RATCHET PRICE MECHANISM UNDER CURRENCY CHANGEOVER: A NATURAL HOUSING MARKET EXPERIMENT

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Abstract

This paper examines the effect of a currency changeover on prices. A parsimonious model shows that, during a period of currency changeover, sellers and buyers conversely opt for the currency dominating the negotiation based on exchange rate fluctuations between the preceding and the new currency—potentially affecting the closing price. The currency changeover experienced by the Israeli real estate market in the past decade serves as a unique natural experiment for testing our behavioral model. Results of micro- and macro-level estimation indicate that exchange rate fluctuations associate with an upward ratchet price effect during a currency changeover period. Further, the ratchet price mechanism disappears once the currency changeover phase is completed. Our findings underline the importance of policy measures that are designed to accelerate and truncate the currency transition period.

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1. INTRODUCTION

Studies show that in the public's adaptation to a currency changeover, the perception of the new nominal price may be subject to cognitive and emotional biases (see, for example, Soman *et al.*, 2002; Jonas *et al.*, 2002). Interestingly, however, the potential effect of these cognitive and emotional biases on market prices has yet to be sufficiently explored in the literature (see the literature review in Section 3).

In this study, we examine the effect of behavioral heuristics related to currency changeover on the price level. Specifically, using data from a unique natural currency changeover experiment in the Israeli real estate market, we assess the real effect on housing market transaction prices. We motivate the empirical tests by means of a parsimonious model of a dual-price reference under a currency changeover with exchange rate fluctuations. The model shows that the potential emergence of a dual-currency price reference among sellers and buyers may translate into a real price effect. We then test for the price effect under the Israeli real estate market currency changeover experience.

In the first half of the 1980s, the Israeli market suffered from a major economic crisis that led to an informal dollarization of the market (Galdino & Leiderman, 2005; Melvin & Peiers, 2007). However, long after the economy had stabilized and the local currency (New Israeli Sheqel; hereafter *sheqel*) had regained its extensive dominance, the dollar maintained its control of the real estate market, where asking prices, negotiations, and closings were regularly conducted in dollars (in contrast, only payments were maintained in sheqels). As our analysis shows, only in 1998 had the de-dollarization reached real estate transactions and gradually diffused into the market. A decade later, this process concluded when the sheqel practice finally dominated the vast majority of the transactions (see further description in Section 3).

Because a currency changeover is often accompanied by stormy economic conditions and reactive fiscal and monetary measures, it is generally difficult to statistically isolate the specific effect of a currency transition on the economy. The "sheqelization" experienced by the Israeli real estate market, however, was accompanied by stable economic conditions. Moreover, the prolonged gradual adaptation to the new currency under a floating dollar-sheqel exchange rate, combined with the sizable amount that is involved in housing transactions, produces unique

natural experiment conditions for empirically assessing the effect of a currency changeover on prices.

Specifically, we estimate the transaction price response to changes in the sheqel-dollar exchange rate during the sheqelization period. As we describe in the next section, the currency changeover period potentially offered a dual-currency reference price—a new sheqel reference price in addition to the prevailing dollar reference price. Under the dual-currency reference price system, sellers (buyers) translated a depreciation (an appreciation) in the sheqel value of the dollar to an adjustment of the sheqel reference price, potentially leading to a favorable closing price (see intuition in Section 2).

In order to explore the price effect of the currency changeover period, we first develop an algorithm that identifies and distinguishes between originally sheqel- and dollar-denominated transactions (information that is not directly observable in the dataset) based on the "roundness" of the recorded sheqel and dollar prices of each transaction. Classifying the universe of all housing transactions in Israel during the currency changeover period to dollar and sheqel transactions, we then conduct two tests to empirically assess the currency changeover effect on housing prices.

On the micro-level, we employ a difference-in-difference approach to generate a quality-adjusted *implied housing transaction-based exchange rate*, controlling for a set of asset physical and locational characteristics. We then estimate the roles of appreciations and depreciations in the sheqel value of the dollar on the implied transaction-based sheqel-dollar exchange rate, controlling for the nominal exchange rate. We further use macro-level data to estimate the separate association of sheqel-dollar appreciations and depreciations with changes in the housing price index, controlling for macroeconomic variables. Finally, we examine the robustness of our findings to issues of sampling and test specifications.

Results provide solid evidence of an upward ratchet price mechanism in response to changes in the sheqel-dollar exchange rate under currency changeover. While a 1-unit *increase* in the nominal dollar-sheqel exchange rate associates with a 1-unit increase in the derived implied transaction-based exchange rate, it follows that a 1-unit *decrease* in the nominal exchange rate has an insignificant net effect on the implied transaction-based exchange rate. Moreover, while the housing price index increases by 0.49% for every 1% increase in the nominal dollar-sheqel exchange rate, it maintains a zero net effect for a decrease in the nominal exchange rate. We further

find that the ratchet price effect disappeared once the currency changeover process was completed. These results are robust to sampling and test design issues.

The main contribution of this research is in demonstrating the role of a currency changeover in generating a dual-currency reference price that, in turn, produces a ratchet price mechanism by seller-buyer decisions that involve substantial economic consequences. Moreover, as the upward ratchet price effect emerges under currency changeover conditions, our findings stress the potentially important role of public policy measures designed to accelerate and truncate the currency transition period.

The plan of the paper is as follows. Section 2 constructs a parsimonious model motivating a ratchet mechanism under currency changeover. Section 3 provides background and a literature review, and Section 4 describes the data and presents related summary statistics. Section 5 presents the empirical model, while Section 6 provides estimation results supporting an upward ratchet price mechanism under currency changeover. Section 7 tests whether the ratchet price mechanism maintains in post-currency changeover periods, whereas Section 8 assesses the robustness of the outcomes to sample and model design specifications. Finally, Section 9 provides a summary and concluding remarks.

2. MOTIVATION

Consider a pre-currency changeover housing market in which all transactions are conducted in one currency—the dollar. Let D_t be the time t dollar reference price of dwelling units observed by both sellers and buyers, where, without loss of generality, we assume that all dwelling units are identical and that $D_t=D$. Denote the time t floating sheqel-dollar exchange rate (the sheqel value of 1 dollar) by X_t. It follows that the equivalent sheqel value of D at time t is DX_t.

Now, suppose that the dollar depreciates at some time s (that is, $X_{s-1}>X_s$). Then, the sheqel equivalence of the dollar reference price decreases from DX_{s-1} to DX_s. If, however, the reference price of D dollars materializes into a closing price, then, in sheqel terms, the dollar depreciation generates a loss to the seller and a gain to the buyer. Likewise, if the dollar appreciates (i.e., $X_{s-1}<X_s$), then reaching a closing price equal to D dollars produces a sheqel loss to the buyer and a sheqel gain to the seller.

Suppose, however, that at time s, a currency changeover (sheqelization) initiates and a sheqel reference price joins the prevailing dollar reference price. As the current sheqel-dollar exchange rate equals X_s, the new sheqel reference price is equal to DX_s. Under this dual-reference price (dollar and sheqel) regime, if the dollar now depreciates (i.e., $X_s > X_{s+1}$), then the seller may attempt to avoid the depreciation in the sheqel value of the dollar by opting for a sheqel transaction and negotiating for the time s sheqel reference price (i.e., the pre-depreciation sheqel price, DX_s) rather than the dollar reference price (D). At the same time, the buyer may exploit the depreciation of the dollar by opting for a dollar transaction, negotiating for the dollar reference price D (which now equals DX_{s+1} sheqels, which is less then DX_s sheqels).

Conversely, if the dollar appreciates at time s+1 ($X_s < X_{s+1}$), then the sellers may opt for a dollar transaction by negotiating for the dollar reference price D (which is now equal to DX_{s+1} sheqels, which is greater than DX_s sheqels) and thus benefit (in sheqel terms) from the dollar appreciation. In contrast, the buyer may now opt for a sheqel transaction, negotiating for the time s sheqel reference price (DX_s), thereby avoiding the greater sheqel price that accompanies the dollar reference price D under dollar appreciation (DX_{s+1}).

Assuming that, under currency changeover, sellers and buyers opt for a price negotiation and a closing price in the currency that maximizes their benefit (using the respective reference price), we argue:

Result 1: If the *seller* maintains some bargaining power, then, during a currency changeover period, *depreciation* in the value of the old currency results in a greater closing price in the new currency than would have otherwise attained in the pre-currency changeover period.

Result 2: If the *buyer* maintains some bargaining power, then, during a currency changeover period, an *appreciation* in the value of the old currency results in a lower closing price in the new currency than would have otherwise attained in the pre-currency changeover period.

Result 3: If the *seller* dominates the bargaining process, then, during a currency changeover period, depreciation (appreciation) in the value of the old currency entails no change (an increase) in the closing price in the new currency. Hence, under

currency changeover, exchange rate fluctuations produce an upward ratchet price mechanism in the new currency.

Result 4: If the *buyer* dominates the bargaining process, then, during currency changeover, appreciation (depreciation) in the value of the old currency entails no change (a decrease) in the closing price in the new currency. Hence, under currency changeover, exchange rate fluctuations produce a downward ratchet price mechanism in the new currency.

3. BACKGROUND AND LITERATURE REVIEW

In the first half of the 1980s, the Israeli market suffered from major economic instability. The prevailing hyperinflation motivated suppliers to link prices of goods and services to the dollar-sheqel exchange rate in order to maintain their real value. Thus, prices were denominated in dollars and converted to the local currency at the time of payment. In effect, the economy experienced an informal currency changeover ("dollarization") (Galdino & Leiderman, 2005; Melvin & Peiers, 2007).

In this regard the real estate market was no exception: dollar-denominated sale and rental contracts became common. However, what began as a partial hedge against inflation (Bar-Nathan *et al.*, 1998) turned into a norm in the real estate market long after the economy stabilized in the second half of the 1980s (Teichman, 2010; Fisher, 2006). While denominated prices of other goods and services had already returned to the sheqel, the real estate market sustained the dollar practice, where asking prices, negotiations, and closings were maintained in dollar terms. The year 1998 marked a turning point at which a de-dollarization process began and gradually permeated housing market transactions. A decade later, the sheqel finally completed its return to dominance of the real estate market.[1]

We employ this unique framework to explore the effect of currency changeover on housing prices. Psycho-economic literature suggests that the perception of a given price may be affected by a currency conversion. In particular,

[1] It is noteworthy that a legislative policy initiated by the parliament in June 2002 imposed sheqelization on *primary* real estate market transactions, where contractors were legally obliged to offer their merchandise in sheqels. Under this policy, however, *secondary* market transactions were not interfered with, and the discretion regarding the denominated currency by which the transaction was to be conducted was left to seller-buyer negotiation.

several studies have argued for a money illusion effect—a systematic bias in the price perception entailed by the currency-unit change (see, e.g., Soman, Wertenbroch, & Chattopadhyay, 2002; and Raghubir & Srivastava (2002) for laboratory evidence; and Del Missier *et al.*, 2007; Gamble *et al.*, 2002; Gamble, 2007; Marques, 2007; Cannon & Cipriani, 2006; Jonas *et al.*, 2002, and Kooreman, 2004, for empirical evidence on the euro changeover). Traut-Mattausch *et al.* (2004, 2007) further suggest an "illusionary price increase" that occurred in post-euro changeover Germany, and Tyszka and Przybyszewski (2006, 2007) propose the idea of a "psychological value" that people attribute to a given currency. Raaij and van Rijen (2003) also explore the misperception related to the "roundness" of the conversion ratio (see also related studies by Del-Missier *et al.*, 2007; Dzokoto, Young, & Mensah, 2010; and Amado *et al*., 2007). Interestingly, while evidence shows perception effects of the currency changeover, it generally did not find an effect on prices (see also Brachinger, 2006; and Jungermann *et al*., 2007). Exceptions to this finding are observed in Mostacci and Sabbatini (2003), Mastrobuoni (2004), and Dziuda and Mastrobuoni (2009), who present evidence of a price effect of a currency transition.

Our investigation of the price effect of a currency changeover in the housing market is motivated by the dual-currency reference price that emerges during the currency transition period. The focus on reference prices follows the original study of Kahneman and Tversky (1979), who argued that decision makers are sensitive to losses and gains in relation to a reference point (rather than merely valuing the final outcome).[2] Studies have shown various points that may serve as references: among others, the expectation-based value (Koszegi & Rabin, 2006), the fair price (Thaler, 1985), peak prices (Baker, Pan, & Wurgler, 2012; Gneezy, 2005), and goals (Heath, Larrick, & Wu, 1999).[3]

[2] According to Kahneman and Tversky (1979), the reference point by which outcomes are considered to be gains or losses "can be affected by the formulation of the offered prospects and by the expectations of the decision-maker" (p. 274).

[3] Also see proposed price references in Winer (1986), Jacobson and Obermiller (1990), Krishnamurthi, Mazumdar, and Raj (1992), Rajendran and Tellis (1994), Briesch, Krishnamurthi, Mazumdar, and Raj (1997), Niedrich, Sharma, and Wedell (2001), and Eichenbaum, Jaimovich, and Rebelo (2011). Studies also show time-varying dynamics of reference points, where adaptation is more likely to occur in favorable situations than in unfavorable ones (see, for example, Ariely *et al.*, 2003; Barkan & Busemeyer, 2003; Gneezy, 2005; Arkes *et al*., 2008, 2010; Grant, Xie, & Soman, 2010; and Grant & Westerholm, 2012).

A number of studies further discuss the simultaneous existence of multiple reference points (Koop & Johnson, 2012; Wang & Johnson, 2009; Sullivan & Kida, 1995; and Lin *et al*., 2006), while others stress the role of reference points in the context of negotiations and bargaining (e.g., Blount *et al.*, 1996; and Bateman *et al*., 1997). Finally, within the real estate literature, Genesove and Mayer (2001) present evidence that the past purchase price serves as a reference for homeowners when reselling their properties (also see Anenberg, 2011; and Seiler, Seiler, & Lane, 2012), and Arbel, Ben-Shahar, and Gabriel (forthcoming) show how past price reduction rates in public housing sales serve as references in home purchase decisions under present reductions.

Finally, our empirical evidence on the ratchet price mechanism in the housing market under currency changeover is consistent with the concept of asymmetric reaction to changes in economic factors shown in other contexts. For example, Duesenberry (1952) finds that consumption asymmetrically reacts to changes in income; Weitzman (1980), Freixas, Guesnerie, and Tirole (1985), Ickes and Samuelson (1987), Litwak (1993), and Choi and Thum (2003) discuss the ratchet effect in employer production aspiration; Ezzamel and Watson (1998) and Bizjak (2008) find that executive compensation only tends to be updated upward; Solow (1980), Kuran (1983), and Shirvani and Wilbratte (1999) show various ratchet price mechanisms; and Khandani, Lo, and Merton (2009) discuss upward ratchet risk mechanism under the refinancing option system.

4. A DESCRIPTION OF THE SAMPLE

The raw sample includes the universe of all secondary housing market transactions in Israel over the period 1998–2008 (total of 478,100 transactions).[4] Our analysis focuses on the effect of currency changeover on housing transaction prices and relies on the classification of the observations into transactions that are originally dollar-denominated and those that are sheqel-denominated. Following the omission of error

[4] As noted earlier, in June 2002 sheqel-denomination was legally imposed on *primary* market transactions. We thus omit primary market transactions from the analysis—about 20% of the observations. Also, as our analysis includes monthly hedonic price estimations (see Section 4 below), we omit observations in local authorities with fewer than five monthly transactions—a total of about 5% of the observations.

reports, missing observations, and unclassifiable transactions, the final sample consists of 335,340 observations.

Table 1 includes summary statistics on the sample of transacted assets. As indicated in the table, the average (non-quality-adjusted) per-square-foot dollar price of originally *dollar*-denominated transactions, $P_{i,t}^{dollar}\ i \in D$, is 184 dollars (792 sheqels), while the average per square-foot dollar price of *sheqel*-denominated transactions, $P_{i,t}^{dollar}\ i \in S$, is 176 dollars (736 sheqels). Table 1 further indicates that the derived average implied transaction-based sheqel/dollar exchange rate of quality-adjusted assets, $\widehat{EX}$ (see a further description in the next section), was 4.50, while the average nominal sheqel/dollar exchange rate, *EX*, was 4.28. Figure 1 shows the nominal and the implied transaction-based exchange rates of quality-adjusted assets over the entire 1998–2008 period. Note that the implied transaction-based exchange rate is most often greater than the nominal exchange rate, thus providing a preliminary indication of the role played by exchange rate fluctuations in affecting prices under the currency changeover period.

Table 1 also presents information on the variables *DEPRECIATION*1 and *DEPRECIATION*2, denoting the depreciation in the sheqel value of the dollar measured in level and yield terms, respectively; and zero otherwise (i.e., when $EX_t > EX_{t-1}$). The average values of *DEPRECIATION*1 and *DEPRECIATION*2 are -0.034 and -0.007, respectively (respective standard deviations are 0.047 and 0.011). Similarly, *APPRECIATION*1 and *APPRECIATION*2 denote the appreciation in the sheqel value of the dollar in level and yield terms, respectively; and zero otherwise (i.e., when $EX_t > EX_{t-1}$). The average values of *APPRECIATION*1 and *APPRECIATION*2 are 0.028 and 0.008, respectively (respective standard deviations are 0.051 and 0.013). During the period under examination (1998–2008), the dollar depreciated (i.e., $DEPRECIATION1_t < 0$) in 48.8% of the periods and appreciated (i.e., $APPRECIATION1_t > 0$) in 43.9% of the periods.

Table 1 also presents summary statistics of dwelling unit structural and locational characteristics controlled in the analysis. They include the area of the dwelling unit in square feet (*AREA*), the number of rooms in the dwelling unit (*ROOMS*), the age of the structure at the time of transaction (*AGE*), a series of dummy variables representing the unit type (such as penthouse, duplex, detached, attached, and ground-level condominium apartment) (*TYPE*2-*TYPE*8, where the base group is a

condominium apartment). As indicated in the table, the typical housing unit is an 888-square-foot, 3–4-room condominium apartment in a 27-year-old structure at the time of transaction. Finally, locational controls include a categorical variable for the local authority where the housing unit is located (*AUTHORITY*), a periphery index (*PERIPHERY*), a socio-economic index (*SOC*) of the local authority where the housing unit is located, and the local authority rank in terms of population size (*POP*).[5]

We further employ a macro-level approach to assess the currency changeover effect on the rate of change in the housing price index (δHPI), controlling for macro-economic variables. Table 2 presents summary statistics for the macro variables. The variable $SHARE_t$ assesses the degree of penetration of the sheqelization process into the housing market by computing the periodical ratio of the number of originally sheqel-denominated transactions to the total number of transactions in the market. As further described in the next section, $SHARE_t$ is generated by our algorithm based on the roundness of the reported sheqel and dollar price of each transaction. It follows that the average value of *SHARE* is 0.535, with a standard deviation of 0.326 (see a further description of *SHARE* in the next section).

Finally, as presented in Table 2, the macro-level estimation controls for macro-economic variables, including the rate of change in the dollar-sheqel exchange rate (δEX), rate of change in the consumer price index (excluding housing) (δCPI), level-change in the short-term interest rate ($\Delta BOND$), level-change in the mortgage rate ($\Delta MORTGAGE$), level-change in unemployment rate ($\Delta UNEMPLOYMENT$), rate of change in average wage ($\delta WAGE$), rate of change in the cost of construction index (δCCI), square feet of housing construction completions (*COMPLETIONS*), and population growth rate (δPOP). It is noteworthy that, on average, the monthly rate of change in the sheqel-dollar exchange rate (δEX) was 0.05% (with a standard deviation of 2.04%); the monthly rate of change of the housing price index (δHPI) was close to

[5] The *SOC* index summarizes socio-economic characteristics of the local authority where the housing unit is located. They include financial resources of the residents, housing density and quality, holdings of home appliances, quantitative and qualitative motorization level, schooling and education, employment profile, and demographics. The *PERIPHERY* index indicates the accessibility of the local authority where the housing unit is located to employment areas and community services. For more on *SOC* and *PERIPHERY*, see Central Bureau of Statistics (2008, 2013).

0.3% (with a standard deviation of 1.0%); and the monthly inflation rate (excluding housing) (δCPI) was just below 0.2% (with a standard deviation of 0.5%).

5. TESTING FOR THE UPWARD RATCHET PRICE MECHANISM

We now turn to the assessment of whether exchange rate fluctuations entail a real price effect under currency changeover. Below we develop two statistical tests of the price effect of sheqelization, including micro- and macro-level approaches. Both tests follow a preliminary analytical step that includes the classification of the observations into originally dollar- and sheqel-denominated transactions as described below.

We assume that the currency used in denominating the closing price is the same currency in which the price negotiation was conducted. As we hypothesize in Section 2, if the seller were to dominate the transaction, she would opt for a sheqel (dollar) denominated transaction following a depreciation (an appreciation) in the value of the dollar so as to attain a favorable closing price. By the same token, if the buyer were to dominate the transaction, she would opt for a dollar (sheqel) denominated transaction following a depreciation (an appreciation) in the value of the dollar.

CLASSIFYING SHEQEL- AND DOLLAR-DENOMINATED TRANSACTIONS

Our micro-level transaction data contain closing secondary market transaction prices—each recorded in both sheqels and dollars, as they were reported by the sellers to the Israel Tax Authority.[6] These closing prices represent the end product of a price negotiation between sellers and buyers. The specific currency (dollar or sheqel) in which the transaction was originally conducted, however, is unobservable. A key preliminary step, then, is to recover the denominated currency of each transaction.

Table A1 in the appendix shows the principles of the algorithm by which we score the dollar and sheqel figures of each transaction according to the degree of

[6] Israeli law requires sellers to report on the sale transaction for tax purposes. The report includes both the sheqel and dollar price of the closing price and the closing date. Inspection of the recorded sheqel and dollar prices for each transaction shows that in 98.5% of the transactions, the ratio of these prices is equal to the daily nominal exchange rate (up to three digits after the decimal point) that was recorded on the date of the transaction. In only 0.8% of the observations, the ratio of the recorded prices was different by 10% or more from the daily nominal exchange rate (these cases were removed from the dataset).

"roundness" of the recorded price. We assume that a "rounder" price (in either sheqels or dollars) represents the currency that was actually employed in conducting the transaction (while the other was simply the one to which the closing price was converted at the reporting date). For example, if the recorded prices of a transaction were, say, 950,000 sheqels and 256,757 dollars (representing 3.7 sheqels per dollar), our algorithm would determine that the transaction was originally denominated in sheqels.[7] Table A2 in the appendix shows the distribution of the difference between the dollar and sheqel price classification scores per transaction. It follows that fewer than 12% of the observations ended up as indecisive cases and were omitted from the estimation (e.g., when the transaction price was 1,200,000 sheqels and 300,000 dollars, when 1 dollar was equal to 4 sheqels). Moreover, in more than 80% of the transactions, the classification was highly decisive (the score difference on the sheqel and dollar prices was greater than or equal to 1). In Section 7, we examine robustness of the results to more restrictive conditions in the classification algorithm.

Figure 2 shows the share of sheqel-denominated transactions over the 1998–2012 period. Note that the sheqelization process of the housing market exhibited three major phases. In the first (January 1998–August 2001), the share of sheqel transactions fluctuated around the 20% level with a moderate upward trend; in the second (September 2001–March 2007), the fluctuating share of sheqel-denominated transactions shifted to the 25%-50% level; and in the third (April 2008–September 2012), the share of sheqel-denominated transactions increased sharply to the 95% level and has maintained its complete domination of the market since.[8]

MICRO-LEVEL TEST

Consider the following model consisting of three structural equations:

[7] Essentially, as detailed in Table A1, our algorithm scores each price as a function of the number of zeros ending the price (in dollars and sheqels) and determines the currency originally denominated in the transaction as the one with the higher score (a greater number of zeros). If, however, the number of zeros in the dollar and sheqel prices is the same, then a "5" as a first non-zero digit on the right-hand side of the number breaks the tie. For example, if the dollar and sheqel prices of a transaction are 458,500 and 91,700, respectively (implying 5 sheqels per dollar), the algorithm determines an originally sheqel-denominated transaction. Finally, prices ending with digits repeating three times (such as "999") are scored as "000."

[8] As our derived $SHARE_t$ variable shows that 96% of monthly transactions from April 2008 to December 2012 were sheqel-denominated, we cannot estimate equation (2) for this time period (i.e., the post-currency changeover period). As noted in Section 3 above, we thus terminate the micro-level estimation in April 2008.

(1) $P_{i,t}^{sheqel} = \alpha_{0t} + \alpha_{1t} CHARACTERISTICS_{i,t} + \varepsilon_{1i,t}$ for all $i \in \{S\}$,

(2) $P_{i,t}^{dollar} = \beta_{0t} + \beta_{1t} CHARACTERISTICS_{i,t} + \varepsilon_{2i,t}$ for all $i \in \{D\}$,

and,

(3) $\widehat{EX}_{i,t} = \gamma_0 + \gamma_1 EX_t + \gamma_2 DEPRECIATION1_t + \gamma_3 APPRECIATION1 + \varepsilon_{3i,t}$ for all i,

where

(4) $$\widehat{EX}_{i,t} = \begin{cases} P_{i,t}^{sheqel} / \widehat{P}_{i,t}^{dollar}, & i \in \{S\}, \\ \widehat{P}_{i,t}^{sheqel} / P_{i,t}^{dollar}, & i \in \{D\}, \end{cases}$$

(5) $\widehat{P}_{i,t}^{sheqel} = \hat{\alpha}_{0t} + \hat{\alpha}_{1t} CHARACTERISTICS_{i,t}$ for all $i \in \{D\}$,

(6) $\widehat{P}_{i,t}^{dollar} = \hat{\beta}_{0t} + \hat{\beta}_{1t} CHARACTERISTICS_{i,t}$ for all $i \in \{S\}$,

(7) $DEPRECIATION1_t = \min(EX_t - EX_{t-1}, 0)$,

(8) $APPRECIATION1_t = \max(EX_t - EX_{t-1}, 0)$,

and where $\{S\}$ and $\{D\}$ are non-overlapping sets of all classified sheqel- and dollar-denominated transactions, respectively; $P_{i,t}^{sheqel}$ is the recorded sheqel price per square foot of asset i at the time of transaction t in the set of sheqel-denominated transactions, and $P_{i,t}^{dollar}$ is the recorded dollar price per square foot of asset i at the time of transaction t in the set of dollar-denominated transactions. ($P_{i,t}^{sheqel}$ and $P_{i,t}^{dollar}$ thus refer to assets in non-overlapping sets $\{S\}$ and $\{D\}$, respectively.) Also, *CHARACTERISTICS* is a matrix of asset physical-locational attributes—including the local authority where the dwelling unit is located, area in square feet, lot size, number of rooms, year of construction, structure type, and socio-economic and periphery indices of the local authority where the asset is located and its rank in terms of population size. The variable $\widehat{P}_{i,t}^{sheqel}$ in (5) is the projected quality-adjusted sheqel price per square foot of asset i, $i \in \{D\}$, based on the estimated parameters in equation (1) and, similarly, $\widehat{P}_{i,t}^{dollar}$ in (6) is the projected quality-adjusted dollar price of asset i, $i \in \{S\}$, based on the estimated parameters in equation (2). Hence, $P_{i,t}^{sheqel} / \widehat{P}_{i,t}^{dollar}$ in (4) is the ratio of the actual sheqel price of asset i, $i \in \{S\}$, over the projected dollar price of i, had it been originally dollar-denominated; and similarly, $\widehat{P}_{i,t}^{sheqel} / P_{i,t}^{dollar}$ is

the ratio of the projected sheqel price of i, $i \in \{D\}$, had it been sheqel-denominated, over the actual dollar price of i. Accordingly, $\widehat{EX}_{i,t}$ on the left-hand side of (3) represents the *implied transaction-based exchange rate* arising from sheqel- and dollar-denominated transactions [as derived by $P_{i,t}^{sheqel}/\widehat{P}_{i,t}^{dollar}$ and $\widehat{P}_{i,t}^{sheqel}/P_{i,t}^{dollar}$ in (4)], while EX_t on the right-hand side of (3) is the number of sheqels per one-dollar *nominal* exchange rate at time t. Also, the variables *DEPRECIATION*1 and *APPRECIATION*1 [as defined in equations (7) and (8), respectively] measure the depreciation and appreciation, respectively, in the sheqel value of the dollar, and equal zero in periods of appreciation and depreciation, respectively. Finally, α_{0t}, β_{0t}, and γ_0-γ_3 are estimated parameters, α_{1t} and β_{1t} are estimated vectors of parameters, and $\varepsilon_{1i,t}$-$\varepsilon_{3i,t}$ are random disturbance terms.

Equations (1) and (2) are two hedonic price equations, one for $i \in \{D\}$ and the other for $i \in \{S\}$, estimated monthly over the period January 1998–March 2008 [hence, a total of 123 estimations of each of the equations (1) and (2)].[9] We employ a difference-in-difference approach by estimating (1) and (2) and computing the projected price $\widehat{P}_{i,t}^{sheqel}$, $i \in \{D\}$, and $\widehat{P}_{i,t}^{dollar}$, $i \in \{S\}$, in equations (5) and (6), respectively. Specifically, by substituting the characteristics of every *dollar*-denominated (*sheqel*-denominated) asset into equation (5) [(6)], we produce a hypothetical *sheqel* (*dollar*) price for that asset had the transaction originally been denominated in *sheqels* (*dollars*). This allows us to then derive in equation (4) the implied transaction-based sheqel-dollar exchange rate by computing the ratios $\widehat{EX}_{i,t} = P_{i,t}^{sheqel}/\widehat{P}_{i,t}^{dollar}$ and $\widehat{EX}_{i,t} = \widehat{P}_{i,t}^{sheqel}/P_{i,t}^{dollar}$ for all $i \in \{S\}$ and $i \in \{D\}$, respectively.

Equation (3) essentially estimates whether, in post-depreciation (appreciation) periods of the sheqelization phase, dual-referenced sellers (buyers) exploit the prevalence of dual-currency reference prices to favorably negotiate for the pre-depreciation (appreciation) sheqel value of the dollar. The null hypothesis is that the coefficient on the control nominal exchange rate variable (γ_1) is equal to 1, whereas γ_2=0 and γ_3=0, implying no price effect of exchange rate variation under currency changeover. A negative coefficient on *DEPRECIATION*1 (γ_2<0), however, indicates

[9] The estimation of equations (1) and (2) ceases in March 2008, as following that date, there are insufficient monthly dollar-denominated transactions that allow the estimation of equation (2).

that sellers opting for a sheqel-denominated transaction when the dollar depreciates maintain a higher closing price. Similarly, a negative coefficient on *APPRECIATION*1 ($\gamma_3<0$) indicates that buyers opting for a sheqel-denominated transaction when the dollar appreciates achieve a lower closing price.

Moreover, two possible outcomes indicating asymmetric effects of depreciations and appreciations under currency changeover are of particular interest in the estimation of equation (3): (*a*) $\gamma_1=1$ and $\gamma_2<\gamma_3\leq 0$, implying that the transmission of changes in the sheqel/dollar exchange rate is more effective under dollar appreciations than dollar depreciations. In particular, $\gamma_1=1$, $\gamma_2=-1$, and $\gamma_3=0$ imply an upward ratchet price mechanism that associates with exchange rate fluctuations. As shown in Result 3 in Section 2 above, the latter case is consistent with a situation in which sellers exercise their superior power in the transaction to exploit the dual-currency reference prices under the currency changeover period to avoid (benefit from) the decreased (increased) sheqel price under dollar depreciation (appreciation) by opting for the pre-depreciation sheqel (dollar) reference price (again, see the intuition in Section 2 above); (*b*) $\gamma_1=1$ and $\gamma_3<\gamma_2\leq 0$ implying that the transmission of changes in the sheqel/dollar exchange rate is more effective under dollar depreciations than dollar appreciations. In particular, $\gamma_1=1$, $\gamma_2=0$, and $\gamma_3=-1$ imply a downward ratchet price mechanism that associates with exchange rate fluctuations. As shown in Result 4 in Section 2 above, the latter case is consistent with a situation in which buyers exercise their excess power in the transaction to exploit the dual-currency reference prices under the currency changeover period to avoid (benefit from) the increased (decreased) sheqel price under dollar appreciation (depreciation) by opting for the pre-appreciation sheqel (dollar) reference price (again, see the intuition in Section 2 above).[10]

MACRO-LEVEL TEST

Consider the following estimated equation:

[10] Note that our estimation of the price effect of currency changeover in the Israeli real estate market employs the universe of all housing transactions over the period 1998–2008. There is thus no concern about a sample selection bias in the dataset. Also, as our main focus is on the estimation of γ_2 and γ_3, any concern regarding the prevalence of an unobservable variable that, on the one hand, correlates with the transaction closing price (e.g., due to unobservable asset or seller attributes) and, on the other hand, associates with the particular currency (sheqel or dollar) that denominates the transaction, should be dismissed, as it would appear in either γ_0 or γ_1.

(9) $$\delta HPI_t = \theta_0 + \theta_1 \delta EX_t + \theta_2 DEPRECIATION2_t \times SHARE_t + \theta_3 APPRECIATION2_t \times SHARE_t + \vec{\theta}_4 CONTROL_t + \varepsilon_{4t},$$

where

(10) $$DEPRECIATION2_t = \min(\delta EX_t, 0);$$

(11) $$APPRECIATION2_t = \max(\delta EX_t, 0);$$

t is a time index; δHPI_t is the monthly rate of change in the housing price index; δEX_t is the monthly rate of change in the number of sheqels-per-dollar exchange rate; and $CONTROLS_t$ is a vector of macroeconomic variables that may correlate with housing price yields, including the rate of change in the consumer price index (excluding housing) (δCPI), level-change in the short-term interest rate ($\Delta BOND$), level-change in the mortgage rate ($\Delta MORTGAGE$), level-change in unemployment rate ($\Delta UNEMPLOYMENT$), rate of change in average wage ($\delta WAGE$), rate of change in the cost of construction index (δCCI), square feet of housing construction completions (*COMPLETIONS*), and population growth rate (δPOP). Also, the variables $DEPRECIATION2_t$ and $APPRECIATION2_t$ intend to capture the potential asymmetric price effect of exchange rate fluctuations, where $DEPRECIATION2_t$ ($APPRECIATION2_t$) equals δEX_t when the dollar depreciates (appreciates); and zero otherwise (note that *DEPRECIATION*2 and *APPRECIATION*2, unlike *DEPRECIATION*1 and *APPRECIATION*1, are measured in yields).[11] Finally, as described above, the variable $SHARE_t$ is the share of the originally sheqel-denominated transactions within the periodic total (sheqel- and dollar-denominated) housing transactions, θ_0-θ_3 and $\vec{\theta}_4$ are estimated parameters and estimated vector of parameters, respectively, and ε_{4t} is a random disturbance term.

[11] Results from the estimation of equation (9) are robust to replacing the variables that appear in yield change (*DEPRECIATION*2, *APPRECIATION*, δEX, and δHPI) with their respective level-change variables. The unreported outcomes can be obtained by request.

The variables *DEPRECIATION*2 and *APPRECIATION*2 in equation (9) are interacted with *SHARE* in order to capture the possible transition to a sheqel transaction of dual-currency reference price sellers and buyers when the dollar depreciates and appreciates, respectively, during the sheqelization period. In line with the intuition described earlier, $\theta_2<\theta_3<0$ ($\theta_3<\theta_2<0$) indicates an asymmetric price effect of exchange rate fluctuations under currency changeover, where dollar appreciations (depreciations) are more effectively transmitted into the sheqel closing price. In particular, $\theta_2<0$ and $\theta_3\geq 0$ ($\theta_3<0$ and $\theta_2\geq 0$) indicates the prevalence of a corresponding upward (downward) ratchet price effect.

6. RESULTS

Table 3 presents results of a regression that tests for a price effect of changes in the sheqel/dollar exchange rate under a currency changeover. Column 1 in the table shows the outcomes obtained from the estimation of equation (3).[12] It follows that the coefficient on the nominal sheqel/dollar exchange rate, γ_1, is positive and significant at the 1% level. Further, as expected, we cannot reject the hypothesis that γ_1 is equal to 1 (p=0.906), indicating that any change in the nominal sheqel/dollar exchange rate, *EX*, is translated into a parallel change in the implied transaction-based exchange rate, $\widehat{EX}$.

Moreover, empirical findings provide solid support for the presence of an upward ratchet price mechanism associated with exchange rate fluctuations during a currency changeover period. The coefficient on the *DEPRECIATION*1 variable, γ_2, is negative and significant at the 1% level. Specifically, the estimated coefficient on *DEPRECIATION*1 implies that a 1-unit decrease in the nominal sheqel/dollar exchange rate associates with a 1.108-unit increase in the implied transaction-based exchange rate. Further, we cannot reject the hypothesis that this coefficient (γ_2) is equal to -1 and to $-\gamma_1$ (p=0.678 and p=0.702, respectively). The coefficient on the *APRECIATION*1 variable, γ_3, is, however, insignificant. Considering, therefore, the net effect of the nominal exchange rate variable (*EX*) and the *DEPRECIATION*1 and *APRECIATION*1 variables, it follows that while a 1-unit increase in the sheqel/dollar

[12] The outcomes from the estimation of the hedonic equations (1) and (2) are not reported and are available upon request. We should note, however, that the average R^2 in the hedonic estimations is equal to 0.54, with maximum and minimum of 0.70 and 0.32, respectively.

exchange rate associates with a 1-unit increase in the implied transaction-based exchange rate, a 1-unit decrease in the exchange rate has no effect on the implied transaction-based exchange rate.

Column 2 in Table 3 reports on the outcomes from the estimation of equation (3) when *APRECIATION*1 is omitted. As is apparent, the results maintain (i.e., that γ_1=1, γ_2=-1, and γ_1=-γ_2 cannot be rejected with p=0.979, p=0.886, and p=0.887, respectively). Also, columns 3–6 in Table 3 present results from repeating the estimation of equation (3) (with and without *APPRECIATION*1) on the sample stratified by $i \in \{S\}$ and $i \in \{D\}$ (sheqel- and dollar-denominated transactions, respectively). As one can see, the results also maintain under this specification.[13]

Table 4 presents results of macro-level estimation of the asymmetric price transmission mechanism under currency changeover (as suggested by the outcomes of the micro-level estimation). The first and second columns display the full and stepwise regression outcomes, respectively, from estimating equation (9) for the period 1998–2008 employing the Prais-Winsten estimation procedure.[14] The findings once again provide support for the prevalence of the upward ratchet price mechanism under the sheqelization period. The coefficients on the *DEPRECIATION*2×*SHARE* and δEX variables (representing the interacted depreciation and exchange rate variables, respectively, during the currency changeover period) equal to 0.72 and 0.49, respectively; both are significant at the 1% level. Further, we cannot reject the hypothesis that these coefficients are equal to one another in absolute terms (p=0.173). The coefficient on *APPRECIATION*2×*SHARE*, however, is insignificantly different from zero (p=0.422). The result thus indicates that, while a 1% increase in the sheqel value of the dollar entails a 0.49% increase in the housing price index, a decrease in the dollar value has a zero net effect on housing prices (as the share of sheqel-denominated transactions in the market increases). That is, sellers effectively

[13] Only in column 5 in Table 3 (for the dollar-denominated transaction stratification) is the coefficient on *APPRECIATION*1 significant. Note, however, that even in this case, the coefficient on *DEPRECIATION*1 is significantly greater (in absolute terms) than that on *APPRECIATION*1 (p<0.001), implying a dominating effect of the former. Moreover, note that the coefficient on *APPRECIATION*1 in this case is positive, indicating that sellers, in fact, benefit from both appreciation and depreciation in the sheqel value of the dollar under the currency changeover period.

[14] We use Prais-Winsten estimation, as we cannot reject the prevalence of serial correlation [Durbin-Watson *d*-statistic(12, 124) = 1.868; lower than dU].

nullify the correlation between the housing price index and the exchange rate whenever the dollar depreciates in sheqel terms while maintaining the positive correlation when the dollar appreciates. Consistent with micro-level outcomes, macro-level results thus indicate that sellers exploit (buyers fail to exploit) the dual-currency reference price to attain a favorable price when the dollar depreciates (appreciates) during a currency changeover.[15]

Results of the macro-level estimation provide further evidence on the economic significance of the ratchet price mechanism. Given the fluctuations of the nominal exchange rate during the currency changeover period (January 1998–March 2008) and based on the estimation of equation (9), we compute the total net effect of *DEPRECIATION2*×*SHARE* on the housing price index. It follows that the ratchet price mechanism has prevented up to a 24% decrease in the housing price index that would have associated with dollar depreciations had sheqelization not prevailed in the market.

7. Does the Ratchet Price Mechanism Maintain After the Currency Changeover Is Completed?

In this section, we test whether the upward ratchet price effect is merely an artifact of a currency changeover period or, alternatively, a mechanism that maintains after the currency changeover is completed. We thus extend equation (9) such that

$$\begin{aligned}(9a)\quad \delta HPI_t = {} & \theta_0 + \theta_{1,1}\delta EX_t \times T1 + \theta_{1,2}\delta EX_t \times T2 + \theta_{2,1} DEPRECIATION2_t \times \\ & SHARE_t \times T1 + \theta_{2,2} DEPRECIATION2_t \times SHARE_t \times T2 + \\ & \theta_{3,1} APPRECIATION2_t \times SHARE_t \times T1 + \theta_{3,2} APPRECIATION2_t \times \\ & SHARE_t \times T2 + \vec{\theta}_4 CONTROL_t + \varepsilon_{5t},\end{aligned}$$

where $T1$ is a dummy variable that equals 1 for observations from January 1998 to March 2008 (the period over which $SHARE_t < 95\%$) and zero otherwise (i.e., observations from April 2008 to December 2012; effectively, post-currency changeover period when $SHARE_t \geq 95\%$); and $T2$ is a dummy variable that equals 1

[15] With respect to the control variables, results further show that, as expected, the interest rate on the one-year bond inversely correlates with housing prices.

for observations from April 2008 to December 2012 and zero otherwise (i.e., $T2$=1-$T1$). All other variables are as described above.

Columns (1) and (2) in Table 5 present the results of the estimation of equation (9a) for the full model and stepwise regressions, respectively. Note that, following this specification, the ratchet price effect disappears in the post-currency transition period. While the coefficients on $\delta EX \times T1$ and $DEPRECIATION2 \times SHARE \times T1$ are significant at the 1% and 5% levels, respectively, the coefficients on $\delta EX \times T2$ and $DEPRECIATION2 \times SHARE \times T2$ are insignificant (p-values are 0.999 and 0.965, respectively). Also, consistent with previous results, the coefficients on $APPRECIATION2 \times SHARE \times T1$ and $APPRECIATION2 \times SHARE \times T2$ are insignificant (p-values 0.236 and 0.987, respectively). Further, we cannot reject the hypothesis that the coefficients on $\delta EX \times T1$ and $DEPRECIATION1 \times T1$ in equation (9a) are equal to the coefficients on δEX and $DEPRECIATION1$, respectively, in equation (9) (p=0.804 and p=0.562, respectively). Results thus provide solid evidence for the disappearance of the upward ratchet price mechanism after the currency changeover is completed.

8. ROBUSTNESS TEST

The estimation of equation (3) reported above shows the prevalence of an upward ratchet price effect that is triggered by dollar depreciation under currency changeover. A key preliminary phase of the analysis, however, includes the distinction between transactions that are originally dollar-denominated and those that are sheqel-denominated. We assess the sensitivity of our evidence to the employed classification algorithm. Essentially, we now impose a stricter condition for the algorithm to decide on the currency in which a transaction was denominated. The description and the outcomes from the stricter algorithm are provided in Tables A1 and A2 in the appendix.[16] Using the stricter classification condition increases the rate of unclassified transactions to 23%.

Columns (1) and (2) in Table 6 present the outcomes from re-estimating equation (3) under the stricter classification algorithm with and without

[16] Essentially, the stricter classification condition requires that a score difference of no less than 1.5 is attained between the dollar and sheqel price classification.

*APPRECIATION*1, respectively, while columns (3)–(6) show the outcomes obtained from repeating this exercise while stratifying the sample into originally sheqel- and dollar-denominated transactions (again with and without *APPRECIATION*1). As one can see, outcomes are robust to these specifications. Particularly, the coefficients on *DEPRECIATION*1 and *EX* in equation (3) are significant at the 1% level and qualitatively maintain the results previously obtained. Also, the coefficient on *APPRECIATION*1 in equation (3) remains insignificantly different from zero.

Columns (3) and (4) in Table 4 further report the outcomes from re-estimating equation (9) when *SHARE* is computed under the stricter dollar and sheqel price classification algorithm. Again, the coefficients on *DEPRECIATION*2×*SHARE* and δEX in equation (9) are significant at the 1% level and qualitatively maintain the results previously obtained. In addition, the coefficient on *APPRECIATION*2×*SHARE* in equation (9) remains insignificantly different from zero. Finally, columns (3) and (4) in Table 5 report on the outcomes from re-estimating equation (9a) under the stricter classification algorithm. As one can see, outcomes are further robust to this specification. Our results are thus robust to the discussed sampling and test design issues.

9. SUMMARY AND CONCLUSION

This research provides empirical evidence of the prevalence of an upward ratchet price effect under currency changeover. The prolonged de-dollarization process of the Israeli real estate market under stable economic circumstances provides natural experiment conditions for empirically assessing the effect of a currency changeover on prices. The analysis employs all housing transactions in Israel over the sheqelization period of the market.

Micro- and macro-level findings indicate that over the currency changeover period, sellers exploit the fluctuations in the exchange rate between the old and the new currency by opting for a transaction in the currency that produces a favorable price. Specifically, we find that, while a 1% increase in the nominal sheqel/dollar exchange rate associated with a 0.49% increase in the housing price index, a 1% decrease in the sheqel-dollar exchange rate associated with a zero net effect on the housing price index. In other words, had the ratchet mechanism not prevailed, housing prices would have decreased by up to 24% over the currency changeover period. We further find that the upward ratchet price effect disappeared once the currency

transition process was completed. These results are robust to sample and model specifications.

Research findings thus provide real-world evidence concerning the effect of a currency changeover period on real prices, suggesting the important role of public policy measures that are designed to accelerate and truncate the currency transition phase.

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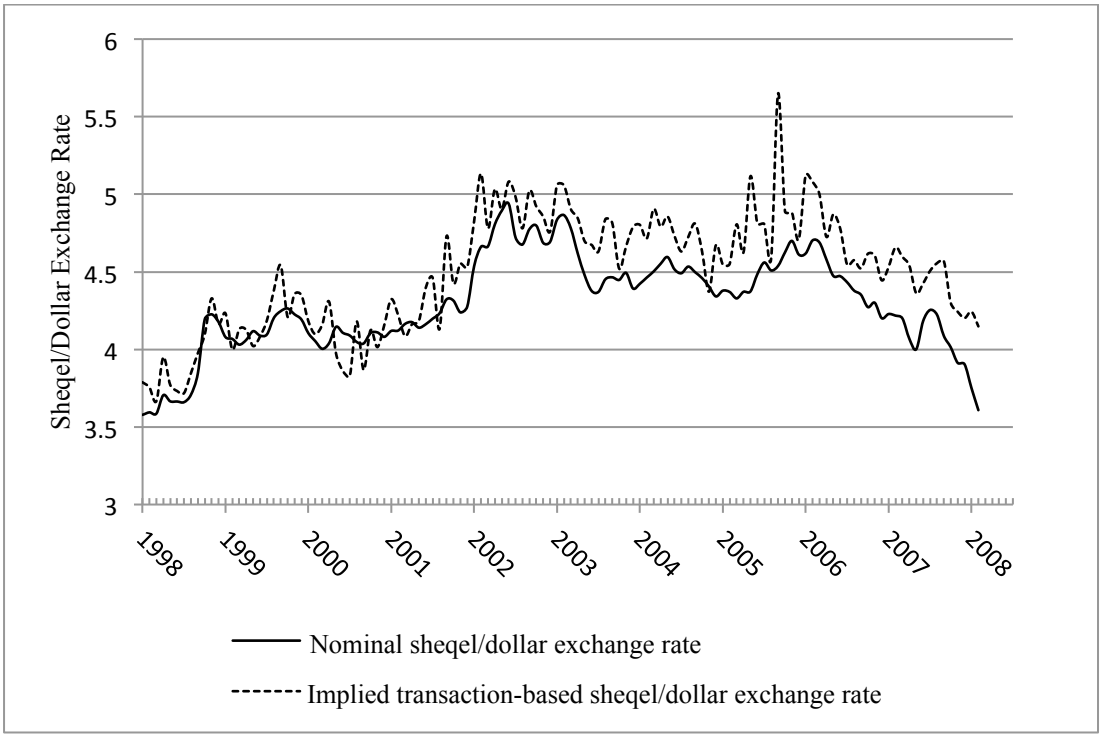
Figure 1: Nominal Exchange Rate and the Derived Implied Transaction-Based Exchange Rate of Quality-Adjusted Assets, 1998–2008



Note: The solid line represents the sheqels per one-dollar monthly average exchange rate (*EX*), whereas the scattered line represents the sheqels per one-dollar monthly average implied transaction-based exchange rate, $\widehat{EX}$.

Figure 2: The Share of Sheqel Denominated Transactions 1998–2012

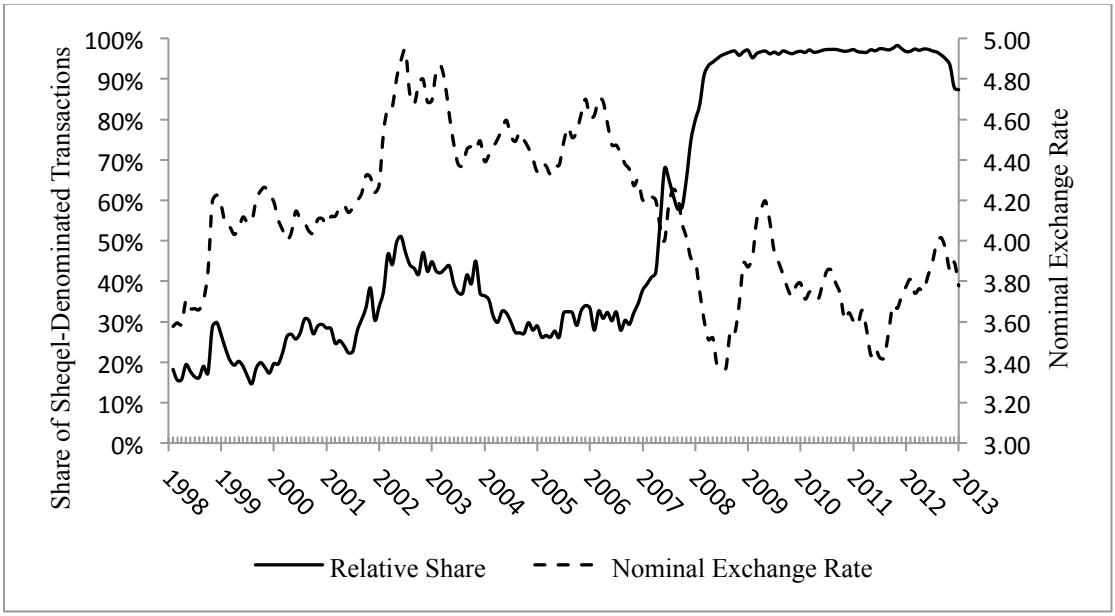


Table 1: List of Micro-Level Variables, Description, and Summary Statistics

Variable	Definition	Avg.	Std.	Min	Max
$P_{i,t}^{sheqel}\ i \in S$	The recorded *sheqel* price per square foot for *sheqel*-denominated transactions	736.41	382.61	35.35	8116.01
$P_{i,t}^{dollar}\ i \in S$	The recorded *dollar* price per square foot for *sheqel*-denominated transactions	176.26	95.12	8.10	2135.23
$P_{i,t}^{dollar}\ i \in D$	The recorded *dollar* price per square foot for *dollar*-denominated transactions	184.49	89.38	9.14	2217.00
$P_{i,t}^{sheqel}\ i \in D$	The recorded *sheqel* price per square foot for *dollar*-denominated transactions	792.95	384.42	37.33	9670.58
EX_t	The monthly nominal sheqel/dollar exchange rate	4.281	0.315	3.510	4.939
$\widehat{EX}_{i,t}$	The implied transaction-based sheqel/dollar exchange rate	4.509	4.917	-79.08	2074.78
*DEPRECIATION*1	$Min(EX_t - EX_{t-1}, 0)$	-0.0343	0.0477	-0.2183	0
*APPRECIATION*1	$Max(EX_t - EX_{t-1}, 0)$	0.0286	0.0511	0	0.3491
AREA	Floor area (in square feet)	888.6	329.1	322.9	2561.8
ROOMS	Number of rooms (including living rooms and bedrooms)	3.49	0.96	1.5	6.5
AGE	The age of the structure (in years) at the time of the transaction	27.6	28.1	1	208

Table 1 (Cont.): List of Micro-Level Variables, Description, and Summary Statistics

Variable	Definition	Avg.	Std.	Min	Max
D_Gross	Dummy variable equals 1 if *AREA* is reported as gross area (and net area is missing); 0 otherwise	0.0630	0.2430	0	1
*TYPE*2	Dummy variable equals 1 if the transacted property is ground level apartment; 0 otherwise	0.0101	0.0997	0	1
*TYPE*3	Dummy variable equals 1 if the transacted property is a penthouse; 0 otherwise	0.0053	0.0728	0	1
*TYPE*4	Dummy variable equals 1 if the transacted property is a duplex apartment; 0 otherwise	0.0038	0.0622	0	1
*TYPE*5	Dummy variable equals 1 if the transacted property is a townhouse; 0 otherwise	0.0136	0.1158	0	1
*TYPE*6	Dummy variable equals 1 if the transacted property is a style 1 attached unit; 0 otherwise	0.0256	0.1581	0	1
*TYPE*7	Dummy variable equals 1 if the transacted property is a style 2 attached unit; 0 otherwise	0.0219	0.1463	0	1
*TYPE*8	Dummy variable equals 1 if the transacted property is a detached unit; 0 otherwise	0.0060	0.0775	0	1
POP	The rank in terms of total population of the local authority in which the property is located (1 is the most populated)	15.86	17.17	1	80
PERIPHERY	The peripheral index of the local authority where the property is located	1.19	1.10	-3.01	2.73
SOC	The socio-economic index of the local authority where the property is located	5.72	1.57	0	9

Notes: $\{S\}$ and $\{D\}$ are non-overlapping sets of all originally sheqel- and dollar-denominated transactions, respectively; $\widehat{EX}_{i,t}$, the implied transaction-based exchange rate, is calculated as $P_{i,t}^{sheqel} / \widehat{P}_{i,t}^{dollar}$ for properties in $\{S\}$ and as $\widehat{P}_{i,t}^{sheqel} / P_{i,t}^{dollar}$ for properties in $\{D\}$.

Table 2: List of Macro-Level Variables, Description, and Summary Statistics

Variable	Definition	Avg.	Std.	Min	Max
δHPI	Monthly rate of change in the housing price index (CBS)	0.0028	0.0108	-0.0248	0.0382
δEX	Monthly rate of change in the sheqel/dollar exchange rate (BOI)	0.0005	0.0204	-0.0445	0.0911
DEPRECIATION2	$Min(\delta EX, 0)$	-0.0073	0.0107	0. 0445	0.0000
APPRECIATION2	$Max(\delta EX, 0)$	0.0079	0.0135	0.0000	0.0911
SHARE	The share of sheqel-denominated transactions in the market	0.5351	0.3264	0.1200	0.9900
δPOP	Monthly rate of change in the population (CBS)	0.0016	0.0003	0.0012	0.0028
$\delta WAGE$	Monthly rate of change of average wages per employee job (CBS)	0.0034	0.0375	-0.0767	0.1213
$\Delta BOND$	Monthly change in interest rates on the one year bond (BOI)	-0.0322	0.5710	-2.0931	2.5179
$\Delta MORTGAGE$	Monthly change in mortgage rate (BOI)	-0.0151	0.1537	-0.4100	0.5100
δCPI	Monthly rate of change in the consumer price index (excluding housing) (CBS)	0.0019	0.0053	-0.0140	0.0259
δCCI	Monthly rate of change in the construction cost index (CBS)	0.0030	0.0066	-0.0182	0.0283
$\Delta UNEMPLOYMENT$	Monthly change in unemployment rate (NII)	$-5x10^{-5}$	0.0008	-0.0026	0.0044
COMPLETIONS	Monthly housing construction completions (in millions of square feet) (CBS)	1129.2	243.3	614.0	184.6

Notes: The source of the series is in parentheses. CBS is the Israel Central Bureau of Statistics, BOI is the Bank of Israel, and NII is the National Insurance Institute of Israel.

Table 3: Regression Results for the Micro-Level Estimation of Equation (3)

	$\widehat{EX}_{i,t}$ for all i		$\widehat{EX}_{i,t}$ $i \in S$		$\widehat{EX}_{i,t}$ $i \in D$	
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.201*	0.190	0.758**	0.743**	-0.045	-0.067
	(0.118)	(0.118)	(0.347)	(0.346)	(0.061)	(0.060)
EX	0.996***	1.001***	0.843***	0.850***	1.061***	1.068***
	(0.027)	(0.027)	(0.080)	(0.079)	(0.014)	(0.0140)
*DEPRECIATION*1	-1.108***	-1.025***	-1.199**	-1.067**	-1.146***	-1.030***
	(0.195)	(0.180)	(0.589)	(0.515)	(0.103)	(0.095)
*APPRECIATION*1	0.203		0.350		0.251***	
	(0.183)		(0.545)		(0.090)	
N	335340	335340	103277	103277	232063	232063
p(F)	0.000	0.000	0.000	0.000	0.000	0.000
R^2	0.004	0.004	0.001	0.001	0.025	0.025
*APPRECIATION*1	Included	Not included	Included	Not included	Included	Not included

Notes: Table 3 presents the outcomes from the estimation of equation (3). Standard errors appear in parenthesis. One, two, and three asterisks represent significance at the 10%, 5%, and 1% level, respectively. Results for the complete sample are presented in columns (1) and (2) (titled $\widehat{EX}_{i,t}$ for all i); columns (3) and (4) provide results for sheqel-denominated transactions only ($\widehat{EX}_{i,t}$ $i \in S$); and columns (5) and (6) provide results for dollar-denominated transactions only ($\widehat{EX}_{i,t}$ $i \in D$). Columns (2), (4), and (6) provide estimation results of equation (3) while omitting *APPRECIATION*1 as an explanatory variable. Finally, the low R^2 values are expected, as the explanatory variables in equation (3) do not control for with-in period asset-specific characteristics.

Table 4: Prais-Winsten Regression Results for Macro-Level Estimation of Equation (9)

	Full Model	**Stepwise**	**Full Model**	**Stepwise**
	(1)	(2)	(3)	(4)
Constant	-0.003 (0.008)	-0.002** (0.001)	-0.003 (0.008)	-0.002** (0.001)
δEX	0.488*** (0.126)	0.410*** (0.058)	0.458*** (0.109)	0.406*** (0.056)
DEPRECIATION×SHARE	-0.719*** (0.248)	-0.662*** (0.175)	-0.676*** (0.224)	-0.659*** (0.168)
APPRECIATION×SHARE	-0.285 (0.354)		-0.225 (0.327)	
δPOP	-1.659 (3.103)		-1.625 (3.096)	
δWAGE	-0.007 (0.020)		-0.007 (0.020)	
Δ*MORTGAGE*	-0.002 (0.005)		-0.002 (0.005)	
Δ*BOND*	-0.002 (0.001)	-0.002* (0.001)	-0.002 (0.001)	-0.002* (0.001)
δCPI	0.120 (0.177)		0.119 (0.176)	
COMPLETIONS	0.002 (0.004)		0.002 (0.004)	
Δ*UNEMPLOYMENT*	1.000 (0.838)		0.989 (0.836)	
δCCI	0.002 (0.116)		-0.005 (0.116)	
t	$2x10^{-5}$ ($3x10^{-5}$)		$2x10^{-5}$ ($3x10^{-5}$)	
N	122	122	122	122
P(F)	0.0000	0.0000	0.0000	0.0000
R^2	0.44	0.42	0.45	0.42
D.W (transformed)	1.95	1.96	1.95	1.96
Time period	Jan98–March08	Jan98–March08	Jan98–March08	Jan98–March08
Classification	original	original	stricter	stricter

Notes: Standard errors in parentheses. One, two, and three asterisks represent significance at the 10%, 5%, and 1% level, respectively. Results for *DEPRECIATION×SHARE* and *δEX* are robust for omitting *APPRECIATION×SHARE*. Additionally, *APPRECIATION×SHARE* remains insignificant for re-estimating equation (9) omitting *DEPRECIATION×SHARE*. Presented outcomes are robust for using OLS rather than Prais-Winsten, estimation procedure (OLS outcomes are available upon request).

Table 5: Prais-Winsten Regression Results for Macro-Level Estimation of Equation (9a)

	Full Model	**Stepwise**	**Full Model**	**Stepwise**
	(1)	(2)	(3)	(4)
Constant	-0.006 (0.007)	-0.005*** (0.002)	-0.006 (0.007)	-0.005*** (0.002)
$\delta EX \times T1$	0.444*** (0.119)	0.357*** (0.051)	0.421*** (0.102)	0.356*** (0.049)
$\delta EX \times T2$	0.004 (2.466)		2.394 (7.617)	
DEPRECIATION2× *SHARE*×*T*1	-0.512** (0.241)	-0.362** (0.171)	-0.481** (0.216)	-0.370** (0.168)
DEPRECIATION2× *SHARE*×*T*2	-0.114 (2.588)		-2.540 (7.731)	
APPRECIATION2× *SHARE*×*T*1	-0.401 (0.337)		-0.358 (0.309)	
APPRECIATION2× *SHARE*×*T*2	-0.041 (2.548)		-2.460 (7.718)	
δPOP	-0.361 (3.048)		-0.355 (3.035)	
$\delta WAGE$	-0.004 (0.014)		-0.004 (0.015)	
$\Delta MORTGAGE$	-0.001 (0.005)		-0.001 (0.005)	
$\Delta BOND$	-0.001 (0.001)		-0.001 (0.001)	
δCPI	0.178 (0.137)		0.176 (0.137)	
COMPLETIONS	0.002 (0.003)		0.002 (0.003)	
$\Delta UNEMPLOYMENT$	0.646 (0.646)		0.671 (0.649)	
δCCI	-0.064 (0.102)		-0.054 (0.103)	
t	$7x10^{-5***}$ $(2x10^{-5})$	$8x10^{-5***}$ $(2x10^{-5})$	$7x10^{-5***}$ $(2x10^{-5})$	$8x10^{-5***}$ $(2x10^{-5})$
N	179	179	179	179
p(F)	0.0000	0.0000	0.0000	0.0000
R^2	0.34	0.29	0.35	0.29
D.W (transformed)	1.93	1.94	1.93	1.94
Months included	Apr08–Dec12	Apr08–Dec12	Apr08–Dec12	Apr08–Dec12
Classification	original	original	stricter	stricter

Notes: Standard errors in parentheses. One, two, and three asterisks represent significance at the 10%, 5%, and 1% level, respectively. The presented outcomes are robust to the omission of $\delta EX \times T2$ (available by request).

Table 6: Regression Results for the Micro-Level Estimation of Equation (3) Under the Stricter Classification Condition

	$\widehat{EX}_{i,t}$ for all i		$\widehat{EX}_{i,t}$ $i \in S$		$\widehat{EX}_{i,t}$ $i \in D$	
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.300**	0.129	-0.141	-0.238	0.409***	0.409***
	(0.136)	(0.209)	(0.693)	(0.687)	(0.089)	(0.088)
EX	0.965***	1.003***	1.022***	1.055***	0.949***	0.949***
	(0.031)	(0.047)	(0.159)	(0.156)	(0.020)	(0.020)
*DEPRECIATION*1	-0.654***	-0.817***	-2.161***	-1.72*	-0.573***	-0.574***
	(0.179)	(0.266)	(1.000)	(0.912)	(0.115)	(0.106)
*APPRECIATION*1	0.069		0.899		-0.001	
	(0.155)		(0.847)		(0.101)	
N	228346	232992	59891	59891	167991	167991
p(F)	0.000	0.000	0.000	0.000	0.000	0.000
R^2	0.004	0.002	0.001	0.001	0.013	0.014
*APPRECIATION*1	Included	Not included	Included	Not included	Included	Not included

Notes: Standard errors in parentheses. One, two, and three asterisks represent significance at the 10%, 5%, and 1% level, respectively. Because the stricter classification condition reduces the number of observations in each time period, we estimate the results only for those periods in which the share of both sheqel and dollar transactions in the market is at least 20% (i.e., $0.2 \leq SHARE_t \leq 0.8$). Results for the complete sample are presented in columns (1) and (2) (titled $\widehat{EX}_{i,t}$ for all i); columns (3) and (4) provide results for sheqel-denominated transactions only ($\widehat{EX}_{i,t}$ $i \in S$); and columns (5) and (6) provide results for dollar-denominated transactions only ($\widehat{EX}_{i,t}$ $i \in D$). Columns (2), (4), and (6) provide estimation results of equation (3) while omitting *APPRECIATION*1 as an explanatory variable. Finally, low R^2 values are expected as the explanatory variables in equation (3) do not control for within period asset-specific characteristics.

Appendix

Table A1: Algorithm for Classifying the Originally Denominated Currency of the Transaction

Last 3 Digits of Price	Example: Price (in Sheqels or Dollars)	"Roundness" Score	Share of Recorded Sheqel Price	Share of Recorded Dollar Price
QZX	71,843	0	23.6%	54.4%
ZX5	71,845	0.5	6.1%	6.8%
ZX0	71,840	1	13.2%	5.4%
X50	71,850	1.5	2.7%	0.9%
X00	71,800	2	5.2%	0.9%
500	71,500	2.5	1.9%	3.2%
000	72,000	3	46.2%	27.4%
YYY	71,999	3	1.1%	0.9%
Total			**100%**	**100%**

Notes: X represents any digit different from "0" or "5"; Z and Q represent any digit; and Y represents any digit different from "0." The price (either sheqel or dollar) that receives a greater "roundness" score is assumed to be the price originally denominated in the transaction. The stricter algorithm requires that the currency that is determined as the one denominating the transaction receives a score of no less than 1.5 greater than the other currency.

Table A2: Distribution of the Difference between Dollar and Sheqel Price Classification Scores

Difference between Dollar and Sheqel Price Classification Scores for Same Transaction	Classification Type		Difference Distribution	
	Original	Stricter	1998–2012	1998–2008
3	Dollar-denominated transactions	Dollar-denominated transactions	9.4%	16.1%
2.5			5.6%	9.6%
2			9.7%	16.4%
1.5			2.2%	3.7%
1		Unclassified	3.8%	5.9%
0.5			1.9%	2.3%
0	Unclassified	Unclassified	11.8%	12.8%
-0.5	Sheqel-denominated transactions	Unclassified	2.2%	2.9%
-1			3.7%	5.1%
-1.5		Sheqel-denominated transactions	1.7%	1.8%
-2			5.6%	4.4%
-2.5			5.7%	3.1%
-3			36.6%	15.8%
Total			**100%**	**100%**

Notes: In each transaction the difference is calculated as the "roundness" score of the reported dollar price minus the "roundness" score of the reported sheqel price. The scores are calculated as presented in table A1.