about a 3.2% (1.9%) decrease (both significant at the 1% level) in *P*75-*P*25 for the 3- (1-) year time window. As the average value of *P*75-*P*25 prior to the information shock is equal to 0.24, our outcome indicates about a 13% (9%) decrease in the price dispersion over the 3- (1-) year period subsequent to the information shock under this alternative measure.

## 5. ROBUSTNESS TESTS

The estimation of equation (1) reported above shows that improved information shock associates with a considerable decrease in the dispersion of subsequent transaction prices. This outcome is based on a panel of monthly observations in 42 cities. We now augment those findings on the correlation between the price information shock and subsequent price dispersion by focusing on smaller geographical areas. The Israeli Central Bureau of Statistics divides all municipalities in Israel hosting no fewer than 10,000 residents into geographical units referred to as statistical areas (the smallest sampling unit employed by the Central Bureau of Statistics), which are equivalent to census tracts in the United States. Each statistical area includes about 3,000-5,000

[14] Note that the standard deviation of the residuals from equation (2), *SD*, is estimated in log of asset price. Hence, the residuals represent errors in percentage of asset value.

residents, and, as with census tracts, the division into statistical areas accounts for aspects of homogeneity with respect to population characteristics, economic status, and living conditions (see Israel Central Bureau of Statistics, 2013).[15]

The analytic gain from using these smaller geographical units comes, however, with a decreased number of transactions per location per period. We thus extend the time-unit of the statistical area panel to one year. Altogether, our panel thus includes all housing transactions in 367 statistical areas (a total of 137,518 observations) over the periods April 2007–March 2010 and November 2011–October 2013 (i.e., three complete years prior and subsequent to the price information shock).[16] Table 4 presents summary statistics of this sample. As indicated in the table, the average dwelling unit across statistical areas is a 3.6-room, 918-square-foot condominium apartment located on the 2nd floor of a 26-year-old structure.

Consider the following equations:

(1a)

$$SD_{\tau s} = \delta_0 + \delta_1 Treatment_\tau + \delta_2 N_{s\tau-1} + \delta_3 \left|\Delta\widehat{P}_{\tau s}\right| + \delta_4 \left|\widehat{\theta}_{6,\tau s}\right| + \delta_5 SD\_Stock_\tau + \vec{\delta}_6 Avg\_Attributes_{\tau s} + \vec{\delta}_7 Var\_Attributes_{\tau s} + \vec{\delta}_8 Dum\_StatArea_s + \varepsilon_{4\tau s}$$

and

(2a)

$$\ln(P_{i\tau s}) = \theta_{0,\tau s} + \theta_{1,\tau s}\ln(Room_{i\tau s}) + \theta_{2,ts}\ln(Area_{i\tau s}) + \theta_{3,ts}\ln(Age_{i\tau s}) + \theta_{4,\tau s}\ln(Floor_{i\tau s}) + \theta_{5,ts}Dum\_New_{i\tau s} + \theta_{6,ts}Month_{i\tau s} + \vec{\theta}_{7,ts}TYPE_{i\tau s} + \varepsilon_{5i\tau s} \quad \text{for all } \tau \text{ and } s,$$

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[15] For example, the three largest cities in Israel—Jerusalem, Tel Aviv, and Haifa—include 181, 164, and 91 statistical areas, respectively.

[16] Similar to the organization of the sample under the city-level estimation, we condition the inclusion of a statistical area *s* at year *t* in the sample on exhibiting no fewer than 30 transactions per couplet *s* and *t*. We further omit statistical areas that do not satisfy the 30-transaction condition for some *t* both prior and subsequent to the information shock.

where equation (1a) examines the effect of the price information shock on price dispersion and equation (2a) is an auxiliary equation whose objective is to estimate the quality-adjusted price dispersion—with both equation estimations being based on a statistical area-level sample.

Similar to the methodology described in Section 3, the dependent variable in equation (1a), $SD_{\tau s}$, is the standard deviation of $\varepsilon_{5i\tau s}$ that follows from equation (2a), where subscripts $i$, $\tau$, and $s$ stand for transactions, annual time-periods, and statistical areas, respectively. The independent variables in equation (1a) include $N_{s\tau-1}$, a one-period lag of the number of transactions in statistical area $s$, reflecting the amount of information that is generated by market depth;[17] $|\hat{\theta}_{6,ts}|$, the absolute value of the estimated coefficient on the variable *Month* from equation (2a), controlling for within-period (year) price changes that may affect the price dispersion, $SD_{\tau s}$ (see description of *Month* below); and $Dum\_StatArea_s$, a statistical area fixed-effect indictor. Also, $\delta_0 - \delta_5$ are estimated parameters, $\vec{\delta}_6 - \vec{\delta}_8$ are vectors of estimated parameters, $\varepsilon_{4s\tau}$ is a random disturbance term, and all other variables are as discussed above (corresponding to statistical areas and annual time-periods).

Equation (2a) is a statistical area-based hedonic price equation estimated for each couplet $s$ and $\tau$ from which we generate the standard deviation of the residuals $\varepsilon_{5itc}$, $SD_{\tau s}$, substituted on the left-hand side of equation (1a). Equation (2a) differs from equation (2) above in two ways. First, the variable *SocioEcon* is omitted from (2a), as it is only available by statistical areas and thus does not vary for a given statistical area. Also, as we now consider annual time-units, the variable *Month* controls for monthly changes in the price level within the year.[18] In addition, $\theta_0 - \theta_6$ are estimated parameters, $\vec{\theta}_7$ is a vector of estimated parameters, $\varepsilon_{5s\tau}$ is a random disturbance term, and all other variables are as discussed above.

[17] As there are no statistical area-level data equivalent to those used on the right-hand side of equation (3), we cannot estimate an equivalence of equation (3) for the statistical area sample. Instead, we use the one-period lag of the number of transactions in a statistical area on the right-hand side of (1a) rather than employ a 2SLS procedure (employed above on the city-level sample).

[18] The variable *Month* assigns a number $m$=1,…,12 corresponding to the month when the transaction occurred in the observed year (e.g, *Month* equals 1 for transactions occurring in March prior to the information shock and to transactions occurring in November subsequent to the information shock). We use *Month* rather than 12 monthly dummy variables in order to avoid a decrease in the degrees of freedom.

Column 1 in Table 5 presents the outcomes from the estimation of equation (1a) based on the statistical area sample.[19] Evidence is robust to this specification. Specifically, it follows from column 1 that the coefficient on the *Treatment* variable is equal to -0.02 (significant at the 1% level), implying that adjusted-price dispersion (as estimated by the standard deviation of price residuals) decreases by about 13%, *ceteris paribus*, subsequent to the price information shock. Column 2 in Table 5 further shows that the decreased price dispersion effect maintains when the examined time period spans one year only prior and subsequent to the information shock (though the effect somewhat moderates). Finally, columns 3 and 4 in Table 5 show that the outcome on the information shock effect is insensitive to substituting the price dispersion measure *SD* with *P*75-*P*25, the difference between the residual in the 75th and the 25th percentiles that follow from the estimation of Equation (2a).[20]

## 6. DOES INFORMATION EFFECT VARY WITH MARKET PARTICIPANT CHARACTERISTICS?

In the above analysis, we provide evidence in support of information effect on quality-adjusted price dispersion of housing transactions. A remaining question, however, is whether the effect of the improved information shock varies with households' characteristics in the market. Below we report on tests of whether the improved information shock varies with statistical area measures of household head's education, income, and socio-economic characteristics.[21]

We re-estimate equation (1a) where we interact the *Treatment* variable in the following form:

(1b)

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[19] Estimation results from the estimation of equation (2a) (not reported) are available upon request.

[20] Summary statistics of the variables used in the statistical area level panel estimation are presented in Table 3. Among others, the average and standard deviation of $SD_{\tau s}$ is 0.14 and 0.05, respectively, and of $P75-P25_{\tau s}$ is about 0.17 and 0.06, respectively. Also, the average $R^2$ of the 2,224 annual statistical area-level estimations of equation (2a) is 0.75.

[21] As noted earlier, the socio-economic index is based on 16 statistical area indicators clustered into 4 groups: standard of living, employment and welfare, schooling and education, and demography. The scale for the socio-economic index ranges from -3 (lowest socio-economic level) to +3 (highest level) (see Israel Central Bureau of Statistics, 2013).

$$SD_{\tau s} = \omega_0 + \omega_1 Treatment_\tau + \omega_2 Characeristic_s + \omega_3 Treatment_\tau \times Charateristic_s + \omega_4 N_{s\tau-1} + \omega_5 \left|\Delta\hat{P}_{\tau s}\right| + \omega_6 \left|\hat{\theta}_{6,ts}\right| + \omega_7 SD\_Stock_\tau + \vec{\omega}_8 Avg\_Attributes_{\tau s} + \vec{\omega}_9 Var\_Attributes_{\tau s} + \vec{\omega}_{10} Dum\_StatArea_s + \varepsilon_{5\tau s},$$

where $Characteristic$=(*School*, *Academic*, *Income, SocioEcon*) and where *School* stands for the average number of years of schooling for household head in a statistical area; *Academic* is the percent of household heads holding an academic degree in a statistical area; *Income* is the average monthly income per standard person in a statistical area;[22] and *SocioEcon* is a statistical area's score on the socio-economic index.

Table 6 presents the outcomes from the estimation of equation (1b) with each of the household characteristics in the market. Those results offer evidence of significant variation in the effects of information shock across households' characteristics in the statistical area. For all four interaction terms, the coefficient $\omega_3$ is positive and significant at the 1% level, $\omega_1$ is negative and significant at the 1% level, and $\omega_2$ is insignificantly different from zero (see columns 1-4 in Table 6). Results thus imply that while these household characteristics do not maintain any direct association with price dispersion, they significantly moderate the effect of information shock on the price dispersion.

In figures 1A-1D we display the marginal effect of the information shock (i.e., when *Treatment*=1) on price dispersion for different levels of the interaction variable (where the X-axis ranges from the 1st to the 99th percentile of the interaction variable in our sample). It follows that the average number of years of schooling of household heads in a statistical area (*School*) moderates the improved information shock effect. That is, while information shock for average number of years of schooling equal to 10.5 associates with a 21% decrease in price dispersion (from *SD*=0.162 to *SD*=0.127), the effect nullifies for average number of years of schooling equal to 16.7. Consistently, the percentage of academic degree holders among household heads in a statistical area (*Academic*) moderates the improved information shock effect: while information shock associates with a decreased price dispersion of about 20% (from 0.156 to

[22] The average monthly income per *standard person* is the single income measure per statistical area published by the Israel Central Bureau of Statistics. This measure assesses the standard of living of households with varying number of persons [see Israel Central Bureau of Statistic (2013)].

0.126) in a statistical area with 6% academic degree holders, the information shock effect disappears in statistical areas with 75% academic degree holders. We also find that average income per standard person negatively correlates with the information shock effect: while information shock in a statistical area with average monthly income per standard person equal to about $550 associates with about a 19% decrease in price dispersion (from 0.155 to 0.125), the effect nullifies in a statistical area with average monthly income per standard person equal to about $3,400. In other words, for every $150 decrease in monthly income per standard person, the improved information shock associates with a 1% decrease in the price dispersion. Finally, a market with a greater score on the socio-economic index associates with a diminished information shock effect: While improved information shock associates with a decreased price dispersion of about 21% (from 0.157 to 0.123) in a statistical area with a socio-economic index score equal to -1.5, the effect disappears in statistical areas with a score of 2.5 on the socio-economic scale.

These findings thus indicate that the major beneficiaries of the improved information shock are sellers and buyers transacting in markets where households exhibit relatively low levels of education, income, and socio-economic characteristics. These outcomes are consistent with the notion that market participants in less privileged regions, having limited access to means that may overcome information shortage, are the main beneficiaries from improved public information, while in areas with a more educated, wealthier, and generally higher socio-economic population, transactions involve greater information even when it is not formally available.

## 7. SUMMARY AND CONCLUSIONS

This research provides new empirical evidence on the effect of information shock on quality-adjusted housing price dispersion. The analysis examines a unique Israeli experience where the Tax Authority was court-ordered to publicly disclose information on all past and current real estate transactions.

Statistical findings provide solid evidence in support of improved information effect on the dispersion of transaction prices. Standard deviation of quality-adjusted prices has decreased by about 13% subsequent to the improved information shock. Further, we find evidence that information effect varies with market characteristics. Research findings provide real-world evidence suggesting the importance of price transparency in a market where transactions involve significant and long-term individual economic consequences.

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**Table 1**: List of Micro-Level Variables, Description, and Summary Statistics

| Variable | Description | Avg. | Std. | Min | Max |
|---|---|---|---|---|---|
| $P$ | Transaction closing price (in USD) | 278671.4 | 197144.8 | 10610 | 4986737 |
| $Room$ | Total number of rooms | 3.66 | 1.06 | 2 | 10 |
| $Area$ | Floor area (in square feet) | 953.74 | 384.17 | 323 | 3229 |
| $Age$ | The age of the structure (in years) at the time of the transaction | 25.05 | 17.78 | -4 | 100 |
| $Floor$ | The story on which the asset is located in the structure | 1.90 | 2.22 | 0 | 32 |
| $Dum\_New$ | Dummy variable equals 1 if *Age* is less than 1 (i.e., new asset); 0 otherwise | 0.101 | 0.302 | 0 | 1 |
| $SocioEcon$ | Socio-economic index score of the statistical area where the asset is located | 0.272 | 0.819 | -2.462 | 2.893 |
| $Type1$ | Dummy variable equals 1 if the asset is a condominium apartment (base category) | 0.949 | 0.218 | 0 | 1 |
| $Type2$ | Dummy variable equals 1 if the asset is a ground-level apartment; 0 otherwise | 0.007 | 0.082 | 0 | 1 |
| $Type3$ | Dummy variable equals 1 if the asset is a penthouse or a duplex apartment; 0 otherwise | 0.003 | 0.053 | 0 | 1 |
| $Type4$ | Dummy variable equals 1 if the asset is a townhouse; 0 otherwise | 0.003 | 0.051 | 0 | 1 |
| $Type5$ | Dummy variable equals 1 if the asset is an attached unit; 0 otherwise | 0.023 | 0.152 | 0 | 1 |
| $Type6$ | Dummy variable equals 1 if the asset is a style 1 detached unit; 0 otherwise | 0.010 | 0.100 | 0 | 1 |
| $Type7$ | Dummy variable equals 1 if the transacted property is a style 2 detached unit; 0 otherwise | 0.004 | 0.062 | 0 | 1 |
| $Month$ | A trend variable that respectively equals 1,…,12 for each month within each chronological year prior and subsequent to the information shock | 6.38 | 3.42 | 1 | 12 |

**Table 2:** List of City-Level Panel Variables, Description, and Summary Statistics

| Variable | Description | Avg. | Std. | Min | Max |
|---|---|---|---|---|---|
| $Treatment_t$ | Dummy variable that equals 1 for periods subsequent to information disclosure (i.e., subsequent to October 2010) | 0.506 | 0.500 | 0 | 1 |
| $SD\_\hat{P}_{tc}$ | 6-month (ending at *t*) moving standard deviation of quality-adjusted housing prices in city *c* | 0.009 | 0.004 | 0.001 | 0.032 |
| $N_{tc}$ | The number of transactions in period *t* and city *c* | 101.4 | 82.6 | 31 | 838 |
| $SD\_Stock_t$ | 3-month moving standard deviation of daily yields of the Tel-Aviv100 stock index | 0.012 | 0.005 | 0.006 | 0.031 |
| $\Delta POP_{tc}$ | The annual rate of change in the number of residents in city *c* | 0.015 | 0.019 | -0.065 | 0.113 |
| $\Delta GDP_t$ | Quarterly rate of change in gross domestic product | 0.009 | 0.014 | -0.016 | 0.032 |
| $ConstrStart_{tc}$ | Quarterly number of housing construction starts in the district where city *c* is located | 633.7 | 389.6 | 60 | 2052 |
| $ConstrEnd_{tc}$ | Quarterly number of housing construction completions in the district where city *c* is located | 548.6 | 350.7 | 73 | 2062 |
| $Avg\_Area_{tc}$ | The average area (in square feet) of assets transacted in period *t* and city *c* | 967.5 | 136.7 | 618.2 | 1481.5 |
| $Avg\_Rooms_{tc}$ | The average number of rooms of assets transacted in period *t* and city *c* | 3.70 | 0.36 | 2.50 | 4.82 |
| $Avg\_Floor_{tc}$ | The average story of assets transacted in period *t* and city *c* | 1.85 | 0.49 | 0.34 | 3.78 |
| $Avg\_Age_{tc}$ | The average age (in years) of assets transacted in period *t* and city *c* | 24.19 | 7.41 | 4.24 | 43.29 |
| $Avg\_SocioEcon_{tc}$ | The average score on the socio-economic index of the statistical area where the asset is located | 0.27 | 0.62 | -1.30 | 1.90 |
| $SD\_Area_{tc}$ | The standard deviation of the area (in square feet) of assets transacted in period *t* and city *c* | 360.7 | 80.9 | 152.1 | 739.0 |
| $SD\_Rooms_{tc}$ | The standard deviation of the number of rooms of assets transacted in period *t* and city *c* | 0.99 | 0.13 | 0.51 | 1.55 |
| $SD\_Floor_{tc}$ | The standard deviation of the story of assets transacted in period *t* and city *c* | 2.08 | 0.53 | 0.74 | 5.76 |
| $SD\_Age_{tc}$ | The standard deviation of the age of assets transacted in period *t* and city *c* | 15.23 | 3.28 | 1.43 | 24.25 |
| $SD\_SocioEcon_{tc}$ | The standard deviation of the score on the socio-economic index of the statistical area where the asset is located | 0.49 | 0.19 | 0.13 | 1.02 |
| $SD_{tc}$ | Standard deviation of the residuals from the estimation of the price equation (2) | 0.184 | 0.054 | 0.069 | 0.412 |
| $P75 - P25_{tc}$ | Difference between the residuals in the 75$^{th}$ and the 25$^{th}$ percentiles | 0.223 | 0.075 | 0.060 | 0.542 |

Notes: Transaction price data provided by the Israel Tax Authority; stock price data provided by the Tel Aviv Stock Exchange; all other data provided by the Israel Central Bureau of Statistics.

**Table 3:** Regression Results for the City-Level Estimation of Equation (1)

| Column | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Dependent Variable | SD | SD | P75-P25 | P75-P25 |
| # of months prior and subsequent to the treatment | 36 months | 12 months | 36 months | 12 months |
| Constant | 0.357*** | 0.177*** | 0.936*** | 0.161 |
| | (0.035) | (0.065) | (0.054) | (0.982) |
| *Treatment* | -0.024*** | -0.013*** | -0.032*** | -0.022*** |
| | (0.001) | (0.002) | (0.002) | (0.003) |
| $\widehat{N}$ | $1.6\times10^{-5}$ | 0.004 | $7.9\times10^{-5}$ | 0.0003 |
| | $(9.3\times10^{-5})$ | (0.068) | $(1.4\times10^{-4})$ | (0.003) |
| $SD\_\hat{P}_{ct}$ | 0.082** | -0.004 | 0.013 | -0.332*** |
| | (0.039) | (0.068) | (0.060) | (0.102) |
| $SD\_Stock_t$ | -0.169* | -0.300* | -0.288** | -0.577** |
| | (0.092) | (0.168) | (0.141) | (0.251) |
| $Avg\_Attributes_{ct}$ | Included | Included | Included | Included |
| $SD\_Attributes_{ct}$ | Included | Included | Included | Included |
| *Dum_City* (city fixed-effect) | Included | Included | Included | Included |
| # of Observations | 2447 | 829 | 2447 | 829 |
| # of Cities | 42 | 40 | 42 | 40 |
| Prob> chi2 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Spatial unit | City | City | City | City |
| Temporal unit | Month | Month | Month | Month |

Notes: Table 4 presents results of WLS estimation of equation (1), where each city observation is weighted by the city's number of transactions out of total number of transactions (outcomes are robust to equal-weighting, however). Standard errors are shown in parentheses. Columns (1) [(3)] present estimation results for the period that includes 36 (12) months prior and subsequent to the information shock. Columns (2) and (4) present estimation results for the period that includes 36 (12) months prior and subsequent to the information shock and following the substitution of *SD* on the left-hand side of equation (1) with the alternative dispersion measure, *P75-P25*. Results are robust to the omission of the city fixed-effect variable, *Dum_City*. Standard errors are given in parentheses. One, two, and three asterisks represent significance at the 10%, 5%, and 1% levels, respectively.

**Table 4:** List of Statistical Area-Level Panel Variables, Description, and Summary Statistics

| Variable | Description | Avg. | Std. | Min | Max |
|---|---|---|---|---|---|
| $Treatment_{\tau}$ | Dummy variable that equals 1 for periods subsequent to information disclosure (i.e., subsequent to October 2010) | 0.521 | 0.500 | 0 | 1 |
| $SD_{\tau s}$ | The standard error of the residuals in price equation (2) | 0.143 | 0.047 | 0.035 | 0.315 |
| $P75 - P25_{\tau s}$ | Difference between the residuals in the 75th and the 25th percentiles | 0.169 | 0.065 | 0.046 | 0.510 |
| $N_{\tau s}$ | The number of transactions in period $\tau$ and statistical area *s* | 61.83 | 33.91 | 31 | 395 |
| $Avg\_Area_{\tau s}$ | The average area (in square feet) of assets transacted in period $\tau$ and statistical area *s* | 918.1 | 205.6 | 480.8 | 1846 |
| $Avg\_Rooms_{\tau s}$ | The average number of rooms of assets transacted in period $\tau$ and statistical area *s* | 3.58 | 0.55 | 2.18 | 5.49 |
| $Avg\_Floor_{\tau s}$ | The average story of assets transacted in period $\tau$ and statistical area *s* | 2.08 | 0.99 | 0 | 9.33 |
| $Avg\_Age_{\tau s}$ | The average age (in years) of assets transacted in period $\tau$ and statistical area *s* | 25.86 | 13.18 | 0.07 | 56.81 |
| $SD\_Area_{\tau s}$ | The standard deviation of the area (in square feet) of assets transacted in period $\tau$ and statistical area *s* | 24.73 | 8.50 | 8.07 | 64.31 |
| $SD\_Rooms_{\tau s}$ | The standard deviation of the number of rooms of assets transacted in period $\tau$ and statistical area *s* | 0.83 | 0.18 | 0.33 | 1.84 |
| $SD\_Floor_{\tau s}$ | The standard deviation of the story of assets transacted in period $\tau$ and statistical area *s* | 1.87 | 0.82 | 0.00 | 9.81 |
| $SD\_Age_{\tau s}$ | The standard deviation of the age of assets transacted in period $\tau$ and statistical area *s* | 9.91 | 5.80 | 0.38 | 30.07 |
| $\lvert\Delta\hat{P}_{\tau s}\rvert$ | The annual rate of change in a quality-adjusted asset (log) price in period $\tau$ and statistical area *s*, in absolute terms | 0.14 | 0.13 | 0.00 | 1.84 |
| $SD\_Stock_{\tau}$ | 1-year moving standard deviation of daily yields of the Tel Aviv 100 stock index | 0.01 | 0.00 | 0.01 | 0.02 |
| $SocioEcon_{s}$ | The score of statistical area *s* on the socio-economic index | 0.34 | 0.78 | -1.93 | 2.76 |
| $Schooling_{s}$ | Average years of schooling of household heads aged 25-54 in statistical area *s* | 13.96 | 1.34 | 7.72 | 17.25 |
| $Academic_{s}$ | Percent of household heads aged 25-54 holding an academic degree in statistical area *s* | 34.73 | 17.15 | 2.96 | 80.83 |
| $Income_{s}$ | Average monthly income per standard person in statistical area *s* (in dollars) | 1,520 | 556 | 344 | 4606 |

Notes: Transaction price data provided by the Israel Tax Authority; stock price data provided by the Tel Aviv Stock Exchange; all other data provided by the Israel Central Bureau of Statistics. The variables $Avg\_Area_{tc}$, $Avg\_Rooms_{tc}$, $Avg\_Floor_{tc}$, $Avg\_Age_{tc}$, $Avg\_SocioEcon_{tc}$ appear in equation (1) as the vector $Avg\_Attributes_{tc}$ and $SD\_Area_{tc}$, $SD\_Rooms_{tc}$, $SD\_Floor_{tc}$, $SD\_Age_{tc}$, and $SD$_SocioEcontc appear as the vector $SD\_Attributes_{tc}$.

**Table 5:** Regression Results for the Statistical Area-Level Estimation of Equation (1a)

| Column | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Dependent Variable | SD | SD | P75-P25 | P75-P25 |
| # of years prior and subsequent to the treatment | 3 years | 1 year | 3 years | 1 year |
| Constant | 0.147*** | 0.111*** | 0.188*** | 0.126*** |
| | (0.018) | (0.037) | (0.026) | (0.048) |
| *Treatment* | -0.019*** | -0.010*** | -0.023*** | -0.012*** |
| | (0.001) | (0.002) | (0.002) | (0.003) |
| $N_{\tau\text{-}1}$ | $2.0\times10^{-5}$ | $-3.0\times10^{-5}$ | $-4.0\times10^{-5}$ | $2.1\times10^{-5}$ |
| | $(2.0\times10^{-5})$ | $(5.0\times10^{-5})$ | $(3.0\times10^{-5})$ | $(7.1\times10^{-5})$ |
| $\lvert\hat{\theta}_{6,ts}\rvert$ | 0.221*** | 0.688*** | 0.159*** | 0.500*** |
| | (0.073) | (0.132) | (0.107) | (0.182) |
| $\lvert\Delta\hat{P}_{\tau s}\rvert$ | -0.003 | -0.011 | -0.008 | 0.002 |
| | (0.004) | (0.007) | (0.006) | (0.010) |
| $SD\_Stock_{\tau}$ | 0.939*** | | 1.397*** | |
| | (0.139) | | (0.204) | |
| $Avg\_Attributes_{s\tau}$ | Included | included | included | included |
| $SD\_Attributes_{s\tau}$ | Included | included | included | included |
| *Dum_StatArea* | Included | included | Included | included |
| Number of Observations | 2224 | 734 | 2224 | 734 |
| Number of statistical areas | 453 | 367 | 453 | 367 |
| Prob>chi2 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Spatial unit | Statistical Area | Statistical Area | Statistical Area | Statistical Area |
| Temporal unit | Year | Year | Year | Year |

Notes: Table 5 presents results of WLS estimation of equation (1a), where each statistical area observation is weighted by the statistical area's number of transactions out of total number of transactions (outcomes are robust to equal-weighting, however). Columns (1) [(3)] present estimation results for the period that includes 3 (1) years (year) prior and subsequent to the information shock. Columns (2) and (4) present estimation results for the period that includes 3 (1) years (year) prior and subsequent to the information shock and following the substitution of *SD* on the left-hand side of equation (1) with the alternative dispersion measure, *P75-P25*. Results are robust to the omission of the statistical area fixed-effect variable, *Dum_StatArea*. The explanatory variable $SD\_Stock_t$ is omitted from the estimation of which outcomes are presented in columns (3) and (4) as it includes two periods only (one year prior and subsequent to the information shock) and thus $SD\_Stock_t$ becomes multicolinear with *Treatment*. Standard errors are given in parentheses. One, two, and three asterisks represent significance at the 10%, 5%, and 1% level, respectively.

**Table 6:** Regression Results for the Interaction Estimation of Equation (1b)

| Column | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | ***Characteristic = School*** | ***Characteristic = Academic*** | ***Characteristic = Income*** | ***Characteristic = SocioEcon*** |
| Constant | 0.120** | 0.123*** | 0.117*** | 0.133*** |
| | (0.035) | (0.021) | (0.024) | (0.018) |
| $Treatment$ | -0.082*** | -0.032*** | -0.035*** | -0.022*** |
| | (0.010) | (0.002) | (0.003) | (0.004) |
| $Characteristic$ | 0.001 | 0.0003 | $0.6\text{x}10^7$ | 0.004 |
| | (0.002) | (0.0003) | ($0.5\text{x}10^7$) | (0.004) |
| $Treatment \times Characteristic$ | 0.004*** | 0.0003*** | $7.2\text{x}10^{8}$*** | 0.007*** |
| | (0.001) | (0.00005) | ($1.2\text{x}10^8$) | (0.001) |
| $N_{t-1}$ | 0.00003 | 0.00002 | 0.00002 | 0.00002 |
| | (0.00002) | (0.00003) | (0.00003) | (0.00003) |
| $\lvert\hat{\theta}_{6,ts}\rvert$ | 0.204*** | 0.197*** | 0.204*** | 0.204*** |
| | (0.073) | (0.073) | (0.073) | (0.073) |
| $\lvert\Delta\hat{P}_{\tau s}\rvert$ | -0.003 | -0.003 | -0.003 | -0.003 |
| | (0.004) | (0.004) | (0.004) | (0.004) |
| $SD\_Stock_t$ | 0.938*** | 0.928*** | 0.935*** | 0.935*** |
| | (0.138) | (0.138) | (0.138) | (0.138) |
| $Avg\_Attributes_{ct}$ | Included | Included | Included | Included |
| $SD\_Attributes_{ct}$ | Included | Included | Included | Included |
| $Dum\_L$ | Included | Included | Included | Included |
| # of Observations | 2224 | 2224 | 2224 | 2224 |
| # of statistical areas | 453 | 453 | 453 | 453 |
| Prob>chi2 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| # of years prior and subsequent to the treatment | 3 years | 3 years | 3 year | 3 year |
| Spatial unit | Statistical Area | Statistical Area | Statistical Area | Statistical Area |
| Temporal unit | Year | Year | Year | Year |

Notes: Standard errors in parentheses. One, two, and three asterisks represent significance at the 10%, 5%, and 1% level, respectively. Results are robust to the omission of observations in which the indicator level is in the top or the bottom 5% (using values between the 5 and the 95 percentiles) or 10% (using values between the 10 and the 90 percentiles) of the indicator values in the sample.

**Figure 1A:** The Effect of Information Shock on Price Dispersion for Different Levels of Average Number of Years of Household Head Schooling in a Statistical Area

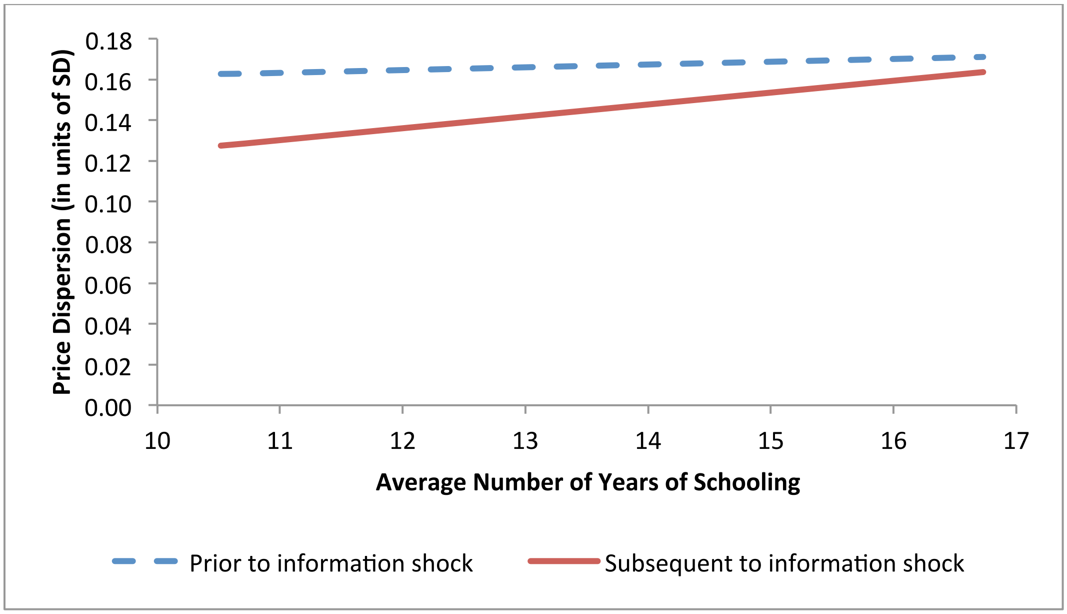



**Figure 1B:** The Effect of Information Shock on Price Dispersion for Different Percentages of Household Heads Holding Academic Degree in a Statistical Area

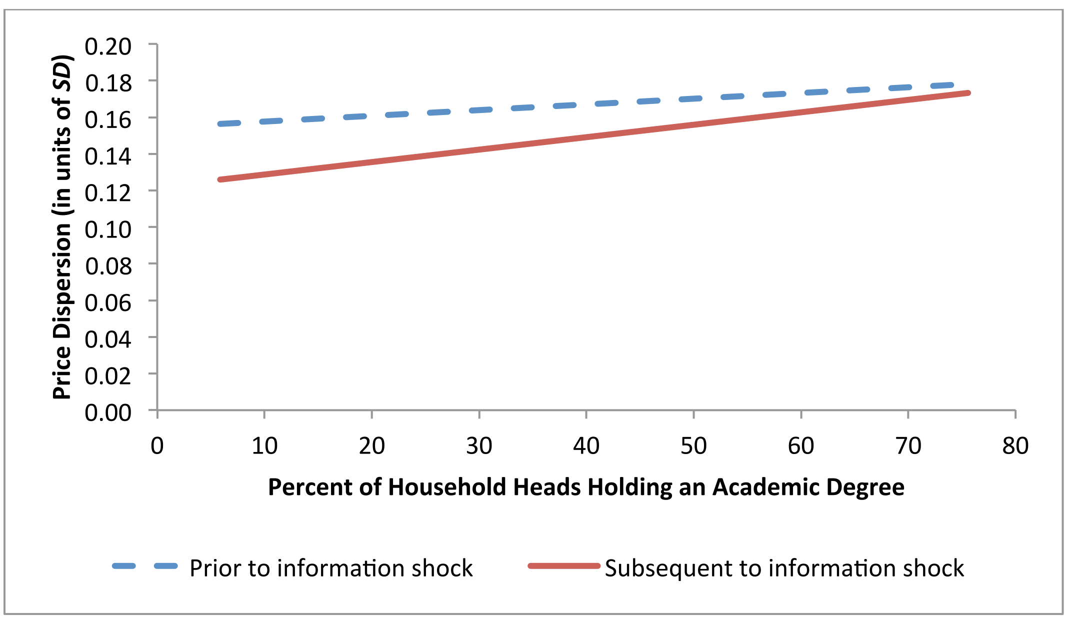


**Figure 1C:** The Effect of Information Shock on Price Dispersion for Different Levels of Average Income Per Standard Person in a Statistical Area

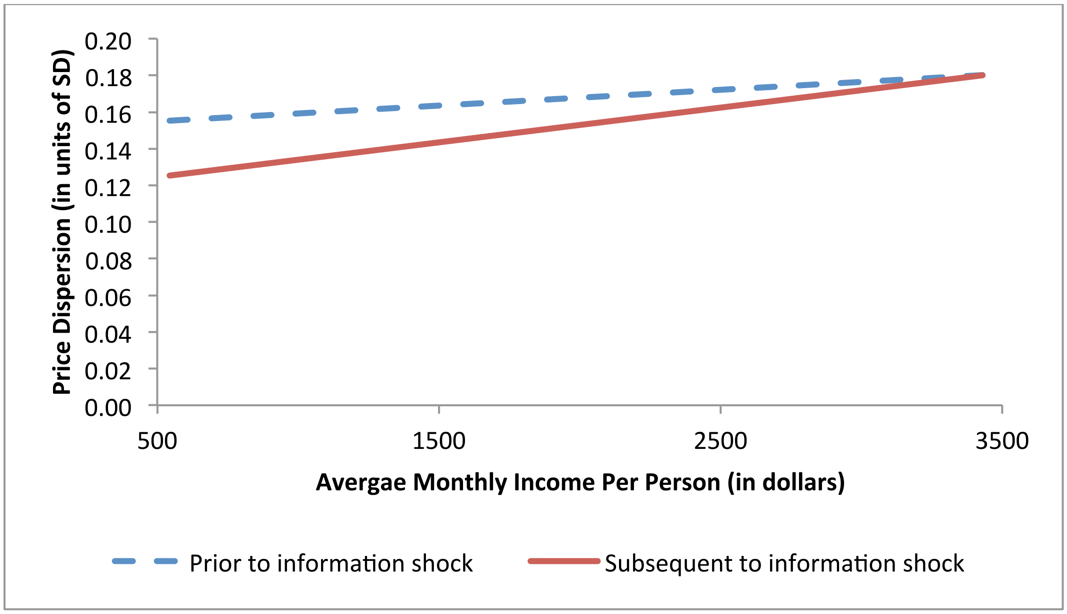
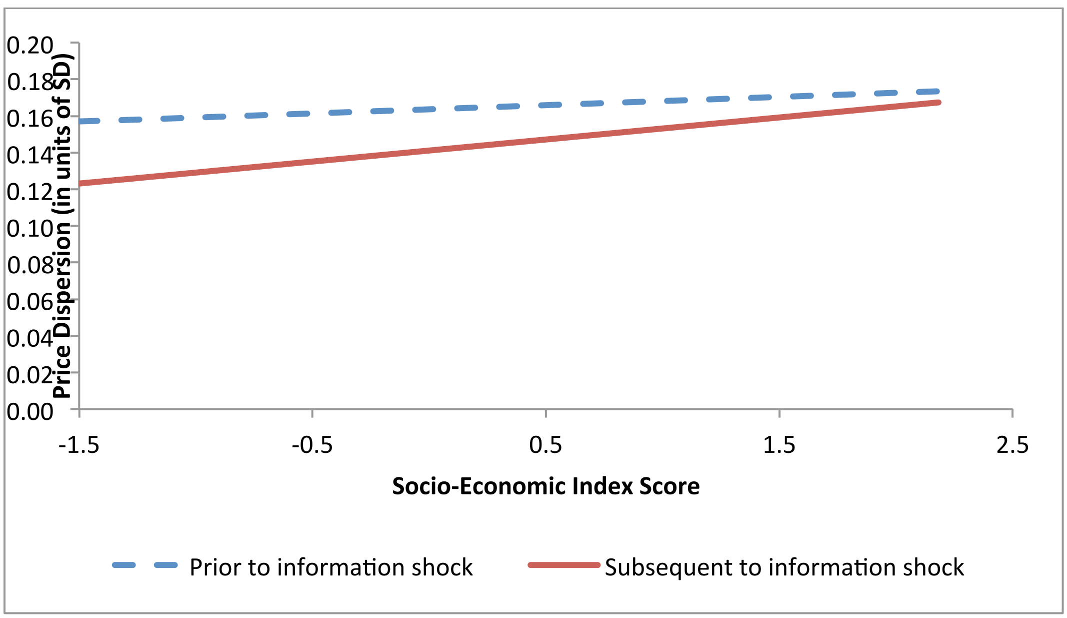



**Figure 1D:** The Effect of Information Shock on Price Dispersion for Different Scores on the Socio-Economic Index of Statistical Area




Notes: Figures 1A-1D display the effect of the information shock on price dispersion for different levels of the interaction variables: *School* (Figure 1A), *Academic* (Figure 1B), *Income* (Figure 1C) and *SocioEcon* (Figure 1D). The solid (scattered) line presents the predicted standard deviation of the residuals, *SD*, following the estimation of equation (1b), subsequent (prior) to the information shock. Values of the interaction variable on the X-axis range from the 1st to the 99th percentile of the interaction variable in the sample.

## Appendix A – Derivation of $SD\_\widehat{P}_{6\,ct}$

For each city $c$ in the sample we estimate:

(A1)

$$\ln(P_{ic}) = \beta_{0,c} + \beta_{1,c}\ln(Room_{itc}) + \beta_{2,c}\ln(Area_{itc}) + \beta_{3,c}\ln(Age_{itc}) + \beta_{4,c}\ln(Floor_{itc}) + \beta_{5,c}Dum\_New_{itc} + \beta_{6,c}SocEcon_{ic} + \vec{\beta}_{7,c}TYPE_{itc} + \vec{\beta}_{8,ic}D_{it} + \theta_{ic} \text{ for all } c,$$

where D is a time fixed-effect; $\beta_{0,c} - \beta_{6,c}$ and $\vec{\beta}_{7,c} - \vec{\beta}_{8,ic}$ are estimated parameters and vectors of parameters, respectively; $\theta$ is a random disturbance term; and all other variables are as described before.[23]

The price equation (1A) is estimated once for each city (altogether 42 estimations whose average R-squared is 0.839 with a minimum of 0.656 and a maximum of 0.902). By substituting the average value for each variable in the sample on the right-hand side of (1A), we produce a price index for each city from which we compute the standard deviation of the rate of change in the quality-adjusted price, $SD\_\hat{P}_{ct}$, to be substituted on the right-hand side of equation (1).

[23] We generate $SD\_\hat{P}_{ct}$ by estimating equation (A1) with a time fixed-effect [rather than by estimating equation (2) above] so as to avoid the loss of panel observations of $SD\_\hat{P}_{ct}$ that would follow cases where the couplet $t$ and $c$ exhibits a small number of transactions. Results, however, are robust to deriving $SD\_\hat{P}_{ct}$ using equation (2) (not reported and available by request).

**Appendix B**

**Table 1B:** Regression Results from the Estimation of Equation (3)

| | |
|---|---|
| Constant | 265.89*** (4.247) |
| $\Delta Pop$ | 43.97 (38.36) |
| $ConstrEnd$ | 0.007** (0.003) |
| $ConstrStart$ | -0.001 (0.002) |
| $\Delta GDP$ | 297.65*** (42.98) |
| $\Delta\hat{P}_{6_{tc}}$ | 29.69*** (9.23) |
| | |
| *Dum_City* (city fixed effect) | Included |
| # of panel observations | 3024 |
| # of cities | 42 |
| Prob > Chi2 | 0.0000 |
| Overall $R^2$ | 0.84 |
| Time-period | Apr 2007-Oct 2013 |
| Spatial unit | City |
| Temporal unit | Month |

Notes: Table 1B presents results from the estimation of equation (3). Standard errors are presented in parentheses. One, two, and three asterisks represent significance at the 10%, 5%, and 1% level, respectively.