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In November 2016 the Egyptian Pound went through a massive devaluation. A jump in prices followed, particularly for traded goods including food, and particularly in Rural Lower, Rural Upper and Urban Lower regions. Using data from the Central Bank of Egypt and the 2008–2015 Household Income, Expenditure and Consumption Surveys, we investigate the pass-through of exchange-rate changes to commodity prices across all regions and, through households' consumption and substitution patterns, the implications for households' cost of living and welfare. Predictions of the one-month and six-month impacts of the devaluation are made. Our results show that typically 4% of exchange-rate changes are passed to prices immediately, and cumulatively approximately 9% are passed over the six months after devaluation. Accounting for households' consumption patterns, we compute fixed-weight Laspeyres price indices and cost-of-living indices to compare the impact of the devaluation to a counterfactual scenario without it. We find that the cost of living of an average household rises by nearly 50%, and its expenditures would have had to rise by twice as much after the devaluation to maintain the 2015 real expenditures. These effects are higher among households in the poorest quintiles in all regions, according to all cost-of-living measures.

Keywords: Exchange rate pass through, inflation inequality, currency devaluation, food security, Egypt

JEL Classification: C43, E31, I31, O18

I. Motivation

In November 2016 Egypt went through a rapid large-scale devaluation of its currency exceeding 50% (refer to figure 1). A combination of factors led to this massive devaluation, including sharply dwindling foreign reserves and the country's desire to comply with IMF conditions for a new loan to the Egyptian government. This devaluation, from 8.78 to 17.63 to a dollar, came on the heels of sizable devaluations in January 2013 and March 2016.[1]

[1] Value of the Pound fell from 6.13 to a dollar in Mid-December 2012 to 6.95 in mid-May 2013 (or by 13.4%), with the bulk of the devaluation occurring in January 2013. In mid-March 2016, the Pound fell again, from 7.73 to 8.85 to a dollar (by 14.5%).

The devaluations of the Egyptian Pound were followed by spikes in inflation, particularly in food prices. In the spring of 2013 and 2016, prices jumped by approximately 15% year on year, and food prices by nearly 20% (refer to figures 1 and A1 in the appendix). Following the 2016 devaluation, inflation rates soared above 30%, while food prices shot up by over 40%. Inflation rates continued above 30% until the fall of 2017 and remain well above their pre-2016 levels since. This high increase in the cost of living is likely to have affected the poor the most since they spend over 50% of their incomes on food, the category that witnessed the highest price increases after the currency devaluations. This study aims to advance our knowledge in several ways: We use extensive and disaggregated data on product prices, input-output relations, and household budgets from multiple sources to study a major recent macroeconomic shock, the currency devaluation of November 2016. We use an advanced strategy to identify the distributional impacts for Egyptian households across geographic and economic dimensions, accounting for households' both direct and substitution welfare effects.

Namely, we try to answer the following questions: How are exchange rate fluctuations in the Egyptian Pound passed through to prices of various commodity groups? What implications do currency devaluations have for households' cost of living? Are these implications sensitive to the way the cost of living changes are computed, say by the Laspeyres' type CPI produced by the Central Agency for Public Mobilization and Statistics (CAPMAS) or by the true cost of living index? Did households in different regions and at different income levels experience different rates of cost of living changes as a result of the devaluations? What are the consequences for inequality and poverty? Answering these questions is crucial for a proper assessment of the monetary shock, and for implementing an effective and well-targeted fiscal response.

The rest of the study is organized as follows. The next section briefly reviews the history of exchange rates and inflation in Egypt, and the existing academic literature linking exchange rate fluctuations and cost of living. Sections III and IV describe our estimation methods and the data used. Section V presents the main results, and section VI concludes with policy implications and directions for further research.

II. Background and Existing Evidence

The Egyptian economy suffered from high inflation levels chronically in the 1980s and early 1990s. The lowest income groups faced the highest relative CPI increases (Zaghloul 1992).

Using true cost of living indices (TCLIs) for Egypt over 1967 to 1997, AlAzzawi (1998) concluded that it was the urban poor who fared systematically worse in terms of cost of living increases than other groups. It took strong and painful policy measures to bring inflation down in the second half of the 1990s. Inflation fell to modest levels in the early 2000s.

Following the floatation of the Egyptian Pound in 2003, however, the Pound depreciated (from 4.5 to 6.2 EGP/USD) and inflation for 2004 rose to near 12 percent. This led to welfare losses of an estimated 7.4 percent of household expenditures, disproportionally afflicted on the poor because of the sensitivity of food prices to exchange rates (Kraay 2007). Another devaluation took place in 2008, followed by a spike in inflation rate to double digits in the ensuing years. Due to the simultaneous international food price crises of 2007–2008 and 2011, food prices were affected the most over this period. The higher inflation rates persisted in much of the following decade, bringing large regional and socio-economic disparities in cost of living. The increases in food prices have been confirmed to cause particular harm to the poorest rural households (AlAzzawi 2017a,b). This is consistent with prior evidence that poor households tend to have relatively high expenditure shares in tradable commodities (Cravino and Levchenko 2015a,b), and that low-quality products they buy are more sensitive to exchange rate fluctuations than the high-quality variants (Antoniades and Zaniboni 2016; Auer et al. 2018). Currency depreciations have been found to cause households' 'flight from quality' toward lower-quality products, aggravating the problem (Burstein et al. 2005). Because of these tendencies, the cost of living of the poor is affected the most.

Our study is concerned with the most recent round of devaluation, in November 2016, when the Egyptian Pound lost more than 50% of its value. The scale and speed of this devaluation, coupled with the fact that it did not simply act to reverse appreciation in the currency over the previous years – the way the 2004 depreciation partially counteracted appreciation from the late 1990s (Kraay 2007) – make the 2016 devaluation potentially more damaging to vulnerable households' standards of living. This devaluation also happened at a time of already weak economic performance and political instability in Egypt following the 2011 uprising that toppled the 30-year rule of the Mubarak regime, the 2013 change of regime, and the ensuing crackdown on groups seen to pose a risk to Egypt's stability. A series of bombings targeting foreign groups during 2015–2017 have kept tourism flows from recovering to their pre-2011 levels, affecting both the private and public sectors, and weakening the capacity of the state to assist the poor.

Finally, the inflation induced by the devaluation has been coupled with a series of cuts in energy subsidies, together delivering the hardest blow to households who spent the highest share of their budget on necessities including food and energy.

III. Methods

Exchange rate pass through

Changes in the cost of living due to currency devaluation or other factors are notoriously hard to estimate because of several challenges. The first challenge is isolating the effect of currency exchange rates on prices from the effect of other factors. We start by examining the extent to which currency devaluation affected prices of various commodity groups across Egyptian regions, referred to as exchange rate pass-through. We use monthly consumer price index data for the 12 main commodity and service categories for all eight Egyptian regions between July 2008 and December 2017 to estimate exchange rate pass-through regressions disaggregated by commodity group and region.[2] These yield estimates of the exchange rate pass-through to prices of different types of goods and services, as well as their regional variation.

Specifically, the following empirical model is loosely adopted from Kraay (2007). The price of a commodity group i in region r and month t, P_{irt}, is modeled as a geometric average of the price of a non-tradable component P_{irt}^{N} and the price of a tradable component P_{irt}^{T}, that is, related to them through a first-order homogeneous exponential function: $P_{irt} = (P_{irt}^{N})^{\alpha_{ir}}(P_{irt}^{T})^{1-\alpha_{ir}}$. This is consistent with the technology for transforming traded goods and local goods into retail tradable goods being Cobb-Douglas (Burstein et al. 2005).

The non-tradable component covers both purely non-traded goods in the commodity group, as well as non-tradable factors used in distribution of traded goods. The tradable price component itself can be modeled as a weighted product of exchange rates E_t and a measure of production costs in Egypt's main trading-partner countries C_t, where E_t and C_t are weighted by commodity- and region-specific parameters δ_{1ir} and δ_{2ir}: $P_{irt}^{T} = E_t^{\delta_{1ir}} C_t^{\delta_{2ir}}$.

[2] The 12 broad categories are: food and non-alcoholic beverages; alcoholic beverages, tobacco and narcotics; clothing and footwear; housing, water, electricity, gas and other fuel; furnishings, household equipment and routine house maintenance; health; transport; communications; culture and recreation; education; restaurants and hotels; miscellaneous goods and services. Data on 59 disaggregated food and essential items' prices featured in household budgets are not available consistently at this time to be utilized. The eight regions are: Cairo; Alexandria; Suez Canal cities; Lower urban; Lower rural; Upper urban; Upper rural; Border region.

Using logarithmic transformation of P_{irt}, we would get an expression estimable by linear regressions. However, these regressions could yield spurious estimates because of expected non-stationarity or persistence in all variables (Campa and Goldberg 2005; Campa and González-Mínguez 2006; Burstein and Gopinath 2015). A consistent approach, particularly in models linking short-term effects among variables and in samples with limited time dimensions, is to first-difference all variables. Estimating the relationships among logged variables in first differences is an approximation to estimating a relationship among the growth rates of the original variables. We thus estimate the following reduced-form equation in growth rates (indicated by ·) using ordinary least squares regressions:

$$\dot{P}_{irt} = \alpha_{ir}\dot{P}^{N}_{rt} + \beta_{ir}\dot{E}_t + \gamma_{ir}\dot{C}_t + \dot{u}_{irt} \qquad [1]$$

where β_{ir} is related to $(1-\alpha_{ir})\delta_{1ir}$ and γ_{ir} is related to $(1-\alpha_{ir})\delta_{2ir}$. $\dot{u}_{irt}$ is a commodity-, region- and time-specific shock uncorrelated with $\dot{P}, \dot{E}, \dot{C}$. Following the exchange-rate pass through literature, we allow for delayed price adjustments to external factors, and we add distributed lags of $\dot{E}_t$ and $\dot{C}_t$ up to a six-month lag.

In equation 1, the domestic price component P^{N}_{rt} can be approximated from prices of purely domestically produced services weighted using their shares in aggregate consumption.[3] E_t is the trade-weighted exchange rate index computed using the exchange rates with Egypt's eighteen most significant trading partners, weighted by their import shares.[4] C_t are approximated using producer price indexes (PPIs) of the ten most significant importers to Egypt, again weighted by their import shares.[5]

Coefficients α_{ir}, β_{ir} and γ_{ir} can be estimated individually using ordinary least squares regressions. The estimated coefficients are expected to be consistent for the true effects given that the explanatory variables and their lags are exogenous in the regressions, the pass-through

[3] These are taken to be the following 14 commodity categories: clothes cleaning, repair and rental; shoe repair; outpatient services; hospital services; transport services; mail services; phone and fax services; culture and entertainment; cultural and recreational services; education; restaurants and hotels; catering; personal care; insurance. These categories account for 31.6% of households' spending on average. To validate our classification of nontradable commodities, we find that rural and lower-income households spend significantly higher shares of their expenditures on tradable categories (refer to table A2 in the appendix), in agreement with prior evidence.

[4] The currencies are: Australian Dollar, Bahraini Dinar, Canadian Dollar, Chinese Yuan, Danish Krone, Euro, Jordanian Dinar, Japanese Yen, Kuwaiti Dinar, Norwegian Krone, Omani Riyal, UK Pound Sterling, Qatari Riyal, Saudi Riyal, Swedish Krona, Swiss Franc, UAE Dirham, US Dollar. Chinese Yuan available since December 2007.

[5] China, Germany, Italy, Korea, Russia, Saudi Arabia, Spain, Turkey, Ukraine, US. These countries accounted for 54.7% of Egypt's imports in 2016.

regressions are dynamically fully specified, and the transformed variables have desirable properties including stationarity and weak dependence (refer to figure 2). Coefficients $\alpha_{ir}, \beta_{ir}, \gamma_{ir}$ can be interpreted as the percentage point changes in the growth rate of the price index ($\dot{P}_{irt}$) due to a one percentage point increase in the growth rate of nontradable-goods prices ($\dot{P}^N_{rt}$), growth rate of the trade-weighted exchange rate ($\dot{E}_t$), and growth rate of the price index in countries exporting to Egypt ($\dot{C}_t$).

The coefficients on $\dot{E}_t$ and its lags can be used to estimate the distributed-lag impacts of a one-time devaluation on the prices of goods i in regions r, say the immediate impact propensity in the month of devaluation (β_{ir}) or the long-run propensity six months after devaluation ($\beta_{ir} + \sum_{k=1,\dots,6} \beta^k_{ir}$ added up over the coefficients on all lags). These predictions are expected to be consistent for the true effects of even a large devaluation as long as the devaluation came about for exogenous reasons not related unduly to domestic factor prices or consumer demand conditions – as is the case with the large-scale November 2016 devaluation.

Finally, worth noting, despite the variable transformations, heteroskedasticity of unknown form may be a problem in the pass-through regressions due to the sporadic occurrence of large devaluations and the associated jumps in the variance of prices (as the Breusch-Pagan tests confirm). For this reason, coefficient standard errors are made robust to arbitrary heteroskedasticity.

Consumption substitution response to price changes

Price changes due to the devaluation, predicted in equation 1, are next applied to households' consumption baskets to estimate the welfare effects of the devaluation. A crucial challenge is that rising prices in a given basket of goods, as measured by the Consumer Price Index (CPI), do not accurately measure changes in the cost of living. This is most notably due to the well-known substitution effect. Quality improvement, introduction of new goods, and seasonal variation in prices within a year are other well-known challenges. More importantly in the case of developing countries, distinct demographic groups have vastly different consumption patterns. A single consumption bundle is a purely theoretical concept that may not describe anyone in the economy. Typical bundles consumed by different demographic groups are subject to different cost increases, particularly when individual prices are more or less sensitive to foreign exchange fluctuations. Accounting for housing cost inflation, and heterogeneity of housing and rent increases, across demographic groups is a related specific challenge (Fares 1997).

The fixed basket CPI does not differentiate the various demographic groups, while indexes accounting for heterogeneity across economic agents can produce different estimates of the cost of living changes across demographic groups. The True Cost of Living Index (TCLI), which measures the ratio of the minimum expenditures required to attain a particular utility level (standard of living) at two different sets of prices (as initially proposed by Konüs 1936), provides a solution to these challenges. TCLIs can be estimated using information on prices and consumption levels alone under simple assumptions about preference functions (Basmann et al. 1984, 1985a,b) and allow us to measure changes in cost of living under different price regimes, while holding the utility level of the consumer constant. AlAzzawi (2017a,b) examined regional and income disparities in cost of living changes in Egypt over the period 2008 and 2017 and found the disparities both between regions and across income levels to be substantial compared to the fixed basket CPI. The current paper will build on this research to isolate and examine the role of the 2016 devaluation in creating or exacerbating these disparities.

To estimate the welfare effect of the devaluation on households it is customary to calculate the compensating variation that would be needed to keep households at the same utility level after the devaluation induced price changes: $CV = e(p_1, u_0) - e(p_0, u_0)$. This compensating variation can be broken down into two estimable components, that due to the higher cost of the initial consumption bundle, and that due to the household's substitution into different commodities as a response to the price changes. The compensating variation can be approximated as follows

$$CV/_{e_0} \approx \sum {}^{(p_1 - p_0)w_0}/_{p_0} + 0.5 \sum w_0 \left[{}^{(x_1 - x_0)}/_{x_0} - \varepsilon_{xe} \sum \left(w_0 \, {}^{(x_1 - x_0)}/_{x_0} \right)\right] \left[{}^{(p_1 - p_0)}/_{p_0}\right] \qquad [2]$$

where w_0 is the share of each product category in households' baseline expenditures e_0, x_t is the consumption of each product category, ε_{xe} is the elasticity of consumption with respect to total expenditure, and the summations are over all product categories. Compensating variation could be estimated as a function of parameters and of a counterfactual change in prices only due to devaluation. To perform this calculation, however, we would need at least two household budget surveys that provide data on consumer expenditure patterns, one before and one after the devaluation[6].

To gauge the impact of devaluation on the welfare of different types of households we examine a counterfactual scenario absent the devaluation and compare that to the (actual) devaluation scenario. We calculate the increase in prices households would have faced if the devaluation had not taken place and compare it to the actual increase in prices they faced with the devaluation. The difference between the two gives a sense of how much worse the devaluation has been for these households. We begin by computing a Laspeyres-type price index similar to CAPMAS's CPI, but based on the 12 commodity groups for which we have price and expenditure data. A Laspeyres price index is a fixed weight index, where the base period consumption patterns are used as weights, to track price changes over time. It has the following general form:

$$I_{t,o} = \frac{\sum_{i=1}^{n} Q_{oi} \ P_{ti}}{\sum_{i-1}^{n} Q_{oi} P_{oi}} \text{ X } 100 \qquad [3]$$

where Q_{oi} is the quantity of good i consumed during the base period 0 and P_{oi} and P_{ti} are the prices of good *i* in periods 0 and *t*, respectively. To be comparable with CAPMAS's CPI series, we also use the weights derived from the 2008/2009 HIECS.

True cost of living across Egyptian regions and income groups

Rising prices as measured by the CPI do not accurately measure changes in the cost of living. A price index is a weighted average of prices, where the weight is fixed, taken to be the expenditure share allocated to each commodity in consumer expenditure budgets, either in the base year (which gives rise to a Laspeyres Index) or in the current year (which gives rise to a Paasche index). It is the changing relative cost of a fixed basket of goods. It thus serves its

[6] The HIECS (2018) data set was finally released by CAPMAS over the last few weeks and we have just received access to it last week. We have been working on the harmonization of the data with the previously available HIECS from 2008-2015. The latter had been processed and harmonized by ERF, while the HIECS 2018 was obtained from CAPMAS without the harmonization, data definitions, or most importantly, the English language labels that had been provided by the ERF versions of the older surveys. This has not allowed us to yet fully exploit the new data set. We are working on completing the translation and harmonization and will be revising the results in this paper further over the next few weeks to both use the new consumption weights in the TCLI calculations as well as the compensating variation calculations.

purpose well: to monitor the extent of price changes over time. Over time, however, consumers can vary their preferences and this can lead to a bias in the fixed weight CPI in terms of how well it gauges *cost of living changes*. It ignores substitutions due to price changes and changes in consumer preferences due, for example, to past consumption and habit formation. It may overestimate cost of living changes if people resort to substitution when prices rise. It may underestimate cost of living changes in the case of taste changes and habit formation (Heien and Dunn 1985; Lieu et al. 2008). These biases in the CPI can lead to inaccurate estimation of the true changes in the cost of living, and any economic variables that rely on it for indexing.

To accurately monitor changes in the cost of living, a "true" index of the cost of living, measured as the ratio of the minimum expenditures required to attain a particular utility level at two different price regimes (originally defined by Konüs 1936), is required. The true cost of living index proposed by Konüs (1936) compares "the monetary cost of two different combinations of goods which are connected solely by the condition that during the consumption of these two combinations, the general status of want-satisfaction (the standard of living) is the same" (Konüs 1936:10). Taking U° as the utility level of the base year and P° and P^1 as the prices of the base period and the current period, respectively, the true cost of living index for U° is thus:

$$C(P^1, U^\circ) / C(P^\circ, U^\circ) \quad [4]$$

where C(P,U) is the cost of attaining utility level U at the price vector P. Therefore, the Konüs-TCLI is defined for a specific utility function: it is 'true' in the sense that it is defined for price changes along a particular indifference curve that provides the same utility level, rather than a fixed bundle. There exists a separate 'true' cost of living index for each possible indifference surface (Diamond 1990, p.740).

The first challenge in calculating the TCLI is therefore to find a particular utility function that captures consumer preferences well. Second, in practice when calculating the parameters of the model, one has to make restrictions on the total number of model parameters given that the estimation has to be performed on a limited number of aggregated commodity groups. These complications have meant that in practice statistical agencies around the world, including CAPMAS, have resorted to fixed weight consumer price indices (CPI) to compute cost of living changes.

A very convenient form of utility function that rationalizes the construction of a TCLI is the Generalized Fechner-Thurstone (GFT) direct utility function. We follow AlAzzawi (2017b) and compute TCLIs based on the GFT direct utility function. The advantage of the GFT-based TCLI is that it can be easily calculated without making any restrictive assumptions about the preferences of consumers. It does not require statistical estimation of the parameters of a system of demand functions that fit a specific utility function and the TCLIs are therefore termed non-parametric. In addition, they have an important advantage in that the only data required for their estimation is the prices and expenditures for both the base and current periods.

The TCLIs based on the GFT utility functions (detailed derivation presented in AlAzzawi 2017b) are:

$$\text{GFT-TCLI (O)} = \prod_{i=1}^{n} (P_i^1/P_i^0)^{\,M_i^0/M^0} \qquad [5]$$

$$\text{GFT- TCLI (1)} = \prod_{i=1}^{n} (P_i^1\ /\ P_i^0)^{M_i^1/M^1} \qquad [6]$$

Where P_i^1 and P_i^0 are current and base period price levels, M_i is the expenditure on the *i*th commodity and M is the total expenditure in the period under consideration. The superscript 0 is for the base period and 1 is for the current period. Thus the non-parametric GFT-based TCLIs can be simply calculated from only price and expenditure data. Note that equation 5 is the same as the geometric average of relatives formula since the sum of the weights is 1. GFT-TCLI(0) is a TCLI where changes in taste between the base and the current periods are not considered. In the GFT-TCLI(l), these taste changes are taken into consideration. The difference between the two reflects the effect of changes in taste due to price changes.

IV. Data

The most detailed data for this study come from four Household Income, Expenditure and Consumption Surveys (HIECSs) spanning the years 2008/2009, 2010/2011, 2012/2013, and 2015. Unfortunately, at the time of our research, the 2018 HIECS data had not been released yet. The available HIECSs were collected by CAPMAS using nationally representative random samples from urban and rural Egypt, and were harmonized and made available by the Economic Research Forum (OAMDI 2018 a,b,c,d). The surveys provide data on the household-level expenditure shares that can be aggregated to the level of socio-economic groups to calculate the weights for each commodity subgroup in the cost of living index.[7]

The price data are from the CPI price series for the 12 main groups of commodities published by CAPMAS (various years) on a monthly basis for the period July 2008 to December 2017 for Egypt's eight regions: Cairo, Alexandria, Suez Canal cities, Urban and Rural Lower Egypt, Urban and Rural Upper Egypt, and the Border region.[8]

Official exchange rates for all available currencies are taken from the Central Bank of Egypt (2018). PPIs in all industrial activities in the ten countries with the highest import shares in Egypt are taken from the Federal Reserve Bank of St. Louis (FRB 2018). To get single measures of exchange rates and production costs across Egypt's trading partners, the country-specific exchange rates and PPIs are weighted by the partners' share in Egypt's imports in the respective years, taken from the World Integrated Trade Solution database (World Bank 2018c).

V. Results

As Section III described in detail, our analysis of the welfare consequences of currency devaluation involved four steps: estimating the exchange rate pass through regressions; predicting the price effects of the November 2016 devaluation for all individual commodity groups in all Egyptian regions; predicting the substitution effects in households' consumption patterns due to the price increases; and estimating the cost of living effects of the devaluation. This section presents the results of these respective estimations.

Exchange rate pass through

Tables 1 and 2 present the main results of the exchange-rate pass-through regressions, namely the immediate (same-month) and the longer-term (six-month) impact propensities of

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[7] The surveys were conducted during April 2008–March 2009, July 2010–June 2011, July 2012–June 2013, and throughout the year 2015. Data collection took place through bi-weekly waves (weekly in 2015), during which distinct groups of households were surveyed. However, the timing of interview of individual households is not reported. This is unfortunate, given that important events such as devaluations or the civil uprising took place during the time span of fieldwork. (Complicating the matching of expenditures and prices in the 2015 HIECS, households were re-visited in the second half of the year to survey their seasonal expenditures and consumption.)

[8] Data for older periods are only available at the annual level, and for the 12 main categories. Additionally, in 2010 CAPMAS changed the basket of goods used to collect the price data for the CPI, and hence the data for the earlier period are not directly comparable. CAPMAS did publish a comparable series going back to July 2008, but not for earlier time periods.

exchange rates on prices, indicated by the coefficients on $\dot{E}_t$ ($\widehat{\beta_{ir}}$), and the sum of coefficients on all monthly lags ($\widehat{\beta_{ir}} + \sum_{k=1,\ldots,6} \widehat{\beta_{ir}^k}$), respectively.[9] We find that, across all commodity groups and regions, the pass through of exchange rates is, on average, four percent within the first month, and nine percent over the six months after a one-time devaluation. When the Egyptian pound gets devalued by 100 percent (say, from 8.80 to 17.60 EGP/USD as in November 2016), domestic prices are predicted to rise by four percent immediately, and a further five percent over the next six months, relative to the counterfactual growth rate in the absence of the devaluation.

This pass through is highest and most significant for highly tradable goods such as food, alcohol, apparel and equipment, and lowest or even negative significant for domestically produced, non-tradable goods such as communication services, cultural services, medical services, education and utilities (housing, water, electricity, gas and fuel), and restaurants and hotels. The pass through is highest in the Rural Upper, Rural Lower and Urban Lower regions, and lowest in Alexandria and the Suez Canal cities. The impact on the all-commodity price index is positive and highly significant in all regions (except for a negative but insignificant estimated 6-month impact in Alexandria, refer to table 2). Over time, the impact evolves subject to different dynamic paths for different commodities and regions, as figure 3 illustrates.

Cost of living changes with and without devaluation: Regional disparities

Tables 3–6 present the main results of the calculation of three measures of welfare changes due to price changes induced by devaluation – the Laspeyres price index (henceforth LPI), TCLI(0) and TCLI(1). Table 3 shows this for the mean household by region, while tables 4-6 show the changes in the price index and the corresponding cost of living index in each quintile expenditure group.

In table 3, the top panel reports the values of the welfare indices for two months: December 2016,[10] 1 month after the devaluation, corresponding to the immediate effects predicted in Table

[9] Tables A3 and A4 in the appendix show the more complete results of the pass-through regressions including all coefficients and model measures of fit, for regressions run either by region or by commodity group. Regressions run by region *and* commodity group are available on request. In short, these extensive results agree with our expectations and results in Tables A3 and A4 quite well, as most coefficients on $\dot{P}_{rt}^N$, $\dot{C}_t$ and lags of $\dot{C}_t$ are positive and significant, and the coefficients on $\dot{E}_t$ are positive and significant in regressions of tradable goods (e.g., alcoexp, equipexp, foodbev), while they are often smaller or negative in regressions of non-tradable goods (e.g., commexp, cultexp, educexp, housexp, medexp).

[10] The official devaluation took place on November 4, 2016. Price data collected by CAPMAS are collected from the start of the month and therefore using the November price data for the immediate effect might bias the results

1; and for May 2017, 6 months after the devaluation, representing the long-term effect (Table 2). In columns 4-6 we report the actual LPI and TCLIs with the effect of devaluation incorporated in these indices. In columns 7-9 we report these indices after factoring out the impact of the devaluation using the coefficient estimates in Tables 1 and 2, respectively. The bottom panel of the table reports the percentage change in these indices between December 2016 and May 2017, making it easier to see the impact of the devaluation on prices and cost of living changes.

A few important observations are evident from table 3. First, there are wide disparities in price and cost of living changes between regions whether the devaluation impact is incorporated or not. When the impact of devaluation is taken into consideration, Cairo faced the largest increases in prices and cost of living followed by Rural Lower and Border regions.

The last three columns report the same indices once we factor out the impact of the devaluation and imply a significant impact of the devaluation on prices and cost of living that varied considerably between regions. For example, in Cairo, while prices increased by 18.6% between December 2016 and May 2017 with the devaluation impact, they would have only increased by 8.5% had the devaluation not taken place. The devaluation alone accounted for more than one-half of the observed increase in the LPI over this period. In Urban Lower Egypt prices would not have increased at all without devaluation over this period while cost of living might have actually declined. In the Canal cities and the Border region, the impact of the devaluation was the lowest, as predicted by the estimates in tables 1 and 2. Alexandria represents the only outlier in this respect with results suggesting that prices rose less with the devaluation than had it not occurred. This result is implausible. In fact, Alexandria's 6-month coefficient carries a large standard error, and the confidence interval indicates that the effect of currency devaluation on regional prices may be large negative or even large positive. It may also have to do with Alexandria's unique position and status as a port city relying on imports, and this may have bearing on consumers' preferences and their response to the currency devaluation. This peculiar result will be investigated further once the 2018 HIECS data on consumer expenditure becomes available.

Comparing the actual change in cost of living by both the TCLI(0) and TCLI(1) to their counterfactuals without devaluation also reveals the large and varying impact of the devaluation

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since it would have taken some time for the full effect of the devaluation to take effect given the lag in importing contracts.

by region. In Cairo, Lower and Upper Egypt (both urban and rural) the devaluation caused one-half or more of the observed increase in the cost of living. As mentioned above, the difference between TCLI(0) and TCLI(1) can be used to gauge the impact of the price change on consumer preferences. Clearly, price changes, both with the devaluation, and the counterfactual changes without, both have an impact on consumer preference as evidenced by the differences in the TCLI(0) and TCLI(1) indices. As theory indicates, there are instances where price increases can lead to substitutions that allow the consumers to maintain their utility levels while spending the same as before (such as in Rural Upper and Lower with devaluation), but in other regions, habit formation and dynamics under which previous consumption patterns dictate future purchases, price increases can actually lead to substitutions that raise the cost of living (all regions in columns 7-9 except Rural Upper and Border).

The main conclusion from Table 3 is that the impact of the devaluation on the mean households was significant, raising the prices they faced and their cost of living by a significant portion of the overall increase in these measures over the 6 month following the devaluation. The magnitude of these effects varies by region.

Income disparities in the welfare effect of the devaluation

Tables 4-6 present LPI and TCLI indices and their changes by income quintile. We began by calculating the mean consumption shares for each quintile and used those consumption shares to compute LPIs and TCLIs for each quintile. Results for the LPI in table 4 indicate that prices rose as much or more for the lower quintiles than for the highest quintile in all regions. In Cairo for example prices rose by 23.2% between December 2016 and May 2017 for the lowest quintile, while they rose by 16.4% for the highest quintile. After factoring out the impact of the devaluation it appears that most of those price increases were devaluation induced. The bottom quintile, for example, would have faced only a 9.3% increase in prices (just 40% of the actual increase observed over this period), while the top quintile would have faced an 8.3% price increase (about one-half of the increase they actual faced). Thus, the extent to which the devaluation affected price inflation also varied considerably by income level. The lowest quintiles were the hardest hit in most regions.

Similar conclusions can be drawn about the TCLIs by income quintile, presented in tables 5 and 6. The difference between the actual increase in cost of living (that includes the impact of the devaluation) and the counterfactual, had the devaluation not occurred, is in many regions largest by the TCLI(1) that is based on the variable preferences. This suggest that the poorest groups were the most adversely affected group by the devaluation. They would have faced a far lower cost of living increase had the devaluation not taken place. This could be due to a combination of changing preferences as a result of the rise in prices as well as previous consumption habits that might have forced them to give up some of the less essential items in order to keep on consuming their essentials.

Finally, we perform a simple exercise to gauge the real impact of the devaluation on different types of households. We ask by how much a household's nominal income would have to increase in May 2017 to keep that household at their 2015 ***real*** expenditure or income level. Table A5 reports these results for Cairo as an example. The top two rows report that actual total household expenditure and disposable income for the mean household in each quintile, and for the overall sample mean in 2015.

In the bottom panel we inflate these values by the LPI, and by the counterfactual LPI absent the devaluation, to get the household expenditure (income) level in May 2017 that would have kept that household at the same real expenditure (income) level as in 2015. With the observed change in prices including the devaluation impact, the mean household would have needed about 9,500 EGP more in May 2017 to stay at their 2015 expenditure level, and 11,600 EGP more to stay at their 2015 disposable income level. The counterfactual without devaluation would have required far lower increases: only 4,300 EGP in expenditure and 5,300 EGP in income. Thus over 50% (30%) of the "necessary" increase in expenditure (income) between 2015 and May 2017 to maintain the mean households' real level was due to the devaluation alone.

We also perform a similar analysis by income quintile. For all quintiles, 55% or more of the necessary increase in expenditure was due to the devaluation, except for the highest quintile where the share was 49%. The lowest quintile was hardest hit. The devaluation cost them 2,500EGP more for their expenditure than they would have needed without it. Similar trends also appear for the disposable income with the lowest quintile suffering the most from the devaluation-requiring 40% more income just to offset its impact while the top quintile only required 25% more income to maintain their real income level of 2015.

VI. Discussion

Our paper aimed to offer policy makers critical information on the pass-through of exchange rate shocks to the prices of various commodities, the resulting welfare burden on households, and its incidence across socio-economic groups. Taking the November 2016 large-scale devaluation as a case study, we estimated the distributed lag effects of the devaluation on the prices of major commodity groups across Egyptian governorates, and the consequences for households' consumption patterns and welfare. We identified socio-economic groups that were affected most adversely by the devaluation, in terms of income level and region of residence.

The results of our study offer policymakers an early estimate regarding the welfare impacts of the November 2016 devaluation. By identifying the welfare losses among the poorest households and by region, we hope to inform the policymaking agenda, and to spur discussion on how to channel public support to these groups in a targeted, effective manner. Our results can help to differentiate among the traditional means of intervention such as in-kind/cash transfers, subsidies, or trade instruments.

We found that typically 4% of changes in the Egyptian Pound exchange rate are passed through to consumer prices immediately, and cumulatively approximately 9% are passed through over the first six months after devaluation. This pass through is highest for highly tradable goods including food, apparel and equipment, and is highest in the Rural Upper, Rural Lower and Urban Lower regions of Egypt.

The November 2016 devaluation caused price changes that had substantial welfare effects through increases in the Laspeyres price index and cost of living indices of households across the entire income distribution. The effect of devaluation accounted for a significant portion of the overall increase in these measures in the six months following the devaluation. Moreover, the devaluation-induced price changes produced systematic disparities across households in different regions and at different positions in the income distribution. The magnitude of these effects was as high as 50% of the overall increase in prices in Cairo, and the Lower and Upper Egypt. Analysis into the impact of the devaluation on households at different positions along the income distribution revealed that by all measures the households at the bottom of the distribution fared worse, consistently facing a lager impact of the devaluation on the increases in the prices they faced and their cost of living compared to those at the top. This is on account of the high share of food in the poor households' expenditures. This raises a concern over food security in Egypt, and the potential role of in-kind transfers or indirect subsidies.

Our study followed well-accepted and robust methodologies, and led to results that have strong consistency properties and are statistically significant. Nevertheless, our discussion above points to several limitations and areas where research extensions would be invaluable. One, direct data on households' post-devaluation consumption patterns was not available. In a follow up study, we aim to use the 2018 wave of the HIECS to test our predictions and offer estimates based on real pre- and post-devaluation data. Two, an important policy question concerns the effect of the devaluation on the position of households relative to the poverty threshold, and their transition in and out of consumption poverty. Three, given our strong results about regional and income-quintile differentials of welfare effects, question arises regarding additional demographic dimensions of the incidence of cost burdens due to the devaluation. This includes household composition, such as sex, age and educational level of the household head. Four, the analysis should be undertaken by households' economic activity. This is important because currency fluctuations affect households' consumption and welfare not only through expenditures, but also their earnings and non-market activities. These extensions will provide more precise evidence regarding the distributional effects of the currency devaluation across the Egyptian population.

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Table 1. Impact propensities of exchange rate changes on prices, by commodity group and region

	All regions	Cairo	Alexandria	Canal cities	Urban Lower	Urban Upper	Rural Lower	Rural Upper	Border
All - CPI	.044***	.020**	.036**	.029***	.024***	.025***	.034***	.037***	.027***
(s.e.)	(.006)	(.008)	(.015)	(.008)	(.008)	(.008)	(.007)	(.008)	(.009)
foodbev	.045***	.026**	.038**	.032***	.027**	.025**	.034***	.042***	.023*
(s.e.)	(.006)	(.013)	(.015)	(.010)	(.012)	(.011)	(.010)	(.010)	(.012)
alcoexp	.084***	.055	.075**	.066**	.064*	.065**	.072**	.066**	.069*
(s.e.)	(.014)	(.037)	(.034)	(.031)	(.033)	(.031)	(.032)	(.030)	(.038)
appexp	.100***	.073***	.093***	.089***	.070**	.086***	.091***	.096***	.094***
(s.e.)	(.014)	(.026)	(.030)	(.026)	(.029)	(.025)	(.034)	(.025)	(.030)
housexp	.009*	-.006	-.002	-.001	-.002	.001	.006	.002	-.004
(s.e.)	(.005)	(.008)	(.015)	(.006)	(.008)	(.008)	(.008)	(.009)	(.008)
equipexp	.338	.040***	.059***	.048***	.066***	2.116***	.079***	.081***	.062***
(s.e.)	(.248)	(.015)	(.018)	(.015)	(.017)	(.178)	(.018)	(.018)	(.017)
medexp	-.015	.036***	.061***	.030***	-.502***	.030***	.031***	.019*	.015
(s.e.)	(.064)	(.012)	(.012)	(.011)	(.067)	(.011)	(.011)	(.010)	(.010)
tranexp	.124***	.116***	.124***	.115***	.115***	.117***	.098***	.105***	.116***
(s.e.)	(.008)	(.018)	(.024)	(.013)	(.016)	(.016)	(.012)	(.013)	(.014)
commexp	-.005	-.015	-.010	-.013**	-.018***	-.014**	-.013**	-.011*	-.016**
(s.e.)	(.004)	(.010)	(.011)	(.006)	(.007)	(.007)	(.006)	(.006)	(.007)
cultexp	-.003	-.05***	-.025	-.035*	-.037**	-.037**	-.016	-.010	-.030*
(s.e.)	(.011)	(.019)	(.027)	(.018)	(.017)	(.015)	(.016)	(.016)	(.016)
educexp	-.029***	-.07***	-.058**	-.058***	-.060***	-.058***	-.053***	-.048***	-.07***
(s.e.)	(.011)	(.023)	(.028)	(.021)	(.020)	(.020)	(.018)	(.018)	(.024)
restoexp	.033***	.019**	.073***	.020**	.018*	.008	.008	.003	.021***
(s.e.)	(.009)	(.008)	(.014)	(.009)	(.010)	(.012)	(.013)	(.017)	(.007)
miscexp	.024***	.004	.022	.018*	.020*	.015	.009	-.002	.011
(s.e.)	(.007)	(.011)	(.017)	(.010)	(.011)	(.010)	(.011)	(.012)	(.015)

Notes: Coefficients interpreted as same-month %-point changes in the growth rate of prices from a 1%-point change in the growth rate of exchange rates. Significant at * 10%, ** 5%, *** 1% two sided test using standard errors robust to arbitrary heteroskedasticity (in parentheses). Regression on all regions uses region-level population weights.

Table 2. Long-term propensities of exchange rate changes on prices, by comm. group and region

	All regions	Cairo	Alexandria	Canal cities	Urban Lower	Urban Upper	Rural Lower	Rural Upper	Border
All - CPI	.144***	.087***	-.018	.069**	.112***	.100***	.126***	.122***	.087***
(s.e.)	(.021)	(.021)	(.174)	(.033)	(.025)	(.021)	(.024)	(.023)	(.032)
foodbev	.217***	.179***	.072	.142***	.189***	.193***	.194***	.197***	.150***
(s.e.)	(.015)	(.034)	(.187)	(.046)	(.037)	(.033)	(.033)	(.033)	(.043)
alcoexp	.025	.512***	-.333	-.140	-.089	-.072	-.078	-.082	-.133
(s.e.)	(.162)	(.151)	(.298)	(.091)	(.082)	(.078)	(.084)	(.080)	(.098)
appexp	.097	.008	-.040	-.011	.009	.023	.267**	.027	-.006
(s.e.)	(.151)	(.059)	(.225)	(.073)	(.089)	(.056)	(.102)	(.056)	(.074)
housexp	-.018	-.024	-.092	-.040	-.024	-.038	-.036	-.045	-.050**
(s.e.)	(.013)	(.022)	(.110)	(.026)	(.023)	(.028)	(.025)	(.033)	(.025)
equipexp	.401*	.114***	.057	.103***	.146***	2.028***	.146***	.151***	.107***
(s.e.)	(.221)	(.035)	(.135)	(.043)	(.035)	(.218)	(.033)	(.034)	(.038)
medexp	.160	.047	.093	.012***	.574***	.055	.059*	.054	.005
(s.e.)	(.137)	(.035)	(.141)	(.044)	(.112)	(.034)	(.035)	(.036)	(.039)
tranexp	.128***	.082*	-.009	.064**	.090**	.093**	.098***	.098***	.106***
(s.e.)	(.021)	(.042)	(.202)	(.040)	(.040)	(.037)	(.034)	(.033)	(.035)
commexp	-.021*	-.040*	-.151	-.064**	-.048**	-.037**	-.040**	-.035*	-.061**
(s.e.)	(.011)	(.023)	(.120)	(.025)	(.019)	(.018)	(.018)	(.018)	(.024)
cultexp	.297***	.285***	.012	.285***	.263***	.188***	.267***	.239***	.150***
(s.e.)	(.029)	(.059)	(.305)	(.088)	(.054)	(.043)	(.048)	(.045)	(.055)
educexp	-.164***	-.25***	-.752**	-.319***	-.231***	-.220***	-.214***	-.204***	-.32***
(s.e.)	(.038)	(.076)	(.328)	(.100)	(.074)	(.073)	(.071)	(.071)	(.095)
restoexp	.055***	.049*	.079	-.024	.024	.016	-.012	-.019	.021
(s.e.)	(.018)	(.027)	(.167)	(.031)	(.029)	(.032)	(.036)	(.045)	(.030)
miscexp	.107***	.066*	-.132	.054	.086**	.091**	.057	.066	.051
(s.e.)	(.023)	(.037)	(.217)	(.045)	(.040)	(.035)	(.044)	(.044)	(.051)

Notes: Coefficients interpreted as six-month %-point changes in the growth rate of prices from a one-time 1%-point change in the growth rate of exchange rates. Significant at * 10%, ** 5%, *** 1% two sided test using standard errors robust to arbitrary heteroskedasticity (in parentheses). Regression on all regions uses region-level population weights.

Table 3: Laspeyres price index and inflation rates with and without devaluation, mean household by region

Region	Year	Month	Actual Laspeyres/TCLI, Jan 2010=100			Laspeyres/TCLI absent devaluation, Jan 2010=100		
			Laspeyres	TCLI (0)	TCLI (1)	Laspeyres	TCLI (0)	TCLI (1)
Cairo	2016	12	233	247	241	229	242	236
	2017	5	276	289	286	248	263	260
Alexandria	2016	12	253	270	261	244	260	251
	2017	5	285	303	289	341	335	331
Canal Cities	2016	12	248	254	249	241	247	242
	2017	5	279	283	274	269	273	270
Urban Lower	2016	12	249	254	256	256	259	267
	2017	5	283	284	284	256	257	257
Urban Upper	2016	12	250	262	259	240	245	241
	2017	5	281	292	286	257	261	259
Rural Lower	2016	12	253	256	253	245	247	244
	2017	5	291	295	287	263	267	264
Rural Upper	2016	12	261	272	266	252	262	257
	2017	5	295	305	296	269	278	274
Border	2016	12	278	287	269	270	278	261
	2017	5	319	328	303	299	306	287
Region			**Actual change in cost of living (%)**			**Change in cost of living, absent devaluation (%)**		
Cairo			18.6	16.9	18.7	8.5	8.6	10.4
Alexandria			12.7	12.5	10.7	39.5	29.0	32.1
Canal Cities			12.5	11.6	10.1	11.6	10.5	11.5
Urban Lower			13.3	12.1	10.9	0.0	-0.7	-3.8
Urban Upper			12.2	11.5	10.5	7.1	6.8	7.2
Rural Lower			14.9	15.4	13.6	7.4	7.8	7.9
Rural Upper			13.2	12.4	11.2	6.9	6.4	6.7
Border			14.5	14.2	12.8	10.7	10.0	10.2

Source: Authors' calculations based on 12 commodity groups and 2008 fixed expenditure shares. Expenditure shares for each region calculated from HIECS 2008/2009 as the mean expenditure share on each commodity group in that region.

Table 4: Laspeyres price index and inflation rates with and without devaluation, by quintile and region

			Actual Laspeyres* index, Jan 2010=100					Laspeyres* index absent devaluation, Jan 2010=100				
Region	**Year**	**Month**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Cairo	2016	12	233.3	234.6	234.1	234.1	227.9	228.2	229.9	229.3	229.7	224.4
	2017	5	287.4	283.5	281.2	279.0	265.2	249.5	249.7	248.7	249.4	243.1
Alexandria	2016	12	261.7	260.3	256.6	252.0	244.7	251.7	250.8	247.0	243.3	236.9
	2017	5	298.5	295.6	289.7	285.6	273.8	327.0	341.1	332.0	333.6	346.8
Canal Cities	2016	12	244.8	253.7	251.9	252.6	244.9	237.7	246.1	244.6	245.5	238.3
	2017	5	273.2	285.4	283.8	284.1	275.6	264.8	276.1	272.1	274.0	265.7
Urban Lower	2016	12	253.4	254.0	250.7	249.7	243.0	259.2	259.2	256.9	256.5	252.5
	2017	5	288.5	288.7	284.1	282.7	274.1	260.0	261.5	257.6	256.1	249.8
Urban Upper	2016	12	256.7	252.5	251.5	251.5	240.4	246.1	241.8	241.2	241.0	230.6
	2017	5	288.9	284.1	282.4	282.6	267.6	263.2	258.4	258.1	258.0	247.2
Rural Lower	2016	12	257.4	254.6	254.2	252.6	247.3	248.7	246.3	246.1	244.7	239.6
	2017	5	295.1	292.5	292.5	290.9	284.1	268.3	264.7	264.5	262.8	256.9
Rural Upper	2016	12	262.9	262.7	260.9	260.2	256.8	253.6	253.3	251.5	250.7	247.8
	2017	5	297.1	296.8	295.7	294.7	290.3	271.4	270.7	268.5	267.8	264.1
Border	2016	12	290.1	271.1	283.9	270.6	275.1	280.8	263.8	275.1	263.0	266.5
	2017	5	330.1	312.0	325.1	310.2	315.1	314.8	288.6	305.7	289.0	294.7

	Actual price inflation* (%)					Actual price inflation* absent devaluation (%)				
Region	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Cairo	23.2	20.8	20.1	19.2	16.4	9.3	8.6	8.5	8.6	8.3
Alexandria	14.0	13.5	12.9	13.3	11.9	29.9	36.0	34.4	37.1	46.4
Canal Cities	11.6	12.5	12.6	12.5	12.6	11.4	12.2	11.2	11.6	11.5
Urban Lower	13.9	13.7	13.3	13.2	12.8	0.3	0.9	0.2	-0.2	-1.1
Urban Upper	12.6	12.5	12.3	12.4	11.3	7.0	6.8	7.0	7.0	7.2
Rural Lower	14.6	14.9	15.1	15.2	14.9	7.9	7.5	7.5	7.4	7.2
Rural Upper	13.0	13.0	13.3	13.3	13.0	7.0	6.9	6.8	6.8	6.6
Border	13.8	15.1	14.5	14.6	14.5	12.1	9.4	11.1	9.9	10.6

Source: Authors' calculations based on 12 commodity groups and 2008 fixed expenditure shares. Expenditure shares for each quintile-region calculated from HIECS 2008/2009 as the mean expenditure share on each commodity group in that quintile-region.

Table 5: Cost of living index based on fixed expenditure shares, and its changes, with & without devaluation, by quintile & region

			Actual TCLI with fixed weights, Jan 2010=100					**TCLI with fixed weights absent devaluation, Jan 2010=100**				
Region	**Year**	**Month**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Cairo	2016	12	256.3	247.9	242.6	243.9	236.3	250.1	242.5	237.3	238.7	232.0
	2017	5	312.5	294.6	285.7	285.5	270.2	275.1	263.8	257.4	259.2	250.8
Alexandria	2016	12	273.8	270.0	280.4	253.1	253.3	263.2	259.9	269.0	244.4	244.6
	2017	5	311.5	305.4	317.0	284.1	281.6	326.7	330.7	341.8	308.7	320.8
Canal Cities	2016	12	261.5	259.3	259.1	260.2	246.7	254.0	251.9	251.7	252.9	239.8
	2017	5	290.9	289.5	289.7	290.8	274.9	281.3	279.1	277.5	279.7	264.5
Urban Lower	2016	12	260.3	254.4	254.7	255.7	241.9	264.9	258.0	259.2	260.7	248.4
	2017	5	293.5	285.6	285.4	286.7	269.2	263.3	258.0	257.9	258.4	244.4
Urban Upper	2016	12	280.4	264.2	261.6	259.1	244.5	262.1	247.0	245.1	242.2	228.2
	2017	5	315.2	295.2	291.5	288.8	269.5	280.4	263.4	261.5	258.5	243.7
Rural Lower	2016	12	263.3	258.9	256.6	252.5	244.3	254.3	250.3	248.1	244.3	236.5
	2017	5	302.8	298.7	296.6	291.8	281.2	274.4	269.8	267.7	263.3	254.2
Rural Upper	2016	12	283.3	278.2	267.8	264.4	259.3	272.8	267.8	258.0	254.7	250.1
	2017	5	319.2	312.9	300.9	296.6	290.1	291.2	285.3	274.2	270.5	265.0
Border	2016	12	326.9	272.6	283.9	272.1	283.7	315.8	265.3	275.2	264.2	274.4
	2017	5	375.4	310.7	323.1	309.5	324.6	352.7	288.9	302.4	288.6	302.3

	Actual Change in Cost of Living (%)					**Change in cost of Living absent devaluation (%)**				
Region	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Cairo	21.9	18.8	17.8	17.1	14.4	10.0	8.8	8.5	8.6	8.1
Alexandria	13.8	13.1	13.0	12.2	11.2	24.2	27.3	27.1	26.3	31.1
Canal Cities	11.2	11.6	11.8	11.7	11.4	10.7	10.8	10.3	10.6	10.3
Urban Lower	12.8	12.3	12.0	12.1	11.3	-0.6	0.0	-0.5	-0.9	-1.6
Urban Upper	12.4	11.7	11.5	11.5	10.2	7.0	6.6	6.7	6.8	6.8
Rural Lower	15.0	15.3	15.6	15.6	15.1	7.9	7.8	7.9	7.8	7.5
Rural Upper	12.7	12.5	12.3	12.2	11.9	6.7	6.5	6.3	6.2	6.0
Border	14.9	14.0	13.8	13.7	14.4	11.7	8.9	9.9	9.2	10.2

Source: Authors' calculations based on 12 commodity groups and 2008 fixed expenditure shares. Expenditure shares for each quintile-region calculated from HIECS 2008/2009 as the mean expenditure share on each commodity group in that quintile-region.

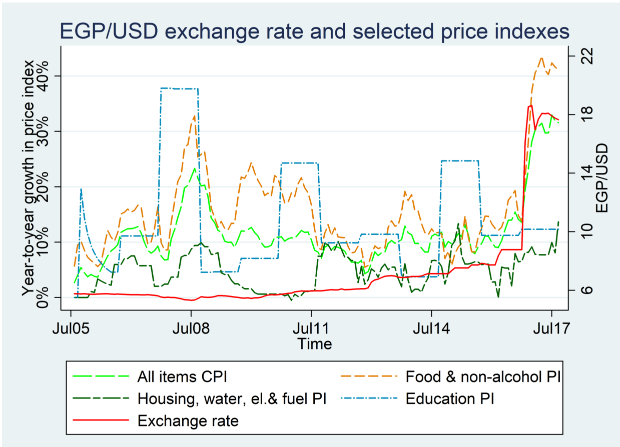
Table 6: Cost of living index based on variable expenditure shares, and its changes, with & without devaluation, by quintile & region

			Actual TCLI with variable weights, Jan 2010=100					TCLI with variable weights absent devaluation, Jan 2010=100				
Region	**Year**	**Month**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
	2016	12	252.5	246.2	238.6	240.8	227.1	245.8	240.5	233.0	235.9	222.9
Cairo	2017	5	310.9	302.1	283.0	288.0	260.4	272.7	268.6	255.7	261.2	243.8
	2016	12	287.9	270.4	259.0	256.1	247.7	275.7	259.6	248.9	246.3	238.8
Alexandria	2017	5	322.7	301.2	287.8	283.5	271.5	360.6	337.2	317.6	322.1	322.2
	2016	12	281.0	265.1	253.3	253.3	236.9	272.9	257.0	245.8	245.7	230.2
Canal Cities	2017	5	315.3	294.6	280.4	279.6	258.8	305.6	286.7	273.0	274.0	256.3
Urban	2016	12	270.3	261.3	258.1	252.1	243.7	284.3	269.8	266.4	262.6	256.9
Lower	2017	5	302.2	291.3	287.2	279.0	267.7	269.6	262.8	260.3	252.9	243.3
Urban	2016	12	268.3	259.1	259.4	252.9	242.3	250.6	241.2	242.1	235.6	225.4
Upper	2017	5	298.4	287.6	287.0	278.3	264.0	268.1	257.9	259.6	252.4	242.0
	2016	12	263.5	255.6	252.7	248.1	241.4	254.8	246.9	244.2	239.8	233.3
Rural Lower	2017	5	298.2	290.5	287.5	282.3	274.0	273.7	266.1	263.6	259.0	252.5
	2016	12	271.2	265.7	263.5	260.9	250.8	261.4	256.0	253.8	251.3	242.3
Rural Upper	2017	5	302.9	295.8	292.6	288.6	275.3	278.6	273.1	270.8	268.1	257.9
	2016	12	287.3	287.4	264.8	255.5	260.2	279.1	278.7	257.0	247.5	253.1
Border	2017	5	325.5	325.7	298.1	287.2	292.9	308.3	307.6	282.9	271.9	278.1

	Actual change in cost of living (%)					Change in cost of living absent devaluation (%)				
Region	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Cairo	23.1	22.7	18.6	19.6	14.7	10.9	11.7	9.7	10.8	9.4
Alexandria	12.1	11.4	11.1	10.7	9.6	30.8	29.9	27.6	30.8	34.9
Canal Cities	12.2	11.1	10.7	10.4	9.3	12.0	11.6	11.1	11.6	11.4
Urban Lower	11.8	11.5	11.3	10.7	9.8	-5.2	-2.6	-2.3	-3.7	-5.3
Urban Upper	11.2	11.0	10.7	10.0	9.0	7.0	6.9	7.2	7.2	7.4
Rural Lower	13.2	13.7	13.8	13.8	13.5	7.4	7.8	8.0	8.0	8.2
Rural Upper	11.7	11.3	11.0	10.6	9.8	6.6	6.7	6.7	6.7	6.4
Border	13.3	13.3	12.5	12.4	12.5	10.5	10.4	10.0	9.9	9.9

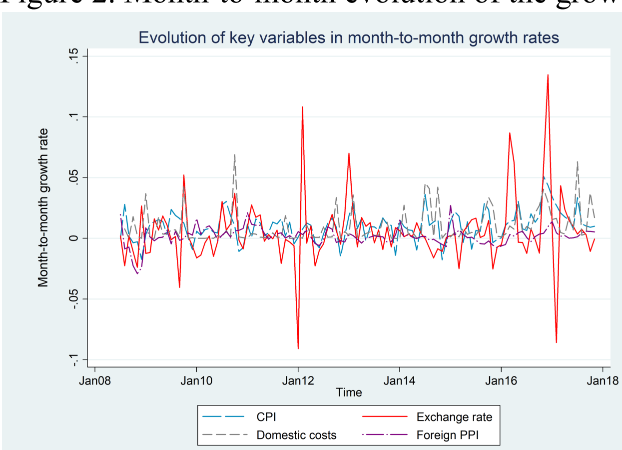
Source: Authors' calculations based on 12 commodity groups and variable expenditure shares. Expenditure shares for each quintile-region calculated from HIECS 2008/2009 as the mean expenditure share on each commodity group in that quintile-region.

Figure 1. Month-to-month evolution of the exchange rate, and selected CPI components (EGP/USD; % growth)



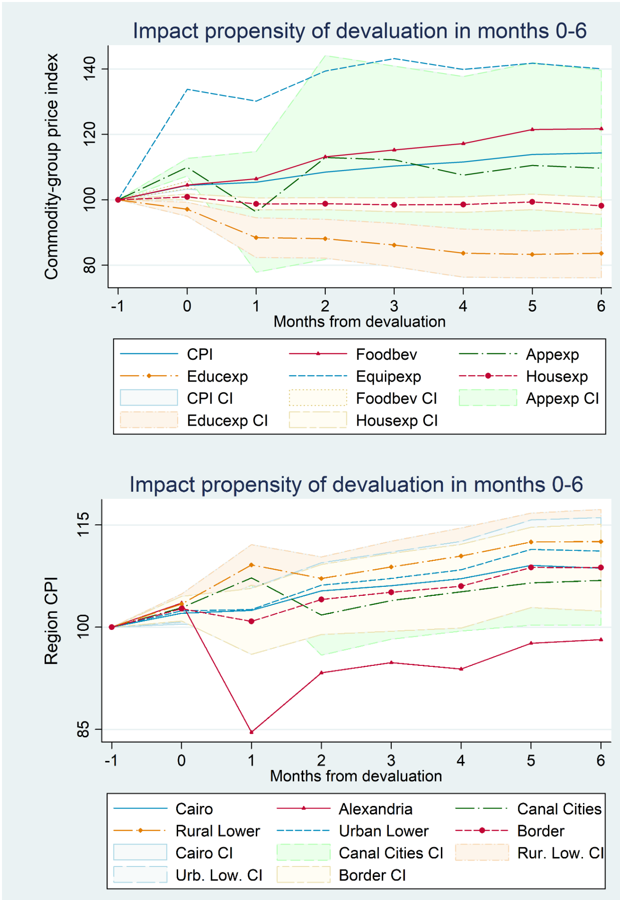
Notes: CPI components, year-to-year, are on the left axis; exchange rate on the right axis. CPI basket using base period 1999/2000. CPI basket changed in September 2007 (base period January 2007) and January 2010 (base period January 2010), and so prices are not entirely comparable between 07.05-08.07, 09.07-12.09, and 01.10.-09.17. Source: Central Bank of Egypt. CPI components available from July 2005.

Figure 2. Month-to-month evolution of the growth rates in key variables



Notes: Oct-Nov 2016 growth rate in exchange rate, of 0.807, is omitted for clarity of presentation.

Figure 3. Pass through of a 100% devaluation to CPI in the same month and over 6 months



i. By commodity group ii. By region

Notes: Suppose all commodity groups (and all regions) have CPI=100 in year t=-1. When EGP is devalued by 100% in year t=0, the impact on prices deepens over the next 6 months. Coefficients leading to these time trends are shown in tables 1–2, and A3–A4. Confidence interval for equipment price index (on average ±1.98×22.680 across the months 0–6) and Alexandria (on average ±1.98×16.094 across the months 0–6) are omitted for clarity of presentation of other results.

Appendix

Table A1. Data sources and summary statistics

Survey wave	Fieldwork	Source	Households	Mean expenditures per capita (st.dev.)[a]	Med. expend. per cap.
HIECS 2008/09	01.04.08-30.03.09	OAMDI 2014a[b]	23,428	3,249 (2,992)	2,516
HIECS 2010/11	01.07.10-30.06.11	OAMDI 2014b	7,719	3,780 (3,381)	2,943
HIECS 2012/13	01.07.12-30.06.13	OAMDI 2014c	7,525	3,911 (3,075)	3,068
HIECS 2015	01.01.15-30.12.15	OAMDI 2014d	11,988	5,221 (5,289)	4,024

[a] Converted to year-2012 purchasing-power parity international dollars (World Bank 2018a,b). Summary statistics account for household sampling weights and household size.
[b] ERF data are 30-50% random extractions from original HIECS surveys administered by Egyptian Central Agency for Public Mobilization and Statistics, which include 48,658 (HIECS 2008/2009), 26,500 (HIECS 2010/2011), 24,863 households (HIECS 2012/2013), and 23,976 (HIECS 2015).

Table A2. Tradable commodities' share of expenditures by hhd residence and income decile

	2008		2010		2012		2015	
Income decile	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
1	0.903[b]	0.880[ab]	0.839[b]	0.770[a]	0.831[b]	0.756[a]	0.826[b]	0.783[ab]
	(0.076)	(0.072)	(0.091)	(0.161)	(0.112)	(0.194)	(0.090)	(0.144)
2	0.879[b]	0.856[ab]	0.820[b]	0.777[ac]	0.798[d]	0.760[a]	0.790[d]	0.746[ab]
	(0.063)	(0.080)	(0.091)	(0.119)	(0.101)	(0.140)	(0.104)	(0.122)
3	0.864[c]	0.839[ac]	0.805[c]	0.758[a]	0.787	0.748[ad]	0.781[c]	0.725[a]
	(0.087)	(0.080)	(0.082)	(0.118)	(0.108)	(0.114)	(0.093)	(0.125)
4	0.858	0.832[ab]	0.790	0.748[a]	0.787[b]	0.730[a]	0.773[b]	0.715[ad]
	(0.077)	(0.085)	(0.099)	(0.110)	(0.086)	(0.123)	(0.096)	(0.130)
5	0.855[b]	0.818[ab]	0.788	0.743[a]	0.767	0.724[a]	0.757	0.705[a]
	(0.077)	(0.089)	(0.100)	(0.115)	(0.095)	(0.125)	(0.107)	(0.129)
6	0.845[c]	0.805[ab]	0.779	0.730[ab]	0.766	0.716[a]	0.753[b]	0.701[a]
	(0.083)	(0.094)	(0.096)	(0.116)	(0.101)	(0.129)	(0.098)	(0.125)
7	0.838[b]	0.792[ab]	0.771[b]	0.702[a]	0.759[b]	0.709[ad]	0.735[c]	0.685[ab]
	(0.086)	(0.109)	(0.091)	(0.135)	(0.116)	(0.148)	(0.106)	(0.133)
8	0.824[b]	0.770[ab]	0.743[c]	0.711[ab]	0.735[c]	0.691[ab]	0.719[b]	0.659[ad]
	(0.104)	(0.123)	(0.134)	(0.116)	(0.124)	(0.120)	(0.126)	(0.138)
9	0.808[b]	0.745[ab]	0.725[c]	0.683[ab]	0.717[b]	0.658[ab]	0.697[b]	0.661[ab]
	(0.122)	(0.133)	(0.140)	(0.137)	(0.130)	(0.156)	(0.143)	(0.145)
10	0.777	0.669[a]	0.687	0.609[a]	0.673	0.612[a]	0.648	0.562[a]
	(0.165)	(0.174)	(0.181)	(0.181)	(0.210)	(0.177)	(0.179)	(0.185)

Mean share (standard deviation) shown. [a] The difference of rural and urban means at any income decile is significant at the 1% level. The difference of means between an income decile and the following decile is significant at ([b]) 1%, ([c]) 5% or ([d]) 10%. The differences in means are tested assuming pairs of independent samples with equal variances, which appears satisfied for rural-urban pairs as well as pairs of income decile groups.

Table A3. Results of exchange-rate pass-through regressions: all commodity groups, by region

	All regions	Cairo	Alexandria	Canal cities	Urban Lower	Urban Upper	Rural Lower	Rural Upper	Border
$\dot{P^N}$	.202	.718***	.147	.621***	.648***	.663***	.610***	.571***	.595***
	(.147)	(.187)	(.144)	(.190)	(.196)	(.185)	(.194)	(.180)	(.199)
$\dot{E}_t$	.044***	.020**	.036**	.029***	.024***	.025***	.034***	.037***	.027***
	(.006)	(.008)	(.015)	(.008)	(.008)	(.008)	(.007)	(.008)	(.009)
$\dot{C}_t$	.136*	.102	.236	.084	.309	.169	.172	.255	.260
	(.082)	(.181)	(.215)	(.207)	(.211)	(.184)	(.235)	(.219)	(.221)
$\dot{E}_{t-1}$	.010	.004	-.190	.044***	.002	-.001	.057***	-.005	-.019
	(.017)	(.005)	(.210)	(.007)	(.009)	(.008)	(.009)	(.010)	(.016)
$\dot{E}_{t-2}$	.031***	.029***	.087*	-.054*	.036***	.030***	-.020***	.041***	.032***
	(.011)	(.003)	(.053)	(.028)	(.004)	(.004)	(.006)	(.005)	(.004)
$\dot{E}_{t-3}$	.019***	.007*	.015**	.021***	.010*	.009*	.017**	.011*	.011**
	(.003)	(.004)	(.007)	(.006)	(.005)	(.005)	(.007)	(.006)	(.005)
$\dot{E}_{t-4}$	.013***	.010**	-.009	.013**	.013*	.011*	.016**	.011	.009
	(.003)	(.005)	(.018)	(.005)	(.007)	(.006)	(.007)	(.007)	(.006)
$\dot{E}_{t-5}$	.023***	.019***	.038	.013	.030***	.026***	.021**	.029***	.028***
	(.004)	(.007)	(.023)	(.008)	(.010)	(.009)	(.010)	(.010)	(.009)
$\dot{E}_{t-6}$	.005	-.004	.005	.004	-.002	.000	.001	-.002	-.000
	(.003)	(.006)	(.006)	(.005)	(.006)	(.005)	(.006)	(.005)	(.006)
$\dot{C}_{t-1}$	.255**	.158	.173	.197	.102	.118	.291	.160	.093
	(.106)	(.202)	(.234)	(.258)	(.238)	(.236)	(.282)	(.280)	(.246)
$\dot{C}_{t-2}$	.046	.038	-.069	.089	.064	.114	.133	.116	-.005
	(.066)	(.189)	(.201)	(.195)	(.215)	(.180)	(.205)	(.192)	(.217)
$\dot{C}_{t-3}$	-.147*	-.074	-.067	-.126	-.068	-.093	-.216	-.113	.002
	(.076)	(.166)	(.207)	(.193)	(.207)	(.184)	(.209)	(.208)	(.214)
$\dot{C}_{t-4}$	-.125	.021	-.135	.024	-.048	-.027	.033	.008	-.101
	(.099)	(.173)	(.219)	(.187)	(.197)	(.176)	(.225)	(.215)	(.210)
$\dot{C}_{t-5}$	-.015	.154	-.057	.029	.176	.113	.049	.047	.073
	(.100)	(.183)	(.219)	(.183)	(.198)	(.185)	(.215)	(.204)	(.191)
$\dot{C}_{t-6}$	.172	-.193	.228	-.170	-.146	-.122	-.154	-.069	-.086
	(.125)	(.198)	(.189)	(.211)	(.231)	(.211)	(.244)	(.234)	(.218)
Constant	.004***	.001	.005**	.002	.001	.001	.002	.002	.002
	(.001)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
Observs.	816	102	102	102	102	102	102	102	102
R-squared	.307	.729	.239	.679	.657	.697	.659	.641	.629

Notes: Coefficients interpreted as %-point changes in the growth rate of prices from a 1%-point change in the growth rate of control variables. Significant at * 10%, ** 5%, *** 1% two sided test using standard errors robust to arbitrary heteroskedasticity (in parentheses). Regression on all regions uses region-level population weights. Regressions by region and commodity group available on request.

Table A4. Results of exchange-rate pass-through regressions: all regions, by commodity group

	foodbev	alcoexp	appexp	housexp	equipexp	medexp	tranexp	commexp	cultexp	educexp	restoexp	miscexp
$\dot{P}^N$	.186	.357*	.265*	.128	.137	.163	.236	.136	.344	.431	.336	.264
	(.133)	(.216)	(.157)	(.091)	(.107)	(.189)	(.159)	(.092)	(.240)	(.272)	(.223)	(.181)
$\dot{E}_t$	.045***	.084***	.100***	.009*	.338	-.015	.124***	-.005	-.003	-.029***	.033***	.024***
	(.006)	(.014)	(.014)	(.005)	(.248)	(.064)	(.008)	(.004)	(.011)	(.011)	(.009)	(.007)
$\dot{C}_t$	.386***	1.037***	-.089	-.100	-.447**	-.131	.003	.104*	-.426***	-.151	-.240	.264**
	(.133)	(.355)	(.248)	(.131)	(.198)	(.176)	(.086)	(.053)	(.090)	(.255)	(.154)	(.106)
$\dot{E}_{t-1}$	.019*	-.176**	-.137	-.022***	-.036	.183	.041***	-.021**	-.040**	-.087***	-.001	-.043**
	(.011)	(.081)	(.088)	(.007)	(.037)	(.128)	(.013)	(.008)	(.019)	(.027)	(.007)	(.019)
$\dot{E}_{t-2}$	.067***	.148	.166	.001	.092***	-.014	.011	.000	.033***	-.003	.024***	.061***
	(.005)	(.147)	(.130)	(.005)	(.007)	(.020)	(.009)	(.003)	(.008)	(.007)	(.007)	(.007)
$\dot{E}_{t-3}$	.021***	-.014	-.007	-.003	.038	.014	.051***	.000	-.010**	-.019***	.009	.047***
	(.004)	(.021)	(.020)	(.004)	(.026)	(.009)	(.004)	(.002)	(.005)	(.007)	(.006)	(.004)
$\dot{E}_{t-4}$	.020***	.033**	-.047***	.001	-.033*	.023	.011***	.003**	.037***	-.025***	.001	.004
	(.003)	(.013)	(.014)	(.004)	(.020)	(.014)	(.004)	(.002)	(.004)	(.006)	(.003)	(.005)
$\dot{E}_{t-5}$	.043***	-.026	.030*	.008	.019**	-.020	-.002	-.001	.025***	-.004	-.004	.015***
	(.005)	(.020)	(.016)	(.005)	(.009)	(.012)	(.005)	(.003)	(.009)	(.006)	(.007)	(.005)
$\dot{E}_{t-6}$	.002	-.024	-.008	-.012***	-.017***	-.012**	-.004	.002	.256***	.003	-.008	-.001
	(.004)	(.015)	(.014)	(.004)	(.006)	(.005)	(.004)	(.002)	(.016)	(.008)	(.005)	(.004)
$\dot{C}_{t-1}$	.472***	-1.405***	-.193	.063	.164	.302	.115	.060	.047	.045	.272	-.366***
	(.152)	(.489)	(.306)	(.128)	(.202)	(.295)	(.101)	(.076)	(.111)	(.220)	(.222)	(.124)
$\dot{C}_{t-2}$	-.001	.772**	-.079	.279**	.050	-.126	.280***	-.198***	.233**	.447*	-.722***	-.001
	(.126)	(.300)	(.131)	(.125)	(.166)	(.159)	(.087)	(.066)	(.101)	(.258)	(.194)	(.123)
$\dot{C}_{t-3}$	-.236*	1.108**	.583***	-.408***	.160	-.471***	.063	.035	-.331***	.014	.738***	-.358***
	(.129)	(.474)	(.143)	(.095)	(.104)	(.152)	(.068)	(.046)	(.089)	(.165)	(.173)	(.125)
$\dot{C}_{t-4}$	-.159	.550**	-.110	-.027	-.034	-.220*	.147*	.091**	-.074	-.529*	-.815***	.198*
	(.155)	(.246)	(.129)	(.089)	(.195)	(.117)	(.088)	(.042)	(.102)	(.270)	(.270)	(.120)
$\dot{C}_{t-5}$	.103	-1.424**	.062	.068	-.238	-.010	-.583**	-.143**	.115	-.022	.073	-.194*
	(.143)	(.635)	(.160)	(.105)	(.161)	(.118)	(.228)	(.062)	(.142)	(.169)	(.250)	(.103)
$\dot{C}_{t-6}$	.006	2.538***	.014	.177	.079	.274	.851***	.056	-.149	.485*	.658***	-.137
	(.147)	(.730)	(.144)	(.119)	(.154)	(.179)	(.317)	(.079)	(.196)	(.274)	(.228)	(.144)
Const.	.005***	.006**	.002	.003**	.003	.004**	.001	-.001	.001	.008***	.006***	.004**
	(.001)	(.003)	(.002)	(.001)	(.002)	(.002)	(.001)	(.001)	(.002)	(.003)	(.002)	(.002)
Obs.	816	816	816	816	816	816	816	816	816	816	816	816
R-sq.	.298	.176	.196	.096	.172	.182	.297	.155	.466	.150	.254	.207

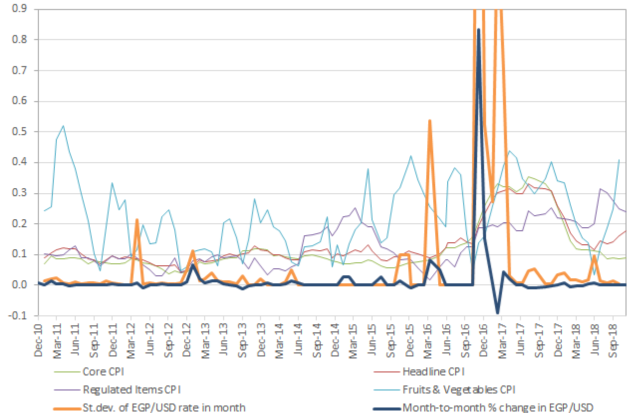
Notes: Coefficients interpreted as %-point changes in the growth rate of prices from a 1%-point change in the growth rate of control variables. Significant at * 10%, ** 5%, *** 1% two sided test using standard errors robust to arbitrary heteroskedasticity (in parentheses). Regressions use region-level population weights. Regressions by region and commodity group available on request.

Table A5: Example of Impact of devaluation on mean expenditures and disposable incomes by quintile, Cairo

		Q1	Q2	Q3	Q4	Q5	Mean
	Mean expenditure/disposable income 2015 prices						
	TOTEXP	18,078	26,631	33,059	41,371	94,142	50,855
	TOTDINC	22,053	31,977	35,169	47,987	120,543	62,445
	Inflated to May 2017 prices by						
TOTEXP	Laspeyres PI	22,273.81	32,176.22	39,711.32	49,305.37	109,564.84	60,337.81
	Laspeyres absent devaluation	19,765.27	28,926.22	35,861.21	44,928.95	101,987.68	55,178.62
	Difference in amount needed to stay at same EXPENDITURE with and without devaluation	2,508.54	3,250.00	3,850.11	4,376.41	7,577.16	5,159.19
TOTDINC	Laspeyres PI	27,171.07	38,635.26	42,245.08	57,190.35	140,292.04	74,089.16
	Laspeyres absent devaluation	24,111	34,733	38,149	52,114	130,590	67,754.16
	Difference in amount needed to stay at same INCOME with and without devaluation	3,060.08	3,902.40	4,095.76	5,076.30	9,702.16	6,335.00

Source: Authors' calculations based on 12 commodity groups and 2008 fixed expenditure shares. Expenditure shares for each quintile calculated from HIECS 2008/2009 as the mean expenditure share on each commodity group in that quintile.

Figure A1. Month-to-month fluctuation in the exchange rate, and selected CPI components



Notes: CPI inflation components (×100%) are annualized.
Source: Central Bank of Egypt. Harmonized CPI components available from January 2011.