Selected Research and Policy Analysis Notes

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This publication will also be published semiannually, and will include research analyses on various economic issues.

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ASSESSING THE EXPOSURE OF ISRAELI INDUSTRIES TO CHANGES IN THE EXCHANGE RATE[1]

- **The average exposure of the Israeli economy to changes in the exchange rate is close to zero. Within the economy, however, some industries are exposed to appreciation of the shekel, meaning that the profitability of their trade is harmed by appreciation, and others are exposed to depreciation.**
- **About 80 percent of workers are employed in industries that are exposed to depreciation—industries that have a larger exposure to the exchange rate on the expenditure side than on the income side. The intensity of these industries' average exposure to depreciation, however, is less than the intensity of the average exposure to appreciation among industries exposed to appreciation.**
- **The manufacturing industry, which employs about 10 percent of workers in the economy, is exposed to appreciation. The share of exports in manufacturing output is close to that of direct manufacturing imports (of inputs) and indirect imports (imported inputs used for the production of domestic inputs purchased by the industry). The source of the industry's exposure to appreciation, however, is the existence of significant competing imports that have a negative impact on the competitiveness of domestic producers in the domestic market during times of appreciation.**
- **The information and communications industry, which currently accounts for about 7 percent of employment, is exposed to appreciation due to the high share of exports in its output and the small amount of inputs that it imports.**
- **The exposure to appreciation of the manufacturing and the information and communication industries reflects a relatively high exposure to appreciation among high-tech firms in these industries. These industries' ability to set the dollar prices of their products, however, probably mitigates the effect of exchange rate changes on their total income.**
- **In contrast, the trade, construction, public services, and other service industries are exposed to depreciation because they import inputs but export almost nothing.**

A. Introduction

The protracted appreciation of the shekel in recent years and the recent acute exchange rate volatility call for a thorough examination of the effect of these processes on domestic industries that are exposed to these changes. Exposure to the exchange rate affects the profitability, and, in turn, the activity of various industries. For this reason, activity and employment in the economy at large are affected as well.

It is also important to understand the extent of different industries' exposure in order to learn about potential sensitivities of industries to significant changes in the exchange rate and the differential effect on various industries of policy changes that affect the exchange rate. The larger the difference between the share of

[1] Written by Eyal Argov, Gal Amedi, and Sigal Ribon.

tradable output in an industry's total output and the share of tradable inputs in its production costs, the more the industry's profitability is affected by the exchange rate

An industry is exposed to appreciation if, due to appreciation, its profitability falls in the short term, i.e., before companies in the industry respond with changes in prices (in foreign currency terms) or in quantities. The more tradable an industry's output (or product) is—whether the output is exported or faces competing imports—the more exposed the industry is to appreciation. This is reflected in a lower return on output (assuming the existence of a constant price in foreign-currency terms)[2] and in contraction of demand due to the lowering of price of competing imports.[3] In contrast, the larger an industry's share of imported inputs for the purpose of its activity, the more exposed the industry is to depreciation, making the inputs more expensive in domestic-currency terms and adversely impacting its activity.

An exposure to the exchange rate, however, does not necessarily mean that exchange rate changes will adversely impact an industry's quantitative output or employment. The response of activity to such changes depends on the initial rate of profitability, the extent to which firms' profitability is adversely impacted, firms' estimate of how transitory the impairment will be, and the way firms respond to the impairment—by changing their prices, if they can, and also by adjusting quantities. Importantly, too, the focus here is on exposure along channels of trade and not via other channels such as financing means or value of assets.

To examine the extent and the direction of various industries' exchange rate exposure, we calculated several simple indicators: the share of exports, of imported intermediates for the industry (direct and total—explained below), and of imports that compete with the industry's products (all of which as a share of industry output).[4] For this purpose, we used recently published input–output tables for 2014. We also produced two aggregate indicators: elasticity of the ratio of income to expenditure exposed to the exchange rate (an indicator of direct exposure to appreciation), based on the share of exports less the share of direct imports to the industry[5], and the total rate of industry exposure to appreciation, which also assigns, more leniently, weights to an industry's competing imports and indirect imports of inputs.[6] The more positive the elasticity or the total rate of exposure is, the more exposed the industry will be to appreciation—and, therefore, the more it will be typified by exposure to appreciation or, in the case of a negative value, exposure to depreciation.

2 The more firms in the industry have market power that allows them to set the foreign-currency price of their output, the less sensitive their income in shekel terms will be to exchange rate changes. (See also Appendix 2 at the end of this document.)

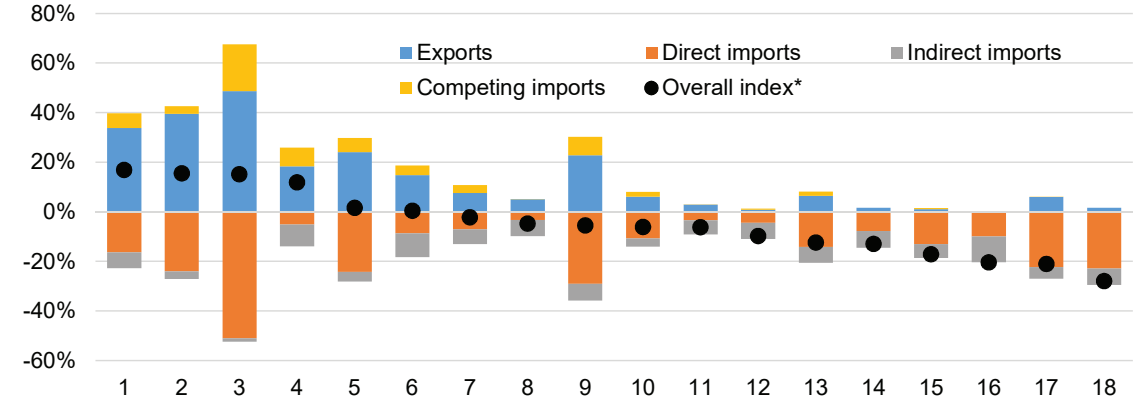
3 In a recent study, Brand and Barak (2022) found that appreciation does adversely impact manufacturing enterprises' domestic sales by increasing demand for competing imports. A. Barak and G. Brand (2022), "The Heterogeneous Effect of the Exchange Rate on Manufacturing Firms in Israel," Bank of Israel Research Department——Discussion Papers (Hebrew).

4 The ratio of competing imports to total output may be presented as the ratio of competing imports to output intended for the domestic market (i.e., not for export)—because in that case, the substitutability of imports for domestic production, multiplied by the share of output intended for the domestic market in total output, may take place. This obtains as long as some of the industry's output is intended for the domestic market, because otherwise, competing imports are irrelevant to the industry (in the short term). In a test that we performed, we found one such industry that produces nothing for the domestic market: diamond processing—which, however, does not face competing imports. In the other industries, at least 20 percent of output is intended to reach the domestic market.

5 See below and Appendix 2.

6 These are imported inputs that are not directly imported by the firm but are part of the production process of a local firm that is lower on the production chain, from which intermediates are purchased.

Figure 1
Overall Index* of Industries' Exposure to the Exchange Rate (+ is exposure to appreciation)**, and Contribution of Each Component** (Industry's weight in employment of Israelis appears in parentheses, July 2021–June 2022)



1- Mining and Quarrying (0.1%)
2- Information and Communication (7%)
3- Manufacturing (excluding diamonds) (9%)
4- Agriculture (1%)
5- Professional, Scientific, and Technical Activities (8%)
6- Accommodation and Food Service Activities (4%)
7- Administrative and Support Service Activities (4%)
8- Arts, Entertainment, and Recreation (2%)
9- Transportation, Storage, Postal, and Courier Activities (4%)
11- Real Estate Activities (1%)
12- Education (12%)
13- Wholesale and Retail Trade and Vehicle Repair (10%)
14- Other Service Activities (4%)
15- Human health and Social Work Activities (12%)
16- Construction (5%)
17- Electricity, Water, Sewage and Waste Management (1%)
18- Public Administration, and Social Security (10%)

* Competing imports and indirect imports of inputs have a coefficient of 0.5.
SOURCE: Based on Central Bureau of Statistics 2014 Input-Output Table and Labor Force Survey.

B. Exposure indices

B.1 Direct exposure index

Based on data concerning the share of exports and of imports in output and given its limitations, it is possible to estimate the direct exposure of various industries to the exchange rate. This was done by estimating the effect of exchange rate change on the ratio of the income of an average firm in the industry to the firm's direct expenditure as a rough indicator of the industry's added value. The elasticity of this ratio to the exchange rate[7] is the difference between the share of foreign-currency income in total output and the share of foreign-currency expenditure in total expenditure for each industry:[8]

Index for direct exposure = Exports/Output – (Direct import of inputs)/(Total expenditures)

The direct exposure is presented in Column (8) of Table 1 below. It is calculated, in accordance with the description above, as the difference between Column (3)—share of exports in output—and the product of Columns (4) and (7).[9]

The calculation of the direct exposure does not take account of changes in income due to changes in prices

7 Assuming that the other variables, particularly the foreign-currency prices of imported inputs and exports, remain constant.

8 A breakdown of the calculation is presented in Appendix 2.

9 The product originates in the need to switch from the share of imports in output (Column 5) to the share of imports in expenditure.

of competing imports when the exchange rate changes or the indirect purchase of imported inputs via other industries. Instead, it relates to expenditure on and income from a given quantity of output, a constant composition of inputs, and given domestic prices. Over time, exchange rate changes may affect the extent of activity also due to a change in demand because of changes in the relative prices of competing imports or of inputs purchased from other industries. Therefore, the analysis provided here pertains essentially to the short term.

B.2 Total index of industry exposure to the exchange rate

In order to calculate the total index of the rate of exposure to the exchange rate, we weight—in addition to export income and direct expenditure on imports, which we included in the direct exposure (elasticity) described above—the effect of indirectly imported inputs (which reduces costs in the event of appreciation) and the effect of competing imports on the industry (which negatively impacts competitiveness in the event of appreciation). While export income and direct expenditure on imports are fully weighted in the elasticity index, indirect imports of inputs and competing imports are assigned, on an ad hoc basis, a weight of 0.5. This reflects our awareness that not all the reduction in prices induced by appreciation is transmitted to domestic prices and that, in the event of competing imports, one may also presume that the substitution effect is not complete.[10] The total index—presented in Column (9) of Table 1 and in the black dots in Figure 1 below—is calculated on the basis of the following formula:

Total exposure index =Direct exposure + 0.5*(Competing imports)/(Output)

– 0.5*(Indirect imports of inputs)/(Total expenditure)

C. Findings of the study

C.1 Background

Figure 1 and Table 1 below summarize the results of our examination and present the determinants of each industry's total exchange rate exposure. The larger the positive value is, the larger will be the industry's exposure to **appreciation,** i.e., the extent of the industry's vulnerability to appreciation will be greater. Conversely, the larger the negative value is (in absolute terms), the greater the industry's exposure to **depreciation** will be. The black lines in Figure 1, present the total index calculated using alternative values (0.3/0.7) for the coefficient of indirect imports and competing imports, which were set ad hoc, as stated, to 0.5 in the basic calculation. As the figure shows, the range around the basic value is small and the use of other coefficients does not change the ranking of the industries significantly.

It is important to emphasize that the estimates relate to the average level of industry exposure. Variance exists within each industry, such that some companies (those with large-scale exports and small-scale imports of inputs) are adversely affected by appreciation while others (with small-scale exports and large-scale imports of inputs) profit from appreciation. The data in our possession, however, are not detailed enough to reveal the extent of variance in vulnerability of different companies within each industry to exchange rate change.

[10] The findings are not sensitive to the choice of weight, as is shown below.

C.2 Information and communication

Information and communication services, accounting for 7 percent of employment[11], are exposed to appreciation (16 percent for the total exposure index) because they export much of their output and have no meaningful dependency on imported inputs. Within the industry, the main exposure is borne by the high tech sub-industry, which includes software and information services—subindustries that account for 85 percent of the industry.

Taking a broader look at the exposure to appreciation of the entire high-tech sector[12] (including high-tech manufacturers, the bottom line in Table 1), we find what seems to be an acute exposure, higher than in any other main industry. Notably, other researchers found the response of these industries' real activity to the exchange rate to be relatively weak.[13] This, evidently, is because these industries' high rates of profitability allow them to absorb their exposure to currency changes and because the uniqueness of their products and the human resources they employ give them market power with which they can adjust their prices in foreign-currency terms. One of the arrangements that mirrors this power for many high-tech firms—and, particularly, for local centers of multinational firms, in accordance with arrangements with the parent companies—is that the local-currency income from exports of the local center is not dependent on the exchange rate in the short term.[14]

C.3 Manufacturing

The manufacturing industry, accounting for approximately 9 percent of employment, is acutely exposed to international trade. On average, it exports about half of its output and competing imports of manufactured products that reach Israel account for more than 20 percent of its domestic output. Contrastingly, however, its direct imported inputs for manufacturing claim a 50 percent share of its expenditure.[15] Thus, in the event of appreciation, its output value is adversely impacted but the cost of its raw materials falls.

Within the manufacturing industry, too, it is the high-tech sectors (pharmaceuticals, computer manufacturing) that are most exposed to appreciation due to their high share of exports. The average exposure of the rest of manufacturing is small due to its lower share of exports and higher share of imported inputs. (See breakdown in Table 1.)

[11] Shares of employment are calculated on the basis of the distribution of employment between July 2021 and June 2022.

[12] Our definition of high -tech industries resembles, but does not exactly overlap, that of the Central Bureau of Statistics. For details, see notes 3 and 4 in Table 1.

[13] Brand and Barak (2022) in regard to industry of high technological intensity, Table 2.2 in the Bank of Israel Annual Report for 2019, and Table 2.2 in the Annual Report for 2016 in regard to the service industries.

[14] This method is called cost-plus. According to this method, the operating costs of the local center of the multinational firm in Israel (mainly payroll) are covered by the parent firm, which also provides a fixed margin in shekel terms. Thus, in the near term, the local center's income is not contingent on the exchange rate.

[15] The product of Columns (4) and (7) in Table 1.

Table 1: Exports, imports, and exchange-exposure, by industries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(7)*(4)-(3)=(8)	(9)
	Industry	Industry share in employment (%)	Share of exports in industry output (%)	Share of direct imported inputs in output (%)	Share of total imported inputs in output (%)	Share of competing imports in output (%)	Output / industry expenditure (domestic inputs + imports)	Elasticity of income / expenditure ratio[1] (%)	Total industry exchange rate exposure index[2] (%)
	Database from year:	7/2021–6/2022	2014	2014	2014	2014	2014	2014	2014
A	Agriculture, forestry, fishing	1	18	3	11	15	2.0	13	12
B	Mining & Quarrying	0.1	34	6	10	12	2.9	17	17
C	Manufacturing (excl. diamonds)	9	49	33	35	38	1.5	-2	15
	High-tech[3]	2	72	25	28	27	2.0	21	31
	Excl. high-tech[3]	7	39	36	38	43	1.4	-12	8
D-E	Electricity, water, etc.	1	6	11	16	0	2.0	-16	-21
F	Construction	5	0	15	17	0	1.8	-10	-20
G	Trade, etc.	10	6	6	10	4	2.6	-8	-12
H	Transport, etc.	4	23	17	24	15	1.8	-6	-5
49	Land transport	2	5	1	12	1	2.0	3	-7
50–52	Sea–air-warehousing	1	40	31	37	29	1.5	-8	2
I	Accommodation and food	4	15	4	14	8	2.0	6	0
55	Accommodation	1	42	5	11	33	2.6	28	37
56	Food services	3	7	4	15	0	1.8	-1	-11
J	Info and comm	7	39	10	12	6	2.5	15	16
	High-tech[4]	5	53	10	13	7	2.9	25	24
	Excl. high-tech[4]	1	9	8	11	6	2.0	-8	-8
K	Finance, etc.	3	6	4	7	4	2.5	-5	-6
L	Real-estate	1	3	0	2	0	8.1	-1	-6
M	Prof. services, etc.	8	24	9	12	12	2.6	0	2
72	R&D	2	40	15	18	12	2.8	-3	-1
N	Mgmt., etc.	4	8	2	6	7	3.0	1	-2
O	Local adm., etc.	10	2	10	16	0	2.3	-21	-28
P	Education	12	1	1	3	1	5.6	-4	-10
Q	Health, etc.	12	1	5	9	1	2.8	-12	-17
R	Arts, etc.	2	5	2	8	0	2.2	2	-5
S–T	Other, etc.	4	2	3	7	0	2.9	-6	-13
	Total high-tech (incl. R&D)[3,4]	9	60	18	21	17	2.4	16	22

1.Share of exports less share of direct imports multiplied by the output/expenditure ratio; see explanation in Appendix 2.

2.The total index of industry exposure adds, on top of expenditure/income ratio elasticity (Column 8), half of the share of competing imports (Column 6) and subtracts half of indirect imports multiplied by the output/expenditure ratio (Column 5 less Column 4, the difference multiplied by Column 7), it being assumed that the indirect effect of competing imports or indirect imports is smaller than the direct impact. The coefficient (0.5) was chosen ad hoc.

3.High-tech in manufacturing includes pharmaceuticals (21) and computer, electronic and optical products (26); due to limitations in the detail of high-tech data, it does not include manufacture of air and spacecraft and related machinery (303).

4.High-tech in information and communication includes computer programming, consultancy and related activities (62) and also, due to data limitation, information service activities (63). The official high-tech aggregate of the Central Bureau of Statistics includes only data processing, hosting and related activities; and web portals (631) within the last-mentioned component. Unlike the CBS aggregate, we do not include telecommunication (61) in high-tech.

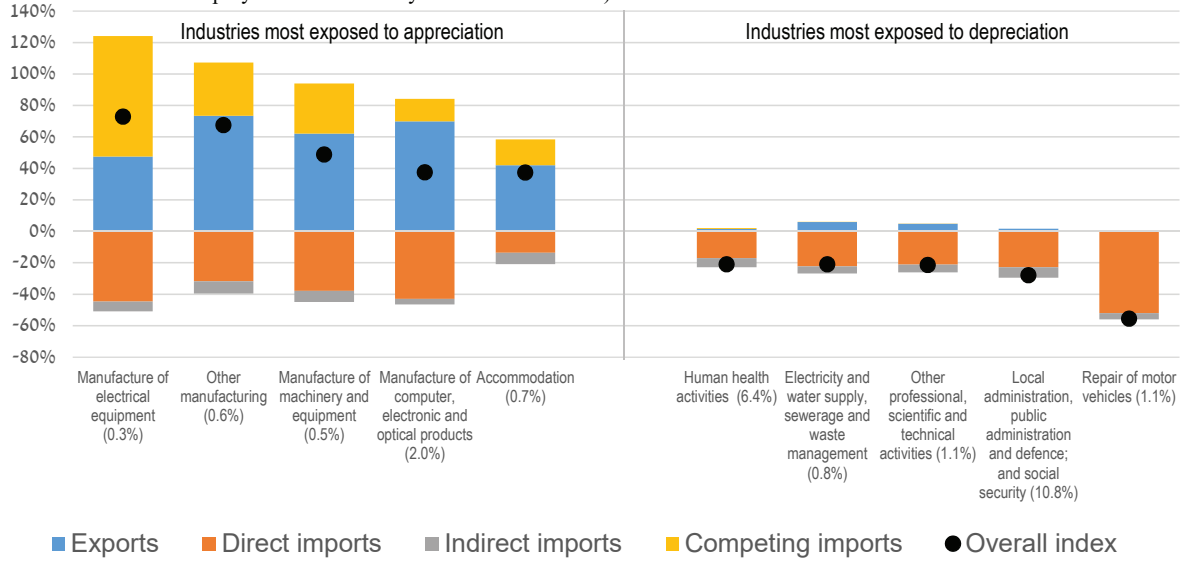
C.4 Other industries

The index for the other industries is negative, meaning that they are exposed to depreciation, i.e., depreciation of the shekel increases their expenditures more than it does their income. The main reason is their sizable share of imports—direct but also indirect—in expenditure along with small if not nil exports. The construction industry is a case in point: its added value increases due to appreciation and is adversely impacted by depreciation. This industry does not export and has no competing imports. Contrastingly, total imports of the industry (direct and indirect) account for 17 percent of its output.

Among the main industries, the one most exposed to depreciation, according to the total index, is administration and support service activities (local administration, public administration, and security, i.e., government) due to its high share of direct imports of inputs (20 percent of expenditure and 10 percent of output). Most of these imports, however, are acquired under the US defense aid program, in which the extent of aid by means of procurement in the United States is constant. Therefore, depreciation makes these imports more expensive in shekel terms but concurrently and mechanically increases the level of assistance in shekels. That is, the exposure of this industry is almost entirely hedged and depreciation is unlikely to cause serious damage to government services.

A close examination of subindustries (parsed into sixty-seven industries; see Figure 2) shows that the subindustries most exposed to appreciation belong to the manufacturing group (production of electrical equipment, machinery, computers, and electronic instrumentation) and that the exposure traces mainly to the effect of competing imports, whereas exports resemble direct imports in size. Contrastingly, the industries most exposed to depreciation belong to services that import some of their inputs but do not export and are not exposed to competing imports.

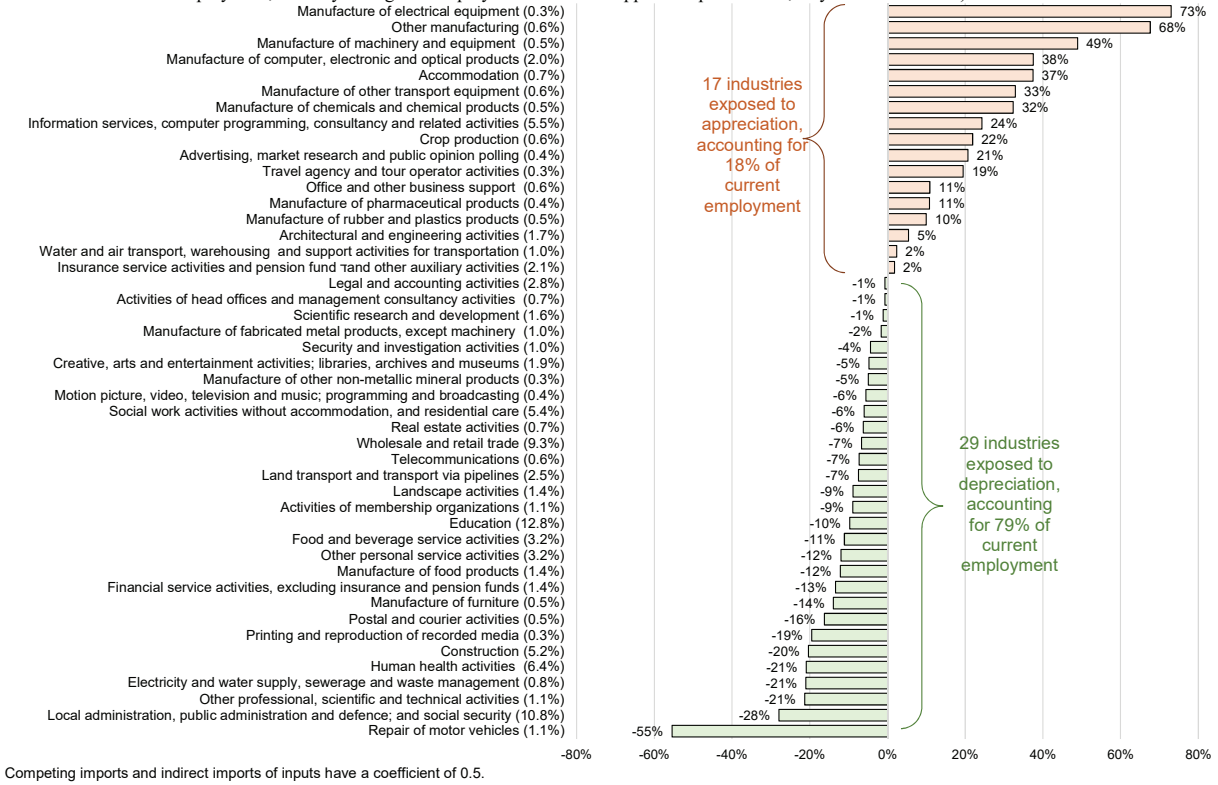
Figure 2
Total index of industry exposure to the exchange rate (a positive sign [+] denotes impairment due to appreciation) and contribution of components in the most-exposed industries
(For industries that account for more than 0.25% of employment. In parentheses next to industry name: weight of industry in domestic employment between July 2021 and June 2022)



* The components of competing imports and indirect imports of inputs are assigned a 0.5 coefficient.
Source: Based on Central Bureau of Statistics (2014 input–output table and Labor Force Survey).

According to Figure 3, which presents the exposure of each of the forty-six industries that account for more than 0.25 percent of employment, some 80 percent of the industries (based on share of employment in the past year) gain from appreciation because their exchange rate exposure is greater on the expenditure side than on the income side. However, the average rate of exposure of industries that are exposed to appreciation is greater than the average exposure to depreciation.

Figure 3
Overall Index* of Industries' Exposure to the Exchange Rate (+ is exposure to appreciation)**, Detailed by Specific Industry** (among 46 industries with at least 0.25% of employment, industry's weight in employment of Israelis appears in parentheses, July 2021–June 2022)



* Competing imports and indirect imports of inputs have a coefficient of 0.5.
SOURCE: Based on Central Bureau of Statistics 2014 Input-Output Table and Labor Force Survey.

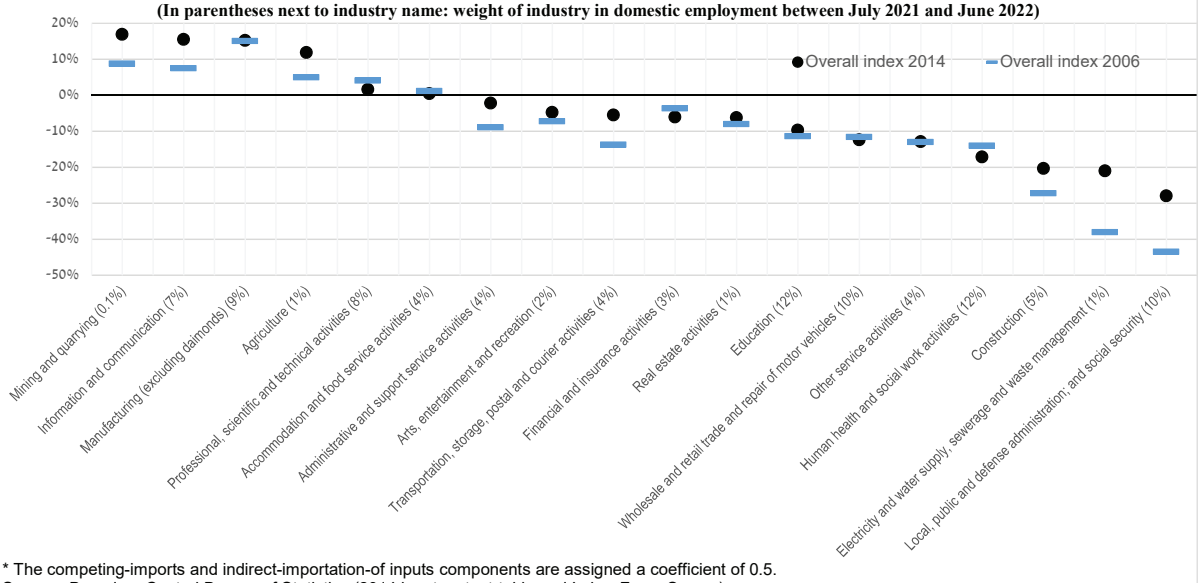
C.5 Changes in exposure relative to 2006

The data analyzed thus far are based on input–output data for 2014. The question that begs to be asked, of course, is to what extent the economy has changed in the years that have passed since then? At the present writing (until a more up-to-date input–output table is prepared), this question cannot be answered. It is possible, however, to examine how sensitive the parameters calculated here are to structural changes. In particular, we can test the extent of their change in the eight years from the previous input–output table (2006) and the current one (2014).

Notably, services exports (foremost high-tech services) developed significantly during this time with the establishment of development centers and the expansion of domestic technology companies. Furthermore, domestic natural gas from the Tamar field began to flow in the second half of 2013, replacing imported coal, fuels, and natural gas. Finally, the currency appreciated at a rapid 19 percent pace (in terms of the nominal effective exchange rate) between 2006 and 2014.

Figure 4 presents the changes in the total exposure index between 2006 and 2014. The table in Appendix 3 shows exports, imports, and the exchange rate exposure parsed by industries in 2006—all the information in Table 1 but for 2006 instead of 2014.

Figure 4
Total index of industry exposure to the exchange rate (a positive sign [+] denotes impairment due to appreciation), 2014 vs. 2006
(In parentheses next to industry name: weight of industry in domestic employment between July 2021 and June 2022)



* The competing-imports and indirect-importation-of inputs components are assigned a coefficient of 0.5.
Source: Based on Central Bureau of Statistics (2014 input–output table and Labor Force Survey).

By and large, the exposure indices of most industries increased in the transition from the 2006 data to those for 2014. Namely, most industries' rate of exposure to appreciation increased during those years—both industries that have net exposure to appreciation and those typified by exposure to depreciation (i.e., their exposure to depreciation decreased). The most noticeable change between 2006 and 2014 was the increase in exposure of the information and communication industry, which climbed from the middle of the pack to the highest level among main industries (except mining and quarrying) and to an exposure rate similar to that of manufacturing. This is the outcome of an increase in the share of exports in information and communication output from 24 percent in 2006 to 39 percent in 2014, occasioned by an upturn in the share of high-tech services (which are relatively highly exposed to appreciation due to their exports) from half of the industry to three-fourths. This occurred even though the exposure to appreciation within the high-tech industries, and in high-tech services at large, actually decreased between the two years. Given the continued growth of exports since 2014, it should be presumed that the average exposure to appreciation of the information and communication industries continued to grow.

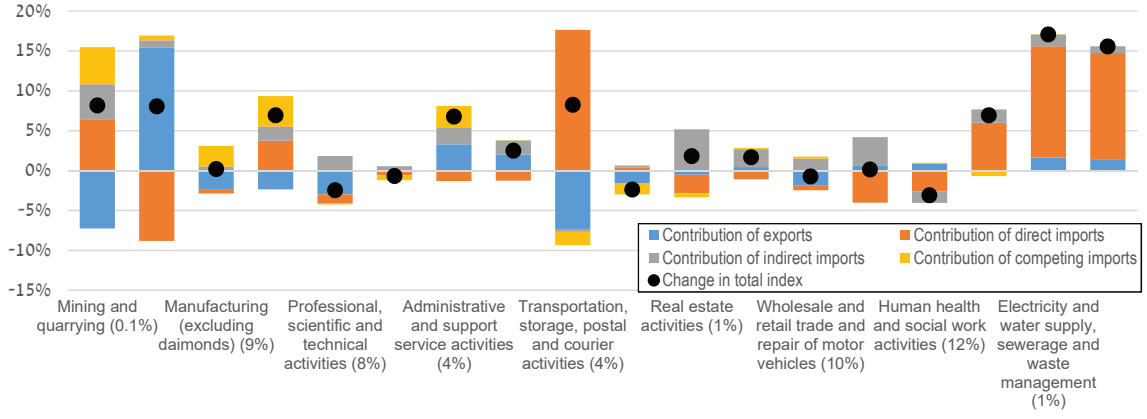
The exposure of agriculture (which accounts for a very small share of employment) also grew due to the combination of an increase in competing imports and a declining share of (directly and indirectly) imported inputs. Much the same happened in mining and manufacturing, another industry of negligible weight.

In industries that are exposed to depreciation (negative exposure to appreciation), such as construction and transport, the exposure narrowed, i.e., the loss occasioned by depreciation contracted, due to a decrease in the share of imported inputs (Figure 5).[16] In the construction industry, much of the explanation may trace

[16] A positive value for imported inputs in the construction industry, as shown in Figure 5, reflects an increase in exposure to appreciation, i.e., less exposure to depreciation, due to a decrease in imported inputs.

to the occurrence of appreciation per se, because the total share of imported inputs in output decreased by about one-fourth—approximating the effective rate of appreciation between the years examined.

Figure 5
Change in total index of industry exposure to the exchange rate (positive change [+] denotes increase in exposure to appreciation) between 2006 and 2014 and the contribution of components to the change*
(In parentheses next to industry name: weight of industry in domestic employment in 7/2021–6/2022)



* Increase in orange/gray = decrease in direct/indirect imports; increase in blue = increase in exports; increase in yellow = increase in competing imports.
Source: Based on Central Bureau of Statistics (2014 input–output table and Labor Force Survey).

In the transportation industry, the decrease in exposure to depreciation (increase in exposure to appreciation) traces to the contraction of imported inputs in total industry expenditure (the orange positive segment in Figure 5). The decrease apparently reflects less use of imported transport services by this industry (outsourcing),[17] a smaller share of imported fuels in land-transport input, fewer imports of transport vehicle products by the sea and air transport industry, and the effect of the appreciation that occurred amid all of these.

Despite the changes between the periods as described, in the main ranking of industries the sign of the total index persisted. Therefore, we believe that despite the time that passed since 2014, the analysis based on the foregoing data yields an adequate estimate of the various industries' exposure to appreciation or depreciation.

D. Indicators and variance of the total exposure of the economy

D.1 Indicators and calculations in this study

Analyzing each industry's exposure offers an indication of the total exposure of the economy, by calculating the average exposure, weighting it by the share of each industry in activity. To perform this calculation, we set the coefficient of indirect imports of inputs in the industry-level exposure index at zero to avoid double counting, because one industry's indirect imports of inputs are another industry's direct imports of

[17] Between the tables for 2006 and for 2014, the share of imports (in total expenditure) by the land, air, and sea transport industry in imported transport services (land, air, and sea) declined.

inputs. The weight of each industry may be estimated by means of its share in output, wage payments, or employment. When weighting is based on output or wage payments, industries that have higher levels of labor productivity are weighted more heavily than they would be on the basis of employment because per-worker output and wage are higher in these industries than in low-productivity industries. We performed the calculation by dividing the economy into eighteen main industries (see breakdown in Table 1) and into seventy subindustries for input–output data for 2006 and 2014.

D.2 Findings of the data analysis

The average exposure of the economy in 2006 was rather small, and according to most indicators it contracted in 2014 and verged on zero that year (Table 2). This estimate is in line with the information that emerges from the industry-level analysis. The exposure to depreciation of most industries contracted between the years measured and verged on zero according to most indicators. Looking closely, we found that while the economy aggregated across eighteen main industries has a small exposure to depreciation (a small negative exposure to appreciation), the more refined aggregation by approximately seventy industries yields evidence of a small average exposure to appreciation, at least when weighting by output and wage.

Table 2: Total exposure index*—weighted average, economy overall

Weighting factor	No. of industries	2006	2014	Difference
Output	18	-0.9%	0.6%	1.5%
Wage payments	18	-2.0%	-0.1%	1.9%
Employment	18	-3.0%	-1.4%	1.7%
Employment (7/2021–6/2022)**	18	-3.4%	-1.6%	1.8%
Output	67/70***	1.3%	2.1%	0.8%
Wage payments	67/70***	1.2%	1.8%	0.5%
Employment	67/70***	-2.2%	-0.2%	2.0%
Employment (7/2021–6/2022)**	67/70***	-1.9%	-0.2%	1.8%

* A positive value indicates exposure to appreciation. In calculating the total exposure index, indirect imports were given a zero coefficient in order to prevent double-counting.
** Weighting by employment in 7/2021–6/2022 for both years.
*** The breakdown by industries changed slightly between 2006 (seventy industries) and 2014 (sixty-seven industries).

To obtain the weighted average based on employment, we also calculated the average exposure in each year on the basis of the composition of employment in the latest period for which data were available (7/2021–6/2022). On this line, the 2006–2014 comparison expresses the change in exposure excluding the effect of the composition (which was held constant) and shows that the decline in exposure to depreciation does not originate in a change in composition but rather in change within industries. For each year (2006 or 2014), a comparison of weighting by employment at the time with weighting by employment in the most recent period indicates that the change in industry structure contributed rather little to change in the economy's exposure. The appreciation that occurred between 2006 and 2014 also had a minor effect on the average exposure.[18]

[18] For this purpose, we performed two technical simulations. In the first, we reduced by 19 percent (commensurate with the rate of appreciation) only the shekel values of imports and exports in the 2006 input–output table; in the second, we increased these values by the same rate in the input–output table for 2014 (i.e., with no change in total output and expenditure) and calculated the weighted indices.

It is also noteworthy that the exposure of output to appreciation exceeds the exposure of employment. This is because more productive industries are also those that export more and, in turn, are more exposed to appreciation.

While the economy's average exposure to the exchange rate is not large, there is considerable variance among industries, as the foregoing analysis shows. This finding may be important for overall economic stability. This stability is also important in macroeconomic terms because when large depreciation or appreciation occurs, frictions and various "rigidities" render the markets unable to shift smoothly to a new equilibrium at which industries that gain from the exchange rate change "hand over" their profits to industries that lose. The outcome may be a long-term adverse impact to companies and workers in one industry and an upturn in the profitability of another industry. In order to assess this risk, we examine in Table 3 the weighted standard deviation of the exposure on the basis of the weighting options shown in Table 2.[19] Most indicators show a decrease in variance during the period, meaning that the economy became less exposed to exchange rate changes. Unlike the change observed in the average exposure to exchange rate changes, much of the contraction of variance in the index may be explained by the sizeable appreciation that took place between 2006 and 2014, lowering the share of imports and exports in total output.[20] A decrease in the share in total activity of industries with especially high exposure to appreciation (manufacturing) or depreciation (public administration) also abetted the general decrease in variance.[21]

Table 3: Total exposure index*—weighted standard deviation

Weighting factor	No. of industries	2006	2014	Difference
Output	18	16.3%	13.4%	-2.9%
Wage payments	18	17.5%	14.1%	-3.5%
Employment	18	16.9%	13.4%	-3.4%
Employment (7/2021–6/2022)**	18	16.4%	13.5%	-3.0%
Output	67/70***	22.0%	18.9%	-3.1%
Wage payments	67/70***	23.6%	20.0%	-3.5%
Employment	67/70***	21.6%	19.6%	-1.9%
Employment (7/2021–6/2022)**	67/70***	21.4%	19.3%	-2.1%

* The weighted standard deviation of the total index of industry exposure.

** Weighting by employment in July 2021–June 2022 for both years.

*** The breakdown by industries changed slightly between 2006 (seventy industries) and 2014 (sixty-seven industries).

E. Conclusion

The analysis above produces an indicator for estimation of the exposure of each industry in the economy, and of the economy at large, to changes in the exchange rate. The analysis is based on data from the most recent input–output tables of the Central Bureau of Statistics, relating to 2014, and examines changes relative to

[19] Unlike Table 2, here we used an exposure index that includes a coefficient for indirect imports of inputs because we are testing the variance of the ris, and the risk at the individual-industry level is indeed contingent on indirect imports.

[20] This is based on the technical simulation described in Note 19.

[21] The use of constant employment weights (for July 2021-June 2022) yields a smaller decline in variance (Table 3).

the tables for 2006. The analysis pertains to the near term and assumes that firms' other decisions—extent of activity and composition of intermediates, as well as global prices and the prices that firms face—are given.

On average, the exposure of the entire economy to exchange rate changes is small and verges on zero. However, the analysis revealed large differences in the exposures of different industries. While manufacturing, information and communication, and high-tech within the latter are considerably exposed to appreciation, other industries are exposed to depreciation (i.e., harmed by depreciation) due to their need to import raw materials and their small or nil share of exports. It is also found that the exposure of industries that are exposed to appreciation grew between 2006 and 2014 and presumably continued to rise in subsequent years due to an increase in the share of exports in their output. Seemingly, however, the industries that are most exposed to appreciation—such as high-tech manufacturing and high-tech services—actually sustain smaller short-term harm to activity on account of appreciation than that implied by the extent of their exposure to the exchange rate due to their ability to set the dollar price of their products.

Appendices

Appendix 1: Source of data and method of calculation

Most of the analysis is based on **the most recent input–output table for the Israeli economy, pertaining to 2014**.[22] Therefore, the analysis reflects neither changes in each industry's production functions and structure of activity nor changes in relative prices of imports and exports as against domestic output in subsequent years.

a. Share of exports in output (Column 3): Each industry's exports are based on the column of total exports in the symmetric input–output table (Table 3). This parameter (like imports, below) is presented as a share of total output, taken from the last column in the table, both in basic prices.

b. Share of direct imports of inputs in output (Column 4): The direct imports of each industry are based on its total import line (including taxes) in the symmetric input–output table (Table 3) and is presented as a share of total output. To estimate each industry's reliance on imports for its activity, the distinction between substitutive imports and complementary imports is immaterial.[23] Import value relates only to imports performed directly by the firm, to the exclusion of indirect imports (those carried out by an industry downstream on the production chain[24]). Imports include only intermediates and exclude capital goods.

c. Share of an industry's imported inputs (direct and indirect) in its output (Column 5): In order to take into account the fact that industries buy intermediates from other industries that import them, we calculated the industries' imports (the sum of direct and indirect). We did this by multiplying the vector of the rate of imports of each industry by its output using Leontief's inverse matrix, which reflects the amount of

[22] The table was published in early 2022; thus, a more up-to-date input–output table is unlikely to appear in the near future.

[23] Complementary imports are imports of goods and services that cannot be manufactured in Israel. Substitutive imports are of goods and services that can be produced in Israel.

[24] For example, flour purchased from a local mill is not recorded as an import of a bakery even if the mill company produced it from imported wheat.

output that each industry uses in order to produce one final unit of output in a certain industry.[25] Here, too, imports include only intermediates and exclude capital goods.

d. Share of competing imports in output (Column 6): To estimate the share of relevant competing imports for each domestic industry, we related to total competing imports (the last column in Table 8, "Competitive Imports - C.I.F.," in the input–output tables) based on the assumption that imports originating in a given industry compete with the output of the same domestic industry. We divided the imports by the total output of the industry at basic prices in order to obtain its share.

e. Complementary imports: as explained above, we bundled complementary imports of intermediates with substitutive imports of intermediates in calculating an industry's exposure to imported inputs. The analysis does not relate to complementary imports of final products—those that cannot be manufactured in Israel, such as passenger cars for private use or trucks as capital goods. These imports, insofar as they do not actually compete with domestic manufacture because they are not manufactured in Israel, have no direct effect on the activity of domestic industries but do affect domestic uses, particularly household private consumption and business investment. Appreciation lowers the cost of importing complementary goods that are not manufactured in Israel for the purpose of domestic uses.

f. Industry output relative to expenses (Column 7): To express the share of imported inputs in total industry expenditure, we calculated the ratio of output (as stated, in a column from a symmetric input–output table) to total expenditure. Total expenditure is the sum of total purchases of intermediates and total imports including taxes. Both of these are lines on a symmetric input–output table.

To estimate the relative importance of the industry, we used several indicators:

Share of employment

The Labor Force Surveys for 2014 and 2006—to obtain weighted indicators for each year, we calculated the share of employment on the basis of the Labor Force Surveys for 2014 and 2006. In regard to 2006, the original survey was conducted in accordance with the old (1993) classification of industries. To express this in terms of the new (2011) classification, we used a conversion key from the Standard Industrial Classification of All Economic Activities 1993 to the Standard Industrial Classification of All Economic Activities 2011 (Appendix A in the Central Bureau of Statistics publication). The data available to us were given at the three-digit level in the old classification and were reclassified at a two-digit level in the new one. Industries in the old classification that were split into different industries in the new classification, were divided in accordance with the observed distribution of the industry's particulars under the old classification in the 2012 Labor Force Survey, when both classifications for the same observations are available to us. Even after these additional adjustments, the share of persons employed in the public administration, defense, and social security industry (O) in 2006 is small. This is because the Labor Force Survey did not count soldiers as employed persons until 2011. To avoid bias relative to other years, it was assumed

[25] The formula for this is (I-A)-1*wm, where A is the matrix of a symmetric input–output table (which reflects how much each industry buys from other industries), normalized to the output of the industries; wm is a vector of the share of directly imported inputs in total output; and I is the matrix of the unit. We divided the components of the vector obtained by this multiplication by the components of the diagonal of the Leontief inverse matrix—(I-A)-1—in order to normalize the calculation to one unit of output. We performed all the calculations on matrices at a sixty-seven-industry level of detail. To perform the calculation for a main industry (as shown in Table 1) before normalization and matrix inversion, we aggregated only the subindustries of the main industry in question, leaving the other industries at the higher level of detail.

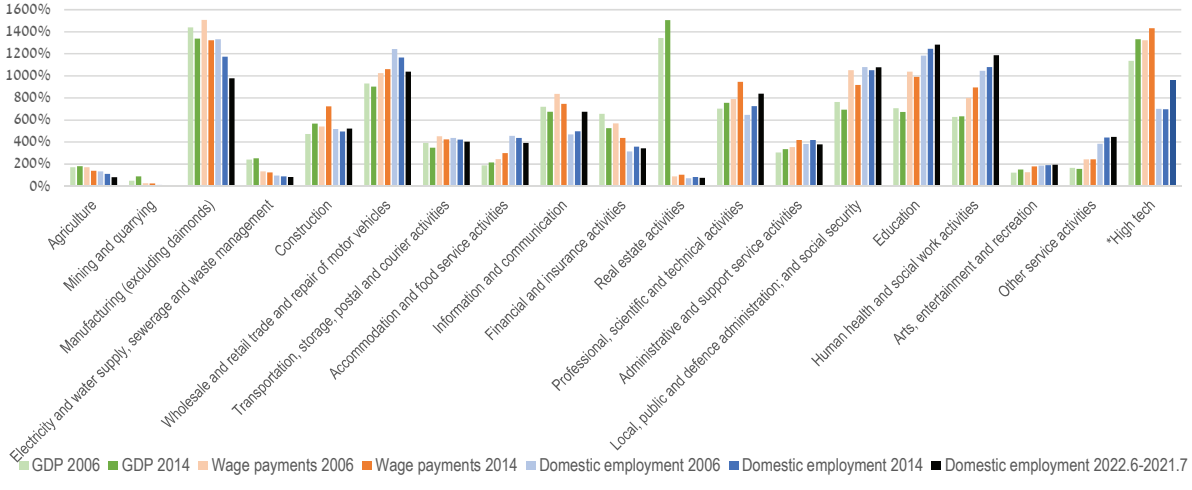
that the share of employment in industry O in 2006 was identical to its weight in the most recent period (approximately 10 percent). In the other industries, we divided the share of employment commensurate with their share of employment excluding industry O in 2006.

Share of output (used for the weighted indices)—the output of each industry was calculated as its total output less its total expenditure (purchase of inputs plus direct imports), all of which from the symmetric input–output table.

Share of wage payments—total wage payments of each industry, taken from the "Compensation for jobs" line in the symmetric input–output table.

Figures A.1 and Table A.1 present the weights and the relevant years for the main industries.

Figure A.1
Share of main industries in employment, wage payments, and GDP



* High-tech includes pharmaceuticals and electronic components (in manufacturing), computer programming, and R&D.
Source: Input–output tables for 2006 and 2014 and Labor Force Surveys for 2006, 2014, and 7/2021–6/2022.

Table A.1: Share of main industries in GDP, wage payments, and employment (pct.)

	Output		Wage payments		Domestic employment	
Industry	2006	2014	2006	2014	2006	2014
Agriculture	1.7	1.8	1.7	1.4	1.3	1.1
Mining and quarrying	0.5	0.9	0.3	0.2	0.1	0.1
Manufacturing (excl. diamonds)	14.4	13.4	15.1	13.2	13.3	11.8
Electricity, water [etc.]	2.4	2.5	1.3	1.2	1.0	0.9
Construction	4.7	5.7	5.4	7.3	5.2	5.0
Trade [etc.]	9.3	9.0	10.3	10.6	12.4	11.7
Transportation [etc.]	3.9	3.5	4.5	4.2	4.4	4.2
Accommodation and food	1.9	2.1	2.5	3.0	4.6	4.4
Information and communication	7.2	6.8	8.4	7.5	4.7	5.0
Finance [etc.]	6.5	5.3	5.7	4.4	3.1	3.6
Real estate	13.4	15.1	0.9	1.0	0.7	0.8
Professional, scientific, technical	7.0	7.6	7.9	9.5	6.5	7.3
Admin. and support	3.1	3.4	3.6	4.2	3.8	4.2
Admin. and security	7.6	6.9	10.5	9.2	10.8	10.5
Education	7.1	6.7	10.4	9.9	11.8	12.5
Health and social work	6.3	6.3	8.0	9.0	10.5	10.8
Arts, entertainment, recreation	1.2	1.5	1.3	1.8	1.9	1.9
Other services	1.7	1.6	2.4	2.4	3.9	4.4
High-tech	11.4	13.3	13.2	14.3	7.0	7.0

Appendix 2: Calculating the elasticity of the income-to-expenditure ratio to the exchange rate

Total income is the sum of shekel income and foreign-currency (USD) income multiplied by the exchange rate:

$$\text{Rev} = \text{RevILS} + \text{RevDol}*e$$

Similarly, total expenditure is:

$$\text{Cost} = \text{CostILS} + \text{CostDol}*e$$

We calculate the elasticity of the income/expenditure ratio[26] as follows:

$$\frac{\partial(Rev/Cost)}{\partial e}\frac{e}{(Rev/Cost)} = \frac{\partial Rev * Cost - \partial Cost * Rev}{Cost^2}\left(\frac{e * Cost}{Rev}\right) =$$

$$\left(\partial Rev - \frac{CostDol * Rev}{Cost}\right)\frac{e}{Rev} = \frac{\partial Rev * e}{Rev} - \frac{CostDol * e}{Cost}$$

The last expression is the elasticity of income relative to exchange rate change, less the share of foreign-currency expenditure in total expenditure.

When a manufacturer treats foreign-currency prices as given (a price taker), income elasticity is exactly the share of income in foreign-currency (at a given exchange rate) in total income. We may write the following:

$$\frac{\partial(Rev/Cost)}{\partial e}\frac{e}{(Rev/Cost)} == \frac{RevDol * e}{Rev} - \frac{CostDol * e}{Cost}$$

However, when the manufacturer has market power, the change in total income may be smaller (in the event of appreciation, for example) than the change in the exchange rate.

As for the expenditure side, presumably the manufacturer always treats the price as given; it is less reasonable to have a situation in which the cost of inputs depends on demand for the manufacturer's products.

[26] The ratio is roughly equal to one plus **added value** as the share of industry expenditure spent on inputs.

Appendix 3: Exports, imports, and exchange rate exposure of domestic industries, 2006

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(7)*(4)-(3)=(8)	(9)
	Industry	Industry share in employment (%)	Share of exports in industry output (%)	Share of direct imported inputs in output (%)	Share of total imported inputs in output (%)	Share of competing imports in output (%)	Output / industry expenditure (domestic inputs + imports)	Elasticity of income/expenditure ratio[1] (%)	Total industry exchange rate exposure index[2] (%)
	Database from year:	7/2021–6/2022	2006	2006	2006	2006	2006	2006	2006
A	Agriculture, forestry, fishing	1	21	5	17	7	1.8	12	5
B	Mining and quarrying	0.1	41	11	21	2	2.1	18	9
C	Manufacturing (excl. diamonds)	9	51	34	37	33	1.5	0	15
	High-tech[3]	2	77	29	34	24	1.7	27	34
	Excl. high-tech[3]	7	41	37	39	36	1.4	-10	6
D-E	Electricity, water, etc.	1	4	18	25	0	2.0	-32	-38
F	Construction	5	0	9	23	1	1.8	-16	-27
G	Trade, etc.	10	8	5	12	3	2.5	-5	-12
H	Transport, etc.	4	30	28	36	18	1.7	-17	-14
49	Land transport	2	4	6	16	6	2.3	-10	-18
50–52	Sea–air-warehousing	1	49	44	51	28	1.4	-13	-4
I	Accommodation and food	4	15	4	15	9	1.9	7	1
55	Accommodation	1	35	5	12	30	2.3	23	29
56	Food services	3	7	4	16	0	1.7	0	-11
J	Info and comm	7	24	7	10	5	2.2	9	7
	High-tech[4]	5	47	5	9	5	2.6	34	32
	Excl. high-tech[4]	1	5	8	12	5	2.0	-11	-12
K	Finance, etc.	3	8	3	6	7	3.3	-3	-4
L	Real-estate	1	3	0	2	1	13.4	2	-8
M	Prof. services, etc.	8	27	9	14	12	2.5	4	4
72	R&D	2	55	16	20	11	2.9	7	7
N	Mgmt., etc.	4	4	2	7	1	3.4	-1	-9
O	Local adm., etc.	10	0	17	23	0	2.2	-36	-44
P	Education	12	0	1	4	1	6.0	-3	-11
Q	Health, etc.	12	0	5	9	1	2.1	-10	-14
R	Arts, etc.	2	3	1	8	0	2.3	1	-7
S–T	Other, etc.	4	1	1	8	0	2.9	-3	-13
	Total high-tech (incl. R&D)[3,4]	9	65	20	24	17	2.1	24	28

1. Share of exports less share of direct imports multiplied by the output/expenditure ratio; see explanation in Appendix 2.
2. The total index of industry exposure adds, on top of expenditure/income ratio elasticity (Column 8), half of the share of competing imports (Column 6) and subtracts half of indirect imports multiplied by the output/expenditure ratio (Column 5 less Column 4, the difference multiplied by Column 7), it being assumed that the indirect effect of competing imports or indirect imports is smaller than the direct impact. The coefficient (0.5) was chosen ad hoc.
3. High-tech in manufacturing includes pharmaceuticals (21) and computer, electronic and optical products (26); due to limitations in the detail of high-tech data, it does not include manufacture of air and spacecraft and related machinery (303).
4. High-tech in information and communication includes computer programming, consultancy and related activities (62) and also, due to data limitation, information service activities (63). The official high-tech aggregate of the Central Bureau of Statistics includes only data processing, hosting and related activities; and web portals (631) within the last-mentioned component. Unlike the CBS aggregate, we do not include telecommunication (61) in high-tech.

THE EFFECT OF THE DISPOSABLE PRODUCTS TAX ON THEIR PRICES: SINGLE-USE CUPS AS A TEST CASE[1]

- **On November 1, 2021 a tax of NIS 11 per kilogram was introduced on certain plastic disposable goods. This paper examines the effect of the tax on the prices of those products using a test case: examining the change in the price of plastic single-use cups.**
- **The actual increase in the prices of the cups was 70 percent higher than the increase derived from the imposition of the tax: an average increase of about NIS 22 per kilogram compared with an increase of about NIS 13 (NIS 11 plus VAT that applies on the tax), derived from the imposition of the tax.**
- **The actual increase beyond the tax liability supports the possibility that the market is not operating in perfect competition due to the structure of the supply side of the market or because the information available to consumers is incomplete.**
- **A substantial part of the differences in the price increases between stores is explained by the marketing chain to which the store belongs. The various brands are much less important than the marketing chains in explaining the variance, apparently because consumers do not attribute great importance to the brand of single-use cups.**
- **When we control for the marketing chain to which the store belongs, the population size of the locality and the average wage in the locality do not contribute to explaining the variance of the price increase between stores.**
- **An excess increase in prices following the imposition of similar taxes is a well-known phenomenon globally. In our case, it seems that the consumer's difficulty in identifying the increase derived from the tax—which is due to the fact that the tax is based on weight, which the customer has difficulty estimating—made it easier to raise the price beyond the tax. The increase in global prices of raw materials and the acceleration of the inflation rate at the same time may also have made it easier to raise prices.**
- **The excess increase in prices indicates a need to find the proper balance between setting a tax that simplifies its collection and is consistent with the achievement of its goal, and a definition that the customer understands. Setting a tax as a percentage of the consumer price would make it easier for consumers to compare between it and the actual increase in price, but may also present other difficulties. Alternatively, the imposition of a set tax can be accompanied by requiring producers/importers to indicate the product's weight, and even the tax that applies to the product, on the packaging.**

1. INTRODUCTION

On November 1, 2021, a new tax was introduced on plastic disposable goods in Israel. The new tax is intended to reduce the use of such goods due to the damage they cause to the environment. This tax joins other environmental legislation in recent years that is intended to reduce the quantity of waste using economic incentives.[2] As opposed to most of these laws, which focus on reducing the quantity of waste

[1] Written by Kobi Braude and Sigal Ribon. We thank Eden Anavim for processing the data and Sigal Nurani for processing the data at the initial stages of the project. We also thank Alon Eizenberg for his valuable advice throughout our work.

[2] The economic incentives may apply to the producer or to the consumer. Most of the existing legislation in Israel imposes the responsibility on the producer, but it is reasonable to assume that the additional cost will be at least partly passed on to the consumer. For a discussion of the economic tools used in handling the issue of waste in Israel, see for instance: Bank of Israel (2020) and Lavi (2020). For more details on the laws of producer responsibility in Israel regarding waste, see https://www.gov.il/he/departments/guides/extended_producer_responsibility (in Hebrew).

by encouraging recycling, the tax on disposable goods—similar to the impost on disposable bags[3]—is intended to reduce the source of the waste by lowering the use of the product. This is an important value in the environmental view. The tax on disposable goods is similar to the impost on disposable bags, and differs from the other legislation in that it has a direct impact on the consumer price, which is immediate and more easily identifiable.[4]

Even though the declared aim of the tax is to reduce the consumption of plastic disposable goods, this study does not examine its effect on the purchased quantity of these products. The aim of this study is to examine another aspect of the tax: how it affected the final consumer price in the short term, immediately after its imposition. The findings of the study may help us understand the transmission mechanisms operating on prices in the economy, particularly how cost shocks roll over to the consumer price, and may help us derive lessons on how to design similar taxes in the future. The data also point to substantial variation in retailers' responses to the new tax. However, this information does not enable us to examine retailers' characteristics so that we would be able to connect those characteristics with the differences in their response to the tax. We examine these questions by focusing on a single product—simple plastic single-use cups.

2. LITERATURE REVIEW: THE EFFECT OF SIMILAR TAXES ON THE PRODUCT'S PRICE – FINDINGS FROM ABROAD

The use of taxes on specific products is widespread around the world, and exists in Israel as well. Their purpose is frequently to reduce consumption of products that involve negative externalities or harm (mostly regarding health) to the user. Common examples of such taxes are those focused on fuel, cigarettes, alcohol, and sweetened drinks. These taxes, imposed on the producer or on the importer, are generally in the form of a set amount per consumption unit. This is in contrast with more general indirect taxes such as VAT or customs, which are set as a percentage of the product's price.

Economic research deals at length with the potential effects of taxes on specific products. These effects can be divided into two major groups (that are not independent of each other): the effect on the consumer price and the effect on the amount consumed. This study focuses on the first aspect—how the consumer price changed as a result of the imposition of the tax. A central issue that the literature deals with in this context—both theoretical and empirical—is the extent of the "tax pass-through" to the consumer as reflected in the price paid by the consumer—partial, full, or even beyond full.

The theoretical analysis of the link between the market structure—the extent of competition, the information available to the consumers, and the nature of demand for the product—and the consumer price's response to the increase in taxes is complex. In general, the less demand for the product responds to an increase in price, the greater we can expect a price increase to be due to the imposition of the tax. Moreover, according to theory, if competition in the market is imperfect, there may be over-shifting, meaning an increase in the consumer price beyond the increase in the tax. Sullivan and Dutkowsky (2012) show that under conditions of monopolistic competition, if the demand function is linear or concave, the tax pass-through

[3] For a description of the impost and its effect on consumer behavior, see Box 6.2 in the Bank of Israel *Annual Report* for 2017.

[4] The Bottle Deposit Law imposes a direct cost to the consumer, but the consumer can avoid it by redeeming the deposit. This reflects the purpose of the law—to encourage recycling, rather than to reduce consumption. The impost on bags applies on shopping bags that are distributed for free, such that it is not relevant to the discussion of an effect on their price, but is only relevant to the volume of their use.

to the consumer price will be partial or full but not beyond that. In contrast, if under such conditions the demand function is convex, it is certainly possible that the consumer price will increase by more than the tax increase.[5] They note that it is more likely that this would occur with regard to products with relatively inelastic demand. The authors emphasize that while this analysis shows that in a noncompetitive market, the pass-through may be partial, full, or even beyond, in a fully competitive market, over-shifting is not possible.

Incomplete information on the part of consumers may also support an excessive price response. Consumers may, for instance, believe that since all producers are taxed by the same amount, they will increase the price by an identical rate. They therefore avoid making the necessary effort to compare prices (between producers or between stores), or to change their consumption patterns.[6] In this context, and as we emphasize below, the manner of setting the tax on disposable goods in Israel exacerbated the problem of consumer information, because of the difficulty in calculating the additional price per unit sold to the consumer as derived from the tax.

Many studies around the world have empirically examined the effect of introducing a tax on specific products, particularly on cigarettes, alcohol, and sweetened drinks. Many of them found that the transmission from the tax to the product's price is greater than 1, meaning that the consumer price increased by more than the size of the new tax. For instance, Shang et al. (2020) examined the effect of introducing a tax on various types of alcohol in the OECD countries, and found that for most products, the price increase was greater than the tax, for some the transmission was not different than 1, and that there were only a few products where the tax was only partially passed on to the consumer. In contrast, Cawley and Frisvold (2017) examined the effect of introducing a tax on sweetened drinks in Berkeley, California, and found that the transmission was smaller than 1. In their assessment, the finding reflects consumer's ability to purchase these drinks at other places, where there is no tax. However, they note that in many studies on various products, a transmission of 1 or larger was found. Grogger (2016) found that the tax on sweetened drinks in Mexico was passed on to the consumer price at a rate of greater than 1. Similar findings were obtained for Denmark (Bergman and Hansen (2016)). Dutkowsky and Sullivan (2014) note a number of studies that found a transmission of greater than 1 for taxes on cigarettes. We did not find studies on the imposition of tax on disposable goods.

3. THE TAX ON DISPOSABLE GOODS AND ITS IMPLICATIONS FOR THE RESEARCH METHOD

As stated above, on November 1, 2021, a purchase tax was introduced on disposable goods made of plastic or that contain a layer of plastic. The tax took the form of a set impost (excise) of NIS 11 per kilogram of product.[7] Since VAT is calculated on the price including the new tax, the actual new tax amounts to NIS

5 Weyl and Fabinger (2013) too show that under imperfect competition, the extent of the price's response to a tax depends not only on the elasticity of supply and demand, but also on additional features of demand.

6 See also Cabral and Fishman (2012).

7 Customs Rate and Exemptions and Purchase Tax on Goods Order (Amendment Number 3), 5782–2021. This rate also applied initially to disposable products made of paper coated in plastic, but it was later reduced for such products. This study does not deal with products of this type.

12.87 per kilogram.[8] The tax is collected on the basis of a declaration by the manufacturer or the importer regarding the total weight of the merchandise.

Even though the tax applies to a wide variety of disposable products, we chose to limit our examination to one type of product. Alongside the disadvantages of such a limitation, it should be emphasized that focusing on a product as homogeneous as possible improves the ability to distill the effect of the tax on the change in price. Among other things, it may eliminate potential effects of the various types of products on the price's response to the tax, for instance because of differences in the elasticity of demand for different products.

This study therefore deals only with simple disposable plastic cups (as opposed to premium, for example), intended for cold drinks, with a volume of 180–200 ml. This is a very common and readily available product, the use of which is more common than almost any other disposable product.[9] In order to further increase homogeneity, we restricted the examination to large packages (100-150 cups). Even though there are various brands (manufacturers and importers) of the product, it is reasonable to assume that in this case, consumers do not attribute any importance to a particular brand. (This matter will be discussed in greater detail below.)

As stated above, the Order defines the tax per kilogram of product, while the product is sold to the consumer by number of units in the package, and not by weight, and the weight is not marked on the package. In order to compare the change in the consumer price of a package that is taxed per kilogram of product, we must convert the size of the package to weight terms based on the number of cups in the package and their weight. Although we focus on a very homogeneous product, it turns out that there is some difference in the weight of the cups, which means a considerable difference in the actual tax imposed on the packages of various brands (which include the same number of cups). Accounting for these differences is essential when examining the change in price of these brands.

It is important to note that the fact that only the number of cups is marked on the package, but not their weight, makes it difficult for consumers to estimate the change that should have taken place in the price due to the tax, compared with the actual change. This may have an impact on the extent of the tax's pass-through to the consumer, which means that it also raises policy questions, as will be discussed below.

Since the order set out a clear date for the tax to take effect (November 1, 2021), our research method is based on comparing the price in the period prior to that date with the price in the period immediately following it.[10] Limiting our examination to these periods greatly reduces the concern that the price change during that time was also affected by other factors. (See below for further discussion of potential effects

[8] Imported disposable plastic products are also subject to an existing customs tax of 8–12 percent. In contrast with VAT, the customs tax is calculated on the price excluding the purchase tax.

[9] According to a survey conducted for the Ministry of Environmental Protection, 73 percent of Israelis reported that they use simple disposable plastic cups for cold drinks at home, even if only occasionally. This rate is higher than the rate for any other type of disposable product except for paper cups for hot drinks. The rate of those using simple disposable plates was 63 percent, and the rate of those using simple disposable cutlery was 58 percent. See: Ministry of Environmental Protection (2020) (in Hebrew).

[10] The intention to impose a tax of NIS 11 per kilogram was announced in July 2021, as part of the discussions on the State Budget, and was approved in Government Decision number 261 on August 1, 2021. The decision did not set the precise date for introducing the tax, but it did state that the tax would be introduced no later than January 1, 2022. Final confirmation that the tax would be introduced, and of the date on which it would be introduced, was given with the Minister of Finance's signature of the regulations on October 19, 2021. The Order was given final approval by the Knesset Finance Committee on November 30, 2021.

such as these). However, this examination may show only a partial picture of the tax's effect on the price, while the effect over time may be greater or smaller than the immediate effect.

4. THE DATA

The main data source for this study is the prices that the large supermarket chains are required to post on their websites each day.[11] These data enable a unique identification of each product by its barcode number. In addition to the date and the daily price of the product, the data also include the product name (including the name of the marketer—hereinafter the "brand name"), and details of the branch (store) at which it is sold (the chain to which the branch belongs and the locality in which the branch is located).

The study examines the change in price immediately after the tax took effect, compared with the preceding period (base period). We define the base period as the two months preceding the imposition of the tax: August 15, 2021 to October 15, 2021. We define the period following the imposition of the tax as November 7, 2021 to November 30, 2021. We omit the two-week period immediately prior to the imposition of the tax and the first week after its implementation, on the assumption that price changes during this period reflect a price update period that may vary from one store to another, and not the representative price in either of the comparison periods. Expanding the basis period to two months is intended to eliminate the potential effects of the holiday period that took place in September—a period that generally has few business days and may reflect unique effects on prices.

As explained above, the weight of the cups is essential in our discussion. This weight does not appear on the package or in the product details that appear on the supermarkets' websites. Therefore, the final sample includes only the 6 barcodes that we were able to weigh on our own. This limitation decreases the sample size only slightly, so in our assessment, the sample properly covers the population of cups sold at the supermarket chains.[12] The price per kilogram is calculated in accordance with the weight of the cups with the appropriate barcode.

In order to examine the effect of locality characteristics on the price's response to the tax, we use the Central Bureau of Statistics "local authorities file". The characteristics are: average wage in the locality; rate of *Haredim* (ultra-Orthodox Jews) in the locality; and rate of large families in the locality. The rate of *Haredim* in the locality is estimated using election data: the number of votes received by the *Haredi* parties (United Torah Judaism and Shas) as a percentage of total valid votes in the locality in the elections for the 24th Knesset (March 2021). The rate of large families is estimated using child allowance payment data: the number of children in the locality, for whom child allowance was paid, in families with five or more children, as a percentage of total children in the locality for whom child allowance was paid.

[11] Our data therefore do not include total consumption of disposable plastic products in Israel. Sales to households are estimated at about 70–75 percent of total consumption, and are divided between the barcoded market (about 48 percent of these sales) and the rest of the market (mainly stores specializing in household goods and in disposable products). The barcoded market itself is divided among the large supermarket chains, which are required to publish prices on the Internet and which are covered by our data, and small chains, neighborhood grocery stores, and so forth, which are not obligated to publish prices on the Internet and are therefore not included in our data. Estimates on sales distribution are based on Ministry of Environmental Protection (2020) and Eliyahu (2021).

[12] The omission of 5 barcodes that we were unable to weigh, out of the 11 that were in the refined sample, led to the omission of just 29 stores out of the 641 in the sample, and to the omission of 2 supermarket chains.

The sample was therefore limited to localities for which the necessary data exist, meaning only those that constitute a municipality on their own (city or local council), and does not include smaller localities (that belong to regional councils). This limitation does not have a material impact on the number of stores in our sample or on their characteristics, since the data we have relate, as stated, to large supermarket chains that are generally not located in the small localities. The stores that are typical of such localities (neighborhood groceries, minimarkets, and so forth) are not included in the data that we have.[13]

Our database also includes information regarding the products sold through the websites of some of the supermarket chains. We obviously cannot attribute these websites to a particular locality, and our treatment of them is explained below.

5. THE SAMPLE COVERAGE: DESCRIPTIVE STATISTICS

The number of stores, supermarket chains, and localities included in the sample show that the data available to us have sufficiently broad coverage (Table 1). Each observation describes the change in the average daily price per kilogram of a particular barcode sold at a particular store between the period prior to the imposition of the tax and the period after its imposition, with the characteristics of the product and of the place of sale.[14]

Table 1: Descriptive statistics of the sample[1]

Variable	Number of appearances in the sample
Number of observations	738
Number of stores	612
Number of supermarket chains[2]	25
Number of barcodes (products)	6
Number of chains selling more than one barcode	9
Number of stores selling more than one barcode	101
Number of barcodes sold at more than one chain	6
Number of localities in the sample	99
of which: Localities in which there is only one store in the sample	19

[1] The sample discussed in the Table includes only stores in municipalities. A slightly broader sample, which includes 805 observations and also includes stores in smaller localities and online stores belonging to the supermarket chains, is used in some of the estimations as described below. [2] We defined subsidiary chains that belong to the same parent chain as separate chains.

[13] The large supermarket chains sometimes place stores in commercial areas belonging to regional councils, and some of the chains are active in the rural sector. These stores are not included in the sample. In contrast, the sample does include small stores (such as convenience stores) that belong to the large chains. In total, the limitation of the sample to municipalities led to the omission of 54 stores. The sample contains almost no Arab localities, since the data are limited to the large supermarket chains.

[14] We omitted a product sold at a certain store if the number of days on the basis of which we calculated the average price during the pretax or post-tax period was less than 4. We related to the price including sales discounts that are not limited to customer club members or those with a supermarket credit card. All observations receive equal weighting, regardless of the volume of the product's sales at the store. We do not have data on that volume.

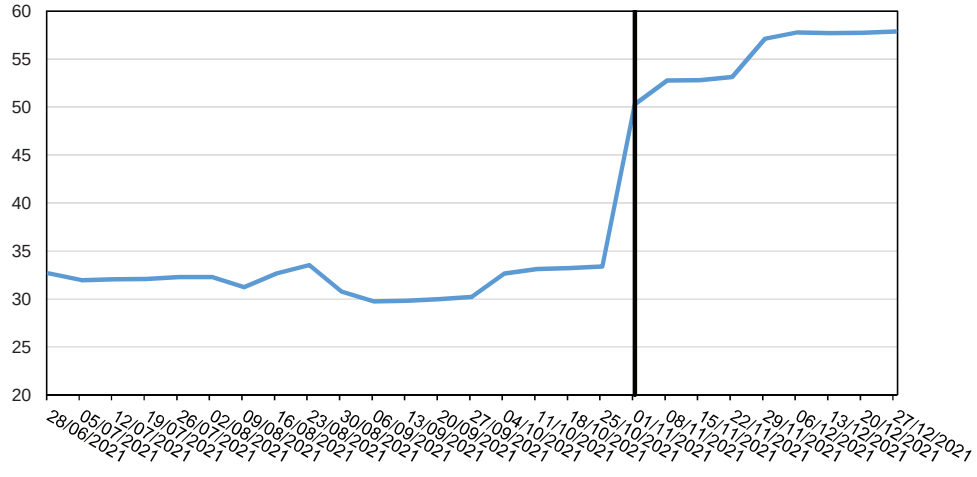
The number of observations is greater than the number of stores because some of the stores sell more than one barcode of the six that are included in the sample. For one-fifth of the localities, the sample includes only one store in that locality. This is partly due to the low number of supermarket chains represented in the smaller localities, and may attest to a low level of competition in those localities. However, we obviously cannot derive from this that this is the only store in the locality, since the data do not include stores that don't belong to the large supermarket chains.

6. FINDINGS

6.1 Price change over time – evidence for identifying the tax effect

The sharp, immediate, and extraordinary increase in the price of cups (per kilogram) around the time the tax took effect (November 1, 2021) is clearly noticeable in Figure 1.[15] This greatly strengthens the argument that the price increase we examine in this study is mainly due to the tax, and not to other factors such as an increase in the price of raw materials. Section 7 below presents additional examinations that support this. The figure also prominently shows that the supermarket chains and/or suppliers avoided raising the price during the period prior to the imposition of the tax, even though the intention to impose the tax soon, and then the precise date as well, were known some time in advance.[16]

Figure 1
The Price of Single-Use Cups, July–December 2021 (NIS per kg, weekly average)



The vertical line marks the first week of November 2021.
SOURCE: Based on price data published on the supermarket chains' websites.

[15] At the beginning of December, there was an additional jump in prices, although it was much smaller than the one at the beginning of November. This jump was due to the fact that two of the supermarket chains revised their prices on the cups only at the later date.

[16] See the previous note. Even though prices increased slightly at the beginning of October relative to September, their level was similar to the August level. It is reasonable to assume that this increase was a correction of the temporary price decline during the September holiday period, and is not connected with the expected tax. Even if there was a price increase connected with the expected tax in the first two weeks of October, which are included in the base period of our test, it means that our estimate of the tax's effect on the price is conservative relative to the actual increase. The Order was given final approval by the Knesset Finance Committee on November 30, 2021, after certain changes were made to it that do not relate to the cups being examined in this study.

As we know, expectations of a price increase may lead to bringing purchases forward, and therefore to a temporary increase in demand that may support an increase in price even before the tax is introduced. The avoidance of raising the price before the tax took effect may show that the supermarket chains or suppliers were concerned about raising the price without justification in the eyes of consumers. However, they also did not wait, and raised the price immediately with the imposition of the tax.[17] The rapid change in the consumer price following the tax increase is consistent with the findings of studies in other countries.[18] An initial look at Figure 1 shows that the change in the price per kilogram is significantly greater than the level of the tax—a price increase of more than NIS 20, compared to the tax that was set at NIS 13 (including VAT).

6.2 Change in the average price and what it means

The tax on disposable products was set as an excise in shekels, similar to other taxes on defined products, and not as a percentage of the product's price as most purchase taxes are. However, in contrast with the excise on fuel, which is defined in relation to the measurement unit at which the product is sold to the consumer, and the price of which (shekels per liter) the customer knows (and where the final consumer price is supervised and published), the tax on disposable goods is set in relation to a measurement unit (kilograms), which is completely disconnected from the measurement unit at which the product is sold to the customer (number of units in the package). Moreover, the weight of the package is not marked on the package, not published, and may vary from one product to another where the products are completely identical from the consumer's standpoint (for instance, between various barcodes of simple plastic cups).[19] This means that the consumer has no practical way of knowing what the effective tax is on the product he is buying, and even more so has no way of comparing it to the actual increase in the price of the product.

This section compares the actual price increases with the set level of the tax. For this purpose, we consider the average price of the cups. However, the data show that there is tremendous variance in the rate of the price increases. In the following sections, we will examine the factors that may explain this variance.

Even though all calculations in the study relate to the price per kilogram, Table 2 presents the numbers also in terms of the package's consumer price in order to illustrate the scope of the prices that the consumer actually sees. The "translation" of the excise to the additional price per package sold to the consumer depends on the number of cups in the package and their weight. The tax liability ranges from NIS 1.7 to NIS 2.7 per package of 100 cups (according to their weight), which was between 37 and 50 percent of the average price during the base period (Columns 5 and 6 in the table). Looked at slightly differently, the tax was the equivalent of 42 percent of the price per kilogram during the base period. This means that the tax rate is very substantial.

In practice, the average price of a package of cups increased by 70 percent, markedly higher than the increase implied by the tax (Column 4 compared with Column 6).

[17] The tax also applies to existing inventory, other than some reservations in Section 3 of the Order.

[18] For a review of findings regarding the speed of response, see Cawley and Frisvold (2017).

[19] We found that the weight of the cups defined as "simple" ranges from 130 to 210 grams per hundred cups. The weight of the cups with a volume of 200 ml ranges from 190-210 grams per hundred cups. The weight of cups with a volume of 180 ml ranges from 130-170 grams per hundred cups.

Table 2: Tax level and actual change in the average price of cups

	Average price during the base period (Aug 15 – Oct 15, 2021) (NIS) (1)	Average price after the imposition of the tax (Nov 7-30, 2021) (NIS) (2)	Change in average price (NIS) (3)=(1)-(2)	Rate of change in the average price (%) (4)	Tax liability (NIS) (5)	Rate of change derived from tax liability (%) (6)
Per package of 100 cups	5.5	9.3	3.8	70%	1.7–2.7	37-50%
Per kilogram of cups	31.0	53.2	22.3	70%	12.87	42%

Price per package: Simple average of the prices in all observations. The prices of packages of 150 cups were equivalized to the price of a package of 100.
Tax liability per kilogram – As set in the Order, plus VAT.
Tax liability per package – The rate relates to the lowest (130 grams per 100 cups) and highest (210 grams) weight of cup packages from among the barcodes in the sample.

As discussed in Section 2 above, according to economic theory, if the market is not perfectly competitive, the change in price due to the imposition of a tax may be less than the tax—such that the producer and the consumer split the cost—equal to the tax, or even greater than it (a pass-through of greater than 1 in the effect on the consumer price). In contrast, under perfect competition, a pass-through of greater than 1 is not possible. The actual increase in the price above and beyond the tax liability supports the possibility that the market is not operating under perfect competition due to the structure of the market's supply side or because the information available to consumers is incomplete. In particular, the lack of sufficient information regarding the price change implied by the tax may make it easier to increase the price excessively.

As mentioned previously, the way the tax was defined makes it very difficult for consumers to interpret it in terms of consumer price. The policy implications of this are discussed below. The relative rigidity of demand for cups, or other features of demand, may also contribute to the magnitude of the price increase. In order to examine these possibilities, and in order to learn the extent to which the tax and the additional price increase that accompanied it affected the quantity purchased (at least in the supermarket chains), a study that will also look into the quantity sold (data that we do not have) is necessary.

Another potential explanation for the sharp increase in price is that the extensive publicity that accompanied the imposition of the tax created a public "justification" to raise prices. This, alongside the consumer's difficulty in identifying the change in price due to the tax, made it easier to raise prices. Moreover, as opposed to other processes that gradually raise the producer's costs (such as an increase in the prices of raw materials), the fact that the tax was introduced on a set date made it easier for retailers to carry out a relatively large one-time price increase. As we saw above, most supermarket chains were quick to attach the price increase to the date the tax took effect, and did not choose, for instance, to raise prices gradually. It is also possible that suppliers or retailers exploited the opportunity in order to raise prices that they wanted to increase earlier but did not due to concerns over consumers' reactions in the absence of a visible justification. Hendel et al. (2017) analyzed the effect of the "cottage cheese protest" in 2011 on the price of cottage cheese and the quantity sold, and argue that the reduced ability to raise the price of cottage cheese was apparent even six years after the protests. According to them, the findings show a significant concern on the part of firms regarding consumers' response to price increases. Cabral and Fishman (2012) offer

a theoretical explanation for the fact that producers are deterred from increasing prices following a small increase in the cost of production, due to concern that it would encourage consumers to compare the prices of competing producers, and may therefore harm their sales.

An argument can be made that the price increase was also necessary in view of the increase in the costs of raw materials at that time. In the months preceding the imposition of the tax, there was a significant increase in the prices of "plastic" raw materials. However, an examination of the behavior of the Producer Price Index and of the consumer price of similar products shows that we cannot attribute most of the increase in the price of cups to an increase in the prices of raw materials (see Section 7). Finally, one can argue that the acceleration of inflation in Israel to an annual pace of about 2 percent in the months prior to the imposition of the tax—although inflation was still within the target range—and news of rising raw material prices around the world, also contributed to the public atmosphere that was more accepting of the excess increase in the prices of the cups.

6.3 Variance in the rates of the price increases—general overview

Alongside the marked increase in the average price of cups due to the new tax, the rate of increase varies greatly between stores. Below, we analyze this variance and examine a number of factors that may explain it. The analysis can also show the nature of the market, and how a uniform shock to the cost of a product is translated to significant differences in the increase of the consumer price among various sellers.

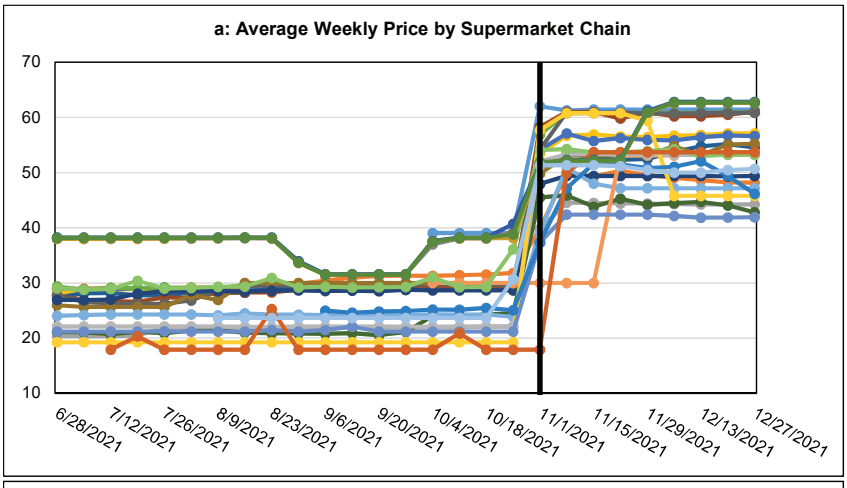
We begin our analysis of the variance in the price increase with two dimensions of the market's supply side: the variety of brands (barcodes), and the supermarket chains. Figure 2c shows that the variance in the price increase between different stores selling the same barcode is much greater than the variance between the average price of the various barcodes.[20] This is consistent with the assessment that consumers do not consider the brand of disposable cups to be important, and we therefore must seek other factors to explain the variance in the price increase. Another point strengthening this assessment is the fact that only about one-sixth of the stores sold more than one barcode (among the barcodes in the sample, Table 1), which may indicate that the stores do not see demand for variety in this product.

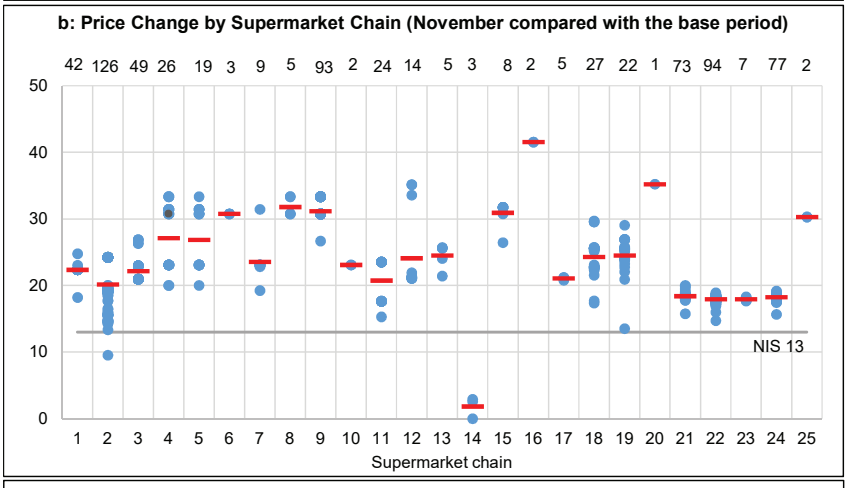
Figure 2a shows that even before the tax was introduced, the price of the cups varied between the chains, and that this variance increased after the tax was introduced. This means that the rate of the price increase due to the tax also varied between the supermarket chains. It should be noted that Hendel et al. (2017) also found a marked increase in the spread of prices between the stores due to the "Cottage Cheese protest".[21] In contrast, the high uniformity in the timing of the price increase due to the new tax is clear, and it is also clear (Figure 2b and 2c) that almost all stores raised the price by more than NIS 13 per kilogram) (the increase implied by the tax). Figure 2b indicates variation between stores of the same supermarket chain with regard to the rate of the price increase, which may attest to other factors, such as the store's location, influencing the price increase. The regressions below will help us examine the effect of a number of such factors.

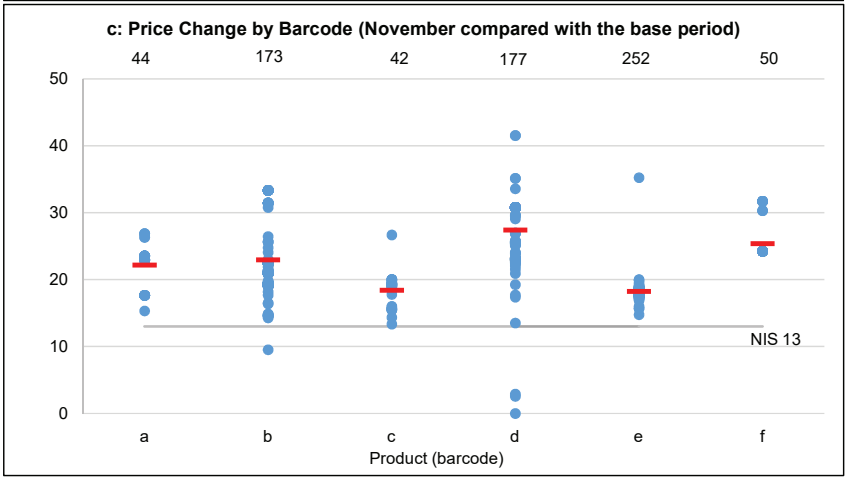
[20] Figure 2c shows that the variation within one of the brands is particularly small, despite the high number of stores selling it. This has to do with the overlap that exists in this case between the brand and the supermarket chain. This overlap also shows that the distinction between the two dimensions—brands and supermarket chains—is not completely clearcut.

[21] They show the increase in the spread of prices between stores in each format (low-cost chains, convenience stores, regular grocery stores, and so forth), but do not indicate whether the increase in the variance was between the chains or within them.

Figure 2
Prices and Price Changes of Single-Use Cups by Supermarket Chain and Barcode







Figures 2b and 2c: Each dot represents a barcode sold at a particular store. Various barcodes that are sold at the same store, and various stores that sell the same barcode, each appeaer as a separate dot. The number of dots appearing in the figures is less than the number of observations, due to overlap between many dots. The red line denotes the average change at each supermarket chain and for each barcode respectively.
The numbers at the top of Figure 2b represent the number of observations included in the sample at each supermarket chain. The numbers at the top of Figure 2c represent the number of observations in which each barcode is sold.
SOURCE: Based on price data published on the supermarket chains' websites.

6.4 Estimating the factors that influence the price change after the introduction of the tax

The analysis thus far shows that the change in the price per kilogram following the introduction of the tax at the beginning of November 2021 was significantly greater than the tax that was introduced, and that the magnitude of the change varies, both among the various barcodes of simple single-use cups and among the supermarket chains. This section presents the findings of an estimation of a linear regression, the aim of which is to assess what factors explain the variance in the change of the price per kilogram. The dependent variable is the change in price between the two periods (converted to shekels per kilogram) of a package of cups with a certain barcode, sold in a certain store.

Table 3a: Results of the basic estimation
Dependent variable: Change in price (NIS per kg) of a package of single-use cups

	1	2	3	4	5	6	7	8
Constant	22.6*** (0.20)	24.5*** (1.12)	22.2*** (0.60)	27.4*** (1.15)	35.7*** (1.16)	38.1*** (1.71)	22.5*** (0.20)	27.4*** (1.15)
Price per kg before the tax was introduced					-0.43*** (0.04)	-0.42*** (0.05)		
Dummy for supermarket chain		√		√		√		√
Dummy for Haredi supermarket chain							1.93* (1.05)	
Dummy for barcode			√	√		√		√
Dummy for online site								-0.63 (0.87)
Adj. R2	0.00	0.80	0.45	0.85	0.14	0.86	0.00	0.85

*** is statistically significant to a level of 1 percent; ** - 5 percent; * - 10 percent. The standard deviation appears in parentheses. Number of observations in each estimation: 805.

Table 3a summarizes the main results of the estimation, including a number of store characteristics.[22] Column 1 shows the estimation with a constant only, and therefore shows the average change in the price per kilogram. As shown in Table 2, we find that the average increase in the price per kilogram was about NIS 22, much greater than the price increase implied solely by the tax.

As stated above, the sample includes 25 supermarket chains, and we treat subsidiary chains belonging to the same parent chain as separate chains. Columns 2 and 3 show the same estimation, with the addition of dummy variables for chain and barcode separately, and Column 4 shows the estimation with both the chain and barcode dummies. It is the distinction between the chains that contributes the most substantial explanation to the variance in the price change (Column 2 compared to all the other columns). In particular, its contribution to the explanation of the variance is far greater than that of the distinction between the various barcodes. The coefficients obtained for the various supermarket chains (which are not presented

[22] The results in the table relate to the basic sample, which includes 59 observations for stores located outside the cities or towns, and 8 observations relating to supermarket chains' online sites. This is in contrast with the smaller sample that includes only physical stores in localities that are cities or towns, and which serves for estimating regressions that also include demographic variables (Table 3b). The estimation of the specifications shown in Table 3a for the smaller sample barely changed the results.

in the Table) show sizable differences between the chains in terms of the size of the price change. These differences can reach up to about NIS 15 per kilogram (without the two outliers). In contrast, the differences in price increases between barcodes are smaller—NIS 8 at the most. Despite the dominant role of the differences between chains in explaining the variance in the price increases, the data we have do not enable us to analyze the reasons for these differences.[23]

Columns 5 and 6 show the contribution of the price before the introduction of the tax to explaining the variance in the price change. In this case as well, most of the explanation has to do with the variance between chains. We do not find significant evidence that the price increase in stores belonging to chains appealing to the *Haredi* community was any different than at stores belonging to other chains (Column 7).[24] Column 8 shows that there is no significant difference between prices posted on the chains' online sites and the prices in the physical stores.

Table 3b shows additional estimations where we examined whether the demographic characteristics of the population living in the locality in which the store operates have an effect on the price change in response to the introduction of the tax.[25]

Columns 1 and 3 show that neither the wage nor the rate of *Haredim* in the locality on their own contribute any explanation for the variance of the price response to the tax in various stores.[26] It seems that the larger the locality is (Columns 5 and 6), and the higher the average wage is (Column 6), the greater the increase in price was. However, the shekel difference between the price increase in the various localities was lower than the differences we saw between the various supermarket chains, some of which operate in the same localities. Thus, the difference between the largest and smallest localities in the sample reaches about NIS 3, while the difference between the localities with the highest and lowest wages reaches about NIS 4.3. If we include the dummy variables for supermarket chain and for barcode in the estimation, the explanatory power increases dramatically, similar to the results in Table 3a, and the contribution of the demographic variables disappears. It therefore seems that a store's attachment to a particular chain provides significant information on the behavior of prices, and obviates the need for information on the demographic characteristics of the locality.

The importance of the supermarket chains, as opposed to the locality's characteristics, to the ability to explain the variance in the price increase may be affected by the fact that we are examining locality-level data rather than more detailed data such as neighborhood or statistical area. This examination does not enable us to take into account the large variance within the locality, either with regard to product prices

[23] We do not have the necessary information regarding various characteristics of the supermarket chains. For instance, we cannot properly classify all chains in the sample as either "discount", "premium", or other categories. We also do not have information regarding the price at which the chain purchases the product from the supplier, or regarding the nature of their contract. The differences between chains may also reflect other considerations having to do with their pricing policy, their customers, and so forth. We have no access to this type of information either.

[24] Shahrabany (2021) found that the price of cooking gas was lower in Haredi localities than in others. A possible explanation that he offers is the relatively heavy use of this product, as well as perhaps community organization that works to lower the prices offered in those localities. It should be noted that our sample does not include all of the chains that target the Haredi sector.

[25] The number of observations in these estimations is lower than in Table 3a, because they relate only to localities for which there are data regarding characteristics of this type, as explained above.

[26] Alternatively, we also examined the share of large families in the locality and the locality's socioeconomic cluster, which are both correlated (in opposite directions) with the average wage in the locality, and we did not find that either had any statistically significant effect. We related to the rate of Haredim (and large families), since this sector uses disposable goods heavily, and the public discussion surrounding the new tax dealt a lot with its impact on this sector. In this regard, see Ministry of Environmental Protection (2020) and Eliyahu (2021).

Table 3b: Estimation results—demographic characteristics

Dependent variable: Change in price (NIS per kg) of a package of single-use cups

	1	2	3	4	5	6	7
Constant	18.8***	27.2***	22.4***	27.5***	17.6***	20.6***	33.0***
	(2.33)	(1.42)	(0.26)	(1.02)	(1.97)	(2.87)	(2.33)
Price per kg before the tax was introduced						-0.40***	-0.22***
						(0.04)	(0.08)
Log of average wage in the locality	1.47	0.07				3.59***	0.30
	(0.98)	(0.40)				(0.95)	(0.40)
Percentage of Haredim in the locality			-0.00	-0.00			
			(0.02)	(0.01)			
Log of population size in the locality					0.40**	0.50***	-0.07
					(0.17)	(0.16)	(0.06)
Dummy for supermarket chain		√		√			√
Dummy for barcode		√		√			√
Adj. R^2	0.00	0.87	0.00	0.87	0.00	0.13	0.88

*** is statistically significant to a level of 1 percent; ** - 5 percent; * - 10 percent. The standard deviation appears in parentheses. Number of observations in each estimation: 738.

or with regard to the identity of the chains operating in that locality. For instance, Eizenberg et al. (2021) document a high level of variance between neighborhoods in Jerusalem in terms of the prices of groceries. Some of the variance between chains is also reflected in their location within the locality (for instance, commercial areas vs. residential neighborhoods or the city center), such that price differences between the chains may also reflect differences between the areas within the locality. As Eizenberg et al. (2021) note in their study, price differences within the locality may endure over time, partly due to entry barriers that make it difficult for additional stores to enter residential neighborhoods, which increases the market power of the existing stores.

The estimations presented here illustrate, as we have seen above, that the price of the single-use cups increased far more than the increase implied by the tax alone. Beyond that, the main insight gleaned from these estimations is that belonging to a supermarket chain explains much of the variance. Since each chain sells a small number of barcodes, and each barcode is sold only at a small number of chains, there is some correlation between the brand and the chain. However, it seems that the important variable is the supermarket chain, and that the barcode is less important, since we can assume that consumers do not attach much importance to the brand (barcode) of the generic single-use cups we examined.

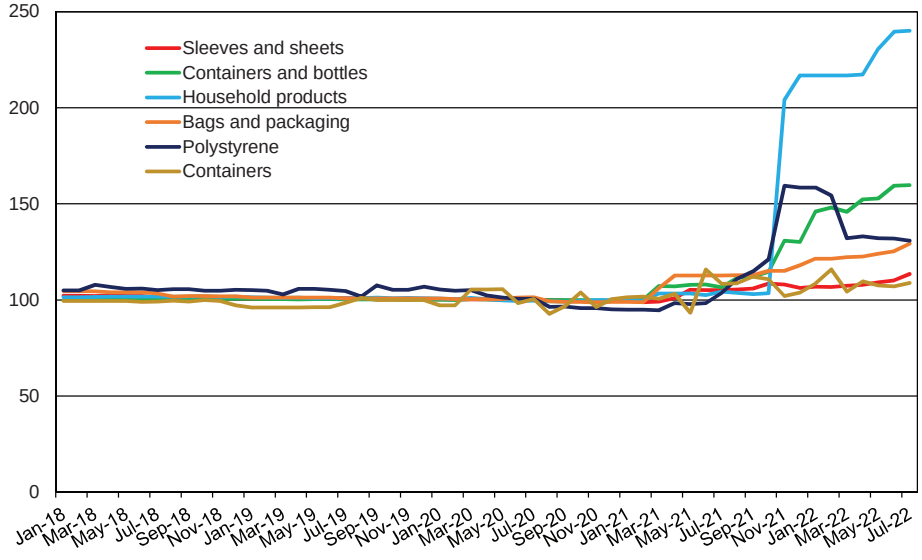
7. CONTROL GROUP: OTHER PLASTIC PRODUCTS

The analysis presented in this work indicates that the price of single-use cups increased at the beginning of November, significantly more than the increase that would have been due to the new tax.

One possible argument is that, in addition to the tax, the change in the consumer price of the cups reflects an adjustment to the increase of global prices of raw materials. During the reviewed period, there was indeed a significant increase in the producer prices of similar products. In order to obtain an impression of the price changes of products based on similar raw materials, we examined the manufacturing producer price indices for the domestic market, as measured by the Central Bureau of Statistics.[27] Figure 3 shows the indices for a number of such products. The prices of plastic boxes increased by only 7 percent during 2021 (December 2021 compared with December 2020). The prices of packaging bags increased by 19 percent, and the prices of plastic containers and bottles increased by about 30 percent.

In contrast, the prices of plastic housewares, which include the prices of single-use products, increased by about 120 percent, almost all of which was in November—when the tax was introduced. Polystyrene prices also increased sharply in November, apparently at least partially reflecting the tax, since the tax also applies to single-use products made of this material.[28] These data indicate that the price increase with the introduction of the tax may also have included a response to the increase in the prices of raw materials. However, based on these raw data, we cannot assess whether the rate of increase in the producer's price reflects an excess increase in the price compared to the new tax, or whether, to the extent that there was such an excess increase in the producer's price, it was in line with the increase in the prices of raw materials.

Figure 3
Producer's Price of Various Plastic Products (index)



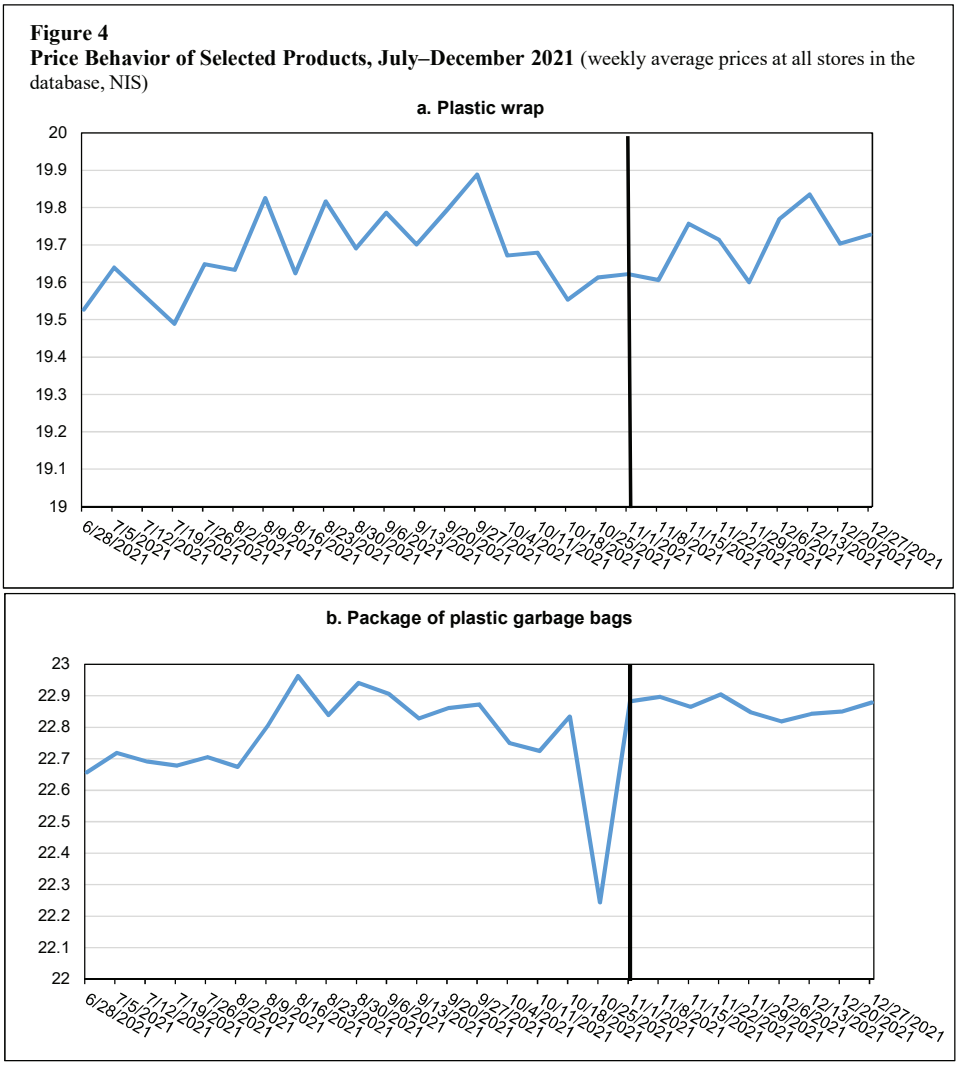
SOURCE: Central Bureau of Statistics.

[27] These prices reflect the price that the producer receives when selling to a direct purchaser, and include purchase tax and VAT.

[28] The fact that the increase in the producer's price of polystyrene was much smaller than that of plastic housewares is consistent with the fact that polystyrene has many other uses, beyond the production of single-use products. The tax did not apply to these other uses, and so did not affect their price.

We can also compare the increase in the price of single-use cups to the change in the consumer prices of other products sold by the supermarket chains, which are made of similar raw materials, but are not subject to the tax. Figure 4 shows the behavior of the prices of two such common products. The fact that we cannot distinguish an increase in price in the last two months of 2021 apparently weakens the argument regarding the increase in raw material prices, since such an increase should have led to similar behavior of the consumer price for the comparison products as well. However, as mentioned above, insofar as the changes in cost are relatively small, sellers may avoid raising consumer prices out of concern that the consumers would shift their purchases to competitors.

Figure 4
Price Behavior of Selected Products, July–December 2021 (weekly average prices at all stores in the database, NIS)



Each of the figures relates to a particular barcode (the defined product of a particular supplier). The vertical line represents the beginning of November, at which time the tax was applied on single-use products.
SOURCE: Based on price data published on the supermarket chains' websites.

8. CONCLUSION AND POLICY IMPLICATIONS

Following the introduction of a tax on disposable products, the prices of simple single-use plastic cups increased sharply—far beyond what should have been the result of the tax. The findings are consistent with the theoretical literature, which shows that such a result is possible given certain features of the market structure and of demand. They are also consistent with numerous empirical studies regarding the effect of similar taxes introduced abroad. We further found that the increase in prices was immediate in most stores, but that the rates of increase varied greatly between them. A large part of this variance was due to differences between the supermarket chains. However, the data do not allow us to analyze the chains' characteristics that may explain these differences. The results demonstrate how a uniform shock to the cost of production—in our case a purchase tax—may have a very different impact on the price for different customers.

The marked increase in the price of the cups beyond what would be derived from the tax raises interesting policy questions. As explained in detail, determining the tax as a set excise per kilogram means that the consumer is practically unable to figure out the level of the tax imposed on the product he is purchasing, or to compare it to the actual price increase. Insofar as this contributed to the price increase beyond what was derived from the tax, we can learn significant policy lessons, mainly having to do with increasing transparency for the consumer. This insight indicates a need to find the proper balance between defining the tax in a way that simplifies its collection or that is in line with achieving its objective and defining it in a way that is understandable to the consumer.

Setting the tax as a percentage of the consumer price would have made it easier for the consumer to compare it to the actual price increase. However, it may undermine the tax's ability to achieve its objective (reducing the use of plastic for environmental reasons), since the link between the tax level and the weight of plastic in the product is weaker. Moreover, setting the tax as a percentage of the price is common with regard to general purchase taxes, while taxes on specific products such as fuel, cigarettes, and alcohol are generally imposed as a set excise. In view of these considerations, and taking into account that the various disposable products are not sold to the consumer by uniform units regarding which the tax can be levied, the use of a set excise can be accompanied by obligating producers or importers to mark the product weight on the package, and even to mark the amount of the resulting tax.[29]

[29] The obligation to add information on the packaging to help customers exists with regard to a variety of products. The marking of nutritional information on food products is an important example in this regard, since it also provides an example of adjusting information to comparable units (such as per 100 grams of product), and saves the consumer the need to calculate this on his or her own. This is also the case regarding the labelling of a product price by unit weight, and not just by package, on store shelves.

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THE LACK OF DOLLAR FUNDING IN ISRAEL AND ABROAD—AN EXAMINATION OF DEVIATIONS FROM THE CIP CONDITION[1]

- **The global economy presents multiple investment opportunities in different countries. As a result, investors worldwide are interested in investing their capital in international markets and hedging their currency exposure, for which they need dollar funding. However, a shortage of such funding has become evident in recent years worldwide and in Israel.[2] This article examines the reasons for the lack of dollar funding and how it is measured. Israel is included in the examination for the first time.**
- **One indicator in examining the lack of dollar funding is the size of the deviation from the CIP (Covered Interest Rate Parity) condition. According to this condition, the direct dollar interest rate (the rate in cash markets) and the indirect dollar rate (reflected in forward foreign-currency contracts) should be the same. Accordingly, the lower the direct dollar rate is relative to the indirect one, the more severe the lack of dollar funding. There have been deviations from the condition in most G10 countries[3] since the great financial crisis of 2008.**
- **In this article, we adopt the measuring methodology of deviations from the CIP condition in Du, Tepper, and Verdelhan (2018) but add two strata. First, we prolong the sampling period for the G10 countries by about five and a half years (from September 2016 to April 2022), covering the pandemic crisis period. Second, we add Israel to the sample.**
- **We show that deviations from the CIP condition exist in Israel as well as in the G10 countries and that their trend in Israel strongly resembles the global one—widening at around the time of the financial crisis and exhibiting a negative basis most of the time, indicating that Israel, too, has a lack of dollar funding.**

General background

The development of the global economy has given diverse sectors in various countries (e.g., high-tech industry, banks, and pension funds) multiple investment opportunities. The main transaction currency is the US dollar, and to conclude the transactions, the investors need to provide dollar funding. Such funding, however, has been lacking in recent years worldwide and in Israel. As the shortage worsens, companies incur costs beyond the ordinary ones (interest). In this article, we assess the reasons for the lack of dollar funding, examine how it is measured, and include Israel in the examination for the first time.

1 Written by Sapir Masband, advised by Daniel Nathan.

2 The examination was performed up to April 2022.

3 The G10 countries are comprised of the following ten developed markets: Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the UK, and the U.S. These countries advise each other and cooperate in economic, monetary, and financial matters.

Theoretical background

The CIP condition

The CIP condition reflects the inability to profit from arbitrage spreads. For the condition to be present, the direct dollar interest rate must be equal to the indirect dollar rate. The direct rate is that obtained on the "direct track," on which the borrower borrows dollars from the bank directly and repays the principal plus dollar interest at maturity of the contract. The indirect rate is the rate obtained on the "indirect track," in which the borrower borrows on the foreign-currency market (in an FX swap contract) in the following manner. First, the domestic currency is deposited with the bank as a guarantee. Concurrently, the borrower signs a forward contract with the bank, in which the sides agree on a future exchange rate at which the borrower, on the date of maturity, will repay the dollars and receive the domestic currency previously deposited in return to guarantee the loan. At maturity, the borrower converts the dollars at the bank at the predetermined exchange rate and then repays its debt to the bank in domestic currency plus interest at the domestic rate. Thus, the borrower avoids exchange-rate risk due to the forward contract that hedges it.

The mathematical expression of the CIP condition is as follows[4]:

$$(1 + i_d) = \frac{F}{S} * (1 + i_f)$$

where i_d is the interest rate on the domestic currency, i_f is the interest rate in foreign currency (the dollar), S is the current exchange rate, and F is the exchange rate set in forward contracts.

According to the CIP condition, as stated, the dollar interest rates on the direct track and the indirect track are in parity. If the condition is not present, arbitragers can borrow dollars at a lower rate and lend them at a higher rate, thus reaping a risk-free arbitrage profit.[5]

The "basis" as an indicator of deviation from the CIP condition

One way to determine whether the CIP condition obtains is by calculating the "basis," defined as the difference between the direct and indirect dollar rates. When the condition is present, the basis must be equal to zero. By and large, as is found in the literature and as shown below, the basis has been negative for most G10 countries (apart from Australia and New Zealand) since the 2008 financial crisis. A negative basis attests that the indirect dollar rate is higher than the direct one, signifying a lack of dollar funding.[6]

The market—the 2008 great financial crisis

Although most international transactions take place in dollars, many players in international markets cannot borrow dollars directly. This gives financial intermediaries (large global banks) a critical role in supplying

4 The mathematical presentation is simplified here. Its exact form appears in Appendix 1.

5 Notice that both rates build in exactly the same risk, such that their spread does not build in risk differentials.

6 Here we relate to developed countries in which the supply of dollars was totally elastic before 2008. In this situation, the indirect and direct interest rates were in parity due to arbitrage conditions. In some developed countries, the spread may be indicative not of a dollar shortage but of a lack of competition in the market.

dollars internationally. The great financial crisis of 2008 affected this supply considerably, inducing many regulatory reforms in the banking sector that resulted mainly in crimping the banks' supply of liquid dollars. This contraction of dollar supply breaches the CIP condition considerably. The literature refers to various factors that explain the deviation from the CIP condition. The explanations of focal concern to us are based on restrictions that have applied to the banks' balance sheets since the 2008 crisis.

Restrictions on dollar supply: One of the major regulatory reforms that banks faced in the aftermath of the 2008 crisis was the need to maintain a supplementary leverage ratio to minimize their risk exposure. This requirement, which obliged banks to hold capital against all assets at a rate irrespective of the characteristics of asset risk, adversely impacted the supply of dollar funding and led to the development of a negative basis.

Before the 2008 crisis, the supply of dollar funding and hedging in the swap market was totally elastic, due to the lack of restrictions on cash. The flat supply curve at zero basis before the crisis (i.e., when the CIP condition was present) reflects that the financial intermediaries incurred no cost when they offered their dollars on the swap market, irrespective of the quantity in demand. Had the deviations from the CIP condition been other than zero at the time, players in the swap market, free of balance-sheet regulatory restrictions, would have borrowed dollars at the lower rate and lent them out at the higher rate.

After the 2008 crisis, and due to new regulations intended to stop banks from taking excessive risks that might adversely impact their financial stability, large banks had to deal with steadily escalating balance-sheet restrictions. The new rules made it more expensive for banks to supply the large amounts of dollar funding needed to hedge their services on the swap market. Consequently, the supply curve for dollar funding sloped upward. The high balance-sheet cost of supplying dollar liquidity on the swap market became a major determinant of the persistence of deviations from the CIP condition in the post-crisis period. In other words, after the crisis, the banks had to be compensated for larger deviations from the CIP condition to agree to increase their supply of dollar funding on the swap market. When the supply curve rises, changes in demand for dollar funding (and hedging) may induce volatility in the equilibrium of the deviation from the CIP (in contrast to a situation where the supply curve is totally elastic). The supplementary leverage ratio requirement was perceived as a grave regulatory restriction of arbitrage in the short term because it limited the size of global banks' positions.

Before the Basel III rules were adopted, most capital-market regulations that coped with large global banks found expression in the "risk-weighted capital" requirement, which required banks to hold capital at a level that would suffice to cover risk assets. The Basel III rules added the compulsory limitation of the leverage ratio. According to these regulations, global banks had to hold an adequate scale of capital against all assets irrespective of their risk characteristics. Before the Basel III rules were adopted, banks outside the United States did not have to contend with any compulsory limit on their leveraging rate. For American banks, the compulsory level rose from 3 percent to 5–6 percent.

Surplus dollar demand: Given the condition of the dollar reserves and the low interest rates in Japan and Europe after the 2008 crisis, demand for dollar funding for hedging dollar assets remained strong, particularly among market players outside the United States. Such players are often willing to pay fees to financial intermediaries.

We distinguish among three types of customers who are willing to pay fees to financial intermediaries:

1. *Banks outside United States that are not leading banks at the global level:* These banks find it hard to break into the direct-dollar-loan market (both as borrowers and as lenders) and, insofar as they succeed, they do so at a high cost. At the same time, they have access to safe deposits in domestic currency; therefore, they choose to raise dollar funding in the foreign-currency market to finance their assets in which the dollar is dominant.

2. *Institutional investors outside the United States (pension, insurance, and other funds)*: Even though these entities have liabilities in domestic currency, they choose (or are required by law in certain countries) to invest much of their portfolio in dollar-dominated assets.

3. *Nonfinancial corporations that borrow in a wide range of currencies:* These entities may incur asymmetric funding costs relative to the risk-free domestic benchmark because the equity markets trade in different currencies. Therefore, they may choose to invest in the inter-currency swap market in order to minimize their funding costs.

Given the points above, large deviations from the CIP condition may reflect a lack of dollar funding supply among financial intermediaries and growing demand for dollar funding among final borrowers.

Analysis—deviation from the CIP condition

Inspired by Du et al. (2018), we calculated the basis for the G10 countries and added Israel. The basis was calculated using an interest rate reflected in three-month forward contracts. In their study, Du et al. (2018) examined the basis for 2000–16 and found that deviations from the zero basis began during the 2008 financial crisis and widened afterward. Our study examines the 2006–16 period and adds 2017–22 (up to April 1, 2022) for all G10 countries.[7]

As Du et al. show, major deviations from the CIP condition first occurred in 2008 and continued vigorously for five years after the crisis. Afterward, they slackened until the beginning of 2020, when a major deviation from the condition occurred due to the COVID-19 pandemic.

The COVID-19 pandemic

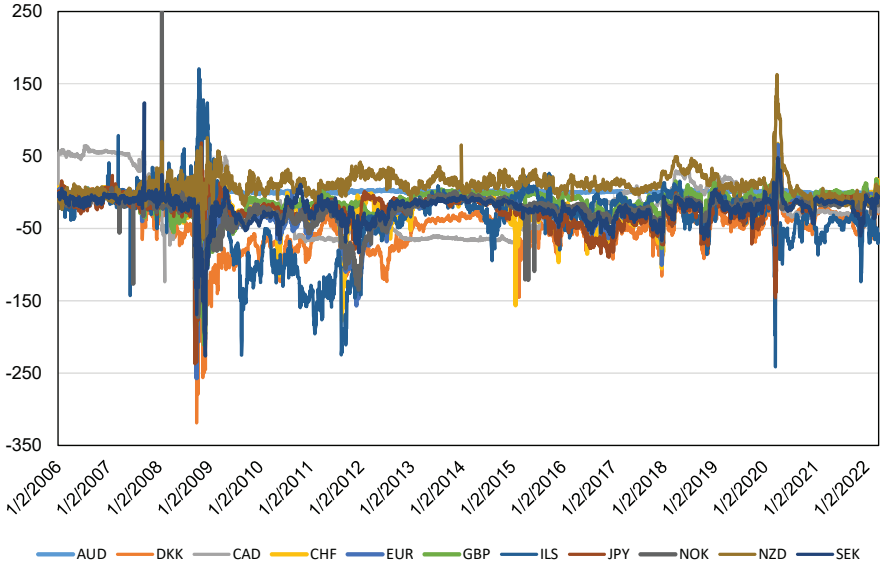
The pandemic induced major deviations from the CIP condition due to demand- and supply-side factors in the dollar funding market. According to Avdjiev, Eren, and McGuire (2020), institutional investors are the key players on the demand side. As stated, these investors have domestic-currency liabilities, but their investment portfolios are diversified at the global level and contain a considerable share of dollar assets. To finance the dollar assets, these investors sign swap contracts to convert domestic currency into dollars and gain access to dollar funding. These investors' asset portfolios grew from the 2008 crisis onward, and so, in tandem, did the need to hedge the assets. The same happened in Israel (Nathan and Ben Zeev, 2022).

On the supply side, banks and other financial intermediaries get their supply of dollars from the global financial markets. In the decade following the 2008 crisis, however, banks that provide hedging services

[7] As stated, we began in 2006 and not in 2000 because Du et al. found in their earlier study that the basis from 2000 to 2008 was zero.

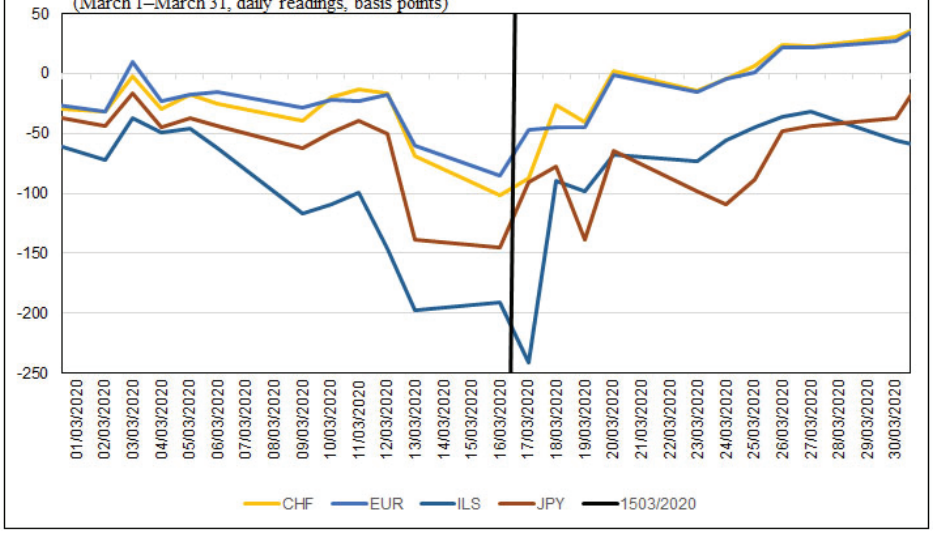
played a declining role in the overall financial system, as reflected in the narrowing of lending margins because of low interest rates and tougher regulation. The financial crunch that began with the COVID-19 pandemic induced a steep decrease in the supply of bank hedging services. Concurrently, US and European

Figure 1
Deviations from CIP Condition based on Interest Originating in 3-Month Forward Contracts in Israel and G10 Countries (January 2, 2006–April 1, 2022, daily readings, basis points)



Note: The data were obtained from quotes by international banks. The basis presented is the difference between the direct dollar interest rate and the indirect rate in annual terms. The direct rate is the USD OIS rate; the indirect rate is our calculation.

Figure 2
Deviations from CIP Condition based on Interest Originating in 3-Month Forward Contracts in Israel, Japan, the Eurozone, and Switzerland in March 2020
(March 1–March 31, daily readings, basis points)



Note: The data were obtained from quotes by international banks. The basis presented is the difference between the direct and indirect dollar interest rates. The direct rate is the USD OIS rate; The indirect rate is our own calculation using the following data: the spot rate of the domestic currency against the dollar, the forward rate as determined in three-month contracts, and the interbank rate in the country in question.

prime money-market funds, traditional providers of dollar funding, dwindled as investors redeemed their holdings to raise liquidity because of the pandemic, resulting in a smaller supply of dollars.

It is easy to see in Figure 2 how the deviation from basis worsened in March 2020. It crested around March 15, the day on which the Federal Reserve announced an increase in its swap lines with five central banks. It may also be seen that the shortage of dollar funding negatively impacted the Israeli foreign exchange market. As a result, the Bank of Israel announced on March 16, 2020, that it would begin providing the market with dollar liquidity in swap transactions.[8] The figure demonstrates how the lack of dollar funding (in March 2020, when the pandemic erupted) manifested in a steep deviation from the CIP condition.

Before we discuss the Israeli case, we should note that the deviation from the CIP condition, reflected in a nonzero dollar basis, is a global phenomenon. Table 1, presenting the matrix of coefficients between the various currency bases and the dollar, shows that the correlations are positive en bloc, and their mean is positive and high at 0.74. These findings indicate the presence of a rather strong covariance among the bases of the various currencies and the dollar, attesting that when a lack of dollar liquidity occurs, it crosses borders and currencies.

Table 1
Coefficient matrix among currency bases

	AUD	DKK	CAD	CHF	EUR	GBP	ILS	JPY	NOK	NZD	SEK
AUD	1										
DKK	0.791719	1									
CAD	0.480682	0.43523	1								
CHF	0.730842	0.836691	0.804667	1							
EUR	0.865994	0.946798	0.561733	0.87011	1						
GBP	0.73921	0.796622	0.302921	0.609718	0.882554	1					
ILS	0.834841	0.69298	0.536448	0.716955	0.780833	0.581822	1				
JPY	0.369095	0.525675	0.829188	0.845004	0.527297	0.153489	0.466786	1			
NOK	0.821052	0.923257	0.647833	0.900194	0.926969	0.738963	0.705361	0.636906	1		
NZD	0.813397	0.669474	0.237465	0.489395	0.764697	0.879177	0.538865	0.029335	0.61805	1	
SEK	0.811955	0.880079	0.703613	0.903327	0.935111	0.746471	0.816613	0.636292	0.944008	0.593296	1

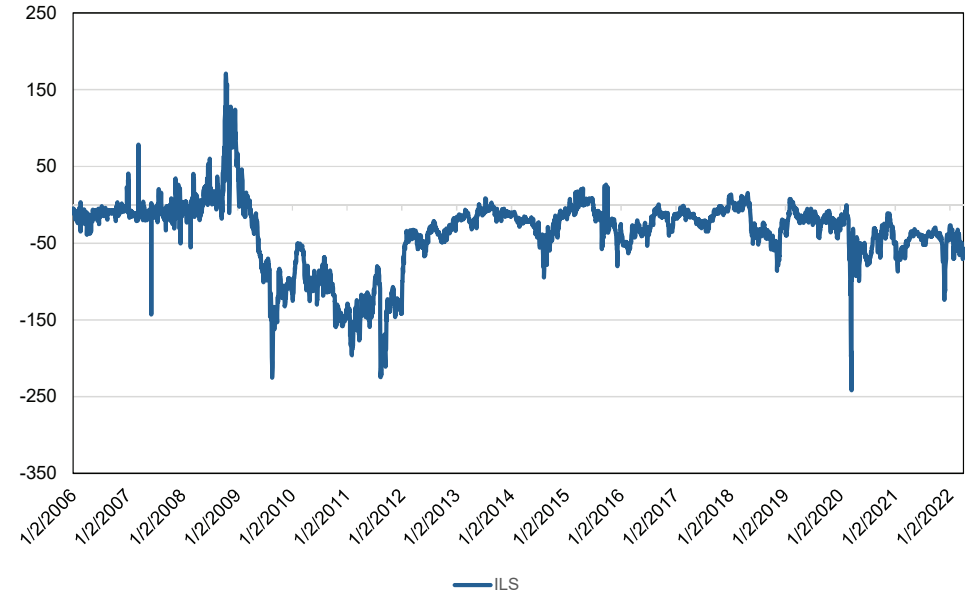
Note: The coefficients take into account the data on various currency bases throughout the sample period (January 1, 2006 through April 1, 2022). Data are daily.

We now focus on Israel. As Figure 3 shows, the trend in deviations from the CIP condition in Israel strongly resembles the global one. Israel, too, was affected by the 2008 great financial crisis and the pandemic.

Table 2 provides descriptive statistics of the USD basis in Israeli contracts to various maturities—one week, one month, and three months. The average basis for these maturities is negative, and the standard deviation is rather large. In addition, all maturities have extreme values, mainly in the negative direction (minimum values).

[8] On March 18, 2020, the program was expanded to USD 15 billion and to terms of more than one week.

Figure 3
Deviations from CIP Condition based on Interest Originating in 3-Month Forward Contracts in Israel
(January 1, 2006–April 1, 2022, daily readings, basis points)



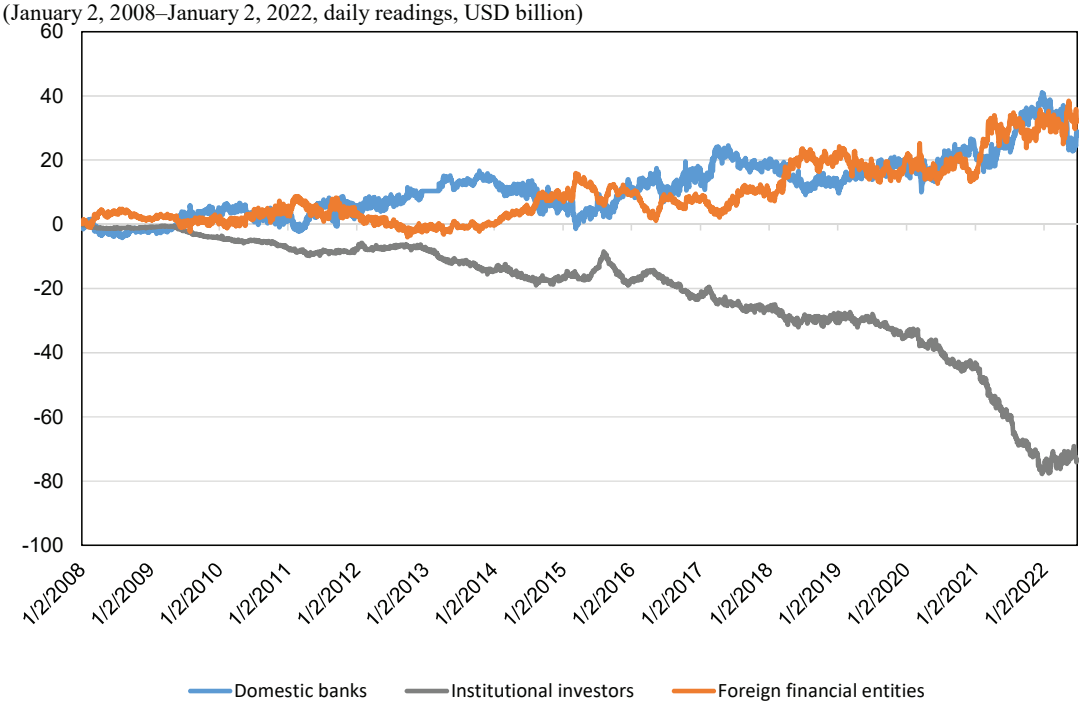
Note: The data were obtained from quotes by Israeli banks. The basis presented is the difference between the direct dollar interest rate and the indirect rate. The direct rate is actually the USD OIS rate; the indirect rate was calculated by ourselves using the following data: the NIS–USD spot rate, the forward rate as determined in three-month contracts, and the Israel interbank (Telbor) rate.

Table 2
Descriptive statistics - the dollar base in Israel over various ranges

Forward contract	mean	sd	min	max
1-week basis	-32.82	47.26	-640.70	710.81
1-month basis	-38.15	44.97	-520.20	193.30
3-months basis	-36.88	46.12	-246.10	172.10

One way of explaining the trend in Israel comes from the demand side—the diversion of much institutional investment to abroad—and from the supply side, reflected in foreign investors' involvement in the Israeli economy. As Figure 4 shows, the key players for dollar funding in Israel on the demand side are institutional investors, whose demand is consistently growing due to diverting much of their investment abroad and hedging their currency exposure through swap contracts. On the supply side, the domestic banks were the main suppliers of dollar funding in Israel until 2012. In 2013, however, foreign financial players entered the picture due to opportunities for arbitrage profits. When they came in, the supply of dollar funding grew in a way that caused the deviation from the CIP condition to narrow (Figure 4).

Figure 4
Cumulative Balances of Swap Transactions on the NIS–USD exchange rate
(January 2, 2008–January 2, 2022, daily readings, USD billion)



SOURCE: Bank of Israel processing.

Further analysis—deviations from the CIP condition increase at end-of-quarters; in Israel, too?

According to Du et al. (2018), deviations from the CIP condition widen toward end-of-quarters due to the toughening of restrictions on the banks' balance sheets and investors' renewed attention to quarterly regulatory measures. Du et al. find that the deviation from the CIP condition for one-month contracts widens exactly a month before the end of the quarter, in which the contract is expected to appear on the quarterly balance sheet. Similarly, the deviation from the CIP condition in one-week contracts widens exactly one week before the end of the quarter. In contrast, three-month contracts that appear in the end-of-quarter statement (irrespective of their payback date) exhibit no particular dynamic.

Du et al. (2018) claim that the end-of-quarter deviation became more salient after January 2015, corresponding to the change in the method of calculating the leverage ratio and with the onset of exposure of the European banks' leverage ratio to the public. These findings are consistent with the belief that tough restrictions on the end-of-quarter balance sheet given banking regulation are translated, in the period following the great financial crisis of 2008, into wider deviations from the CIP.

Du et al. tested this hypothesis and confirmed it for the G10 countries. In this article, we examine the matter for Israel. Importantly, Israel, like other European countries, adopted the regulatory restrictions on the leverage ratio as presented in the Basel III directives (Bank of Israel, *Israel's Banking System—Annual Survey, 2015,* Chapter 2, "Activities of the Banking Supervision Department"). In our examination, as Du et al. hypothesized, we find that in Israel, too, the deviations from basis widen (become more negative)

Table 3
Deviation from basis at end-of-quarter to each term—Israel

Variables	1 Week	1 Month	3 Months
End of quarter dummy	1.84	-8.93***	-2.15**
	-2.9	-1.61	-1.07
Constant	-27.8***	-30.2***	-29.1***
	-0.887	-0.623	-0.561
Observations	2,026	2,153	2,153
R-squared	0	0.019	0.002

Note: The data were obtained from quotes by international banks. The basis presented is the difference between the direct dollar interest rate and the indirect rate in annual terms. The direct rate is actually the USD OIS rate; we calculated the indirect rate by using the following data: the spot rate of the domestic currency against the dollar, the forward rate as determined in three-month contracts, and the interbank rate in the country in question. The regression was carried out on a selected part of the sample: from 2014 onward, given that regulation in Israel began in 2015. The dummy variable for each of the terms distinguishes between the last week of the quarter and the other weeks and between the last month of the quarter and the first two months. For three-month contracts, the last month in the quarter is marked. The outcomes are expressed in basis points.

toward the end-of-quarter in one-month contracts. Unlike their findings, however, we observed that in Israel, the deviations toward end-of-quarter are not significant in one-week contracts and are substantial in three-month contracts even though, according to the hypothesis of Du et al., we should not see any dynamic whatsoever toward the end of the quarter for a three-month contract (Table 3). Further research is needed to understand why the banks in Israel make three-month contracts more expensive toward end-of-quarters and do not do the same with one-week contracts.

Summary and conclusion

Since the great financial crisis of 2008, the CIP condition has not been maintained in the global markets, leaving the theoretical possibility of creating arbitrage profits. The literature shows that arbitrage profits are explained by the toughening of regulatory restrictions imposed on the banks due to the 2008 crisis. However, the deviation from the CIP did not cease when the financial crisis waned; instead, it persisted.

In most G10 countries, deviation from the CIP condition is reflected in a negative basis; such is the case in Israel as well. We see that the deviation widened again at the time of the pandemic crisis, which caused the crisis in dollar funding to worsen on both the demand and the supply sides. It is also found that the deviation from basis in one-week and one-month contracts widens at end-of-quarters in most G10

countries. In Israel, we find—as the literature shows—that the deviation from basis widens in one-month contracts but also, unlike the findings in the literature, in three-month contracts as well. We do not find this in one-week contracts in Israel, even though such a phenomenon is found abroad.

Appendix

The mathematical expression of the CIP condition follows:

where ___ is the USD interest rate and $y_{t,t+n}$ is the domestic rate. Both rates are in annual n terms/ (When $n=1$, this is an annual rate, when $n=0.25$, it is a three-month rate, and so on.) $X_{t,t+n}$ is the basis (which

$$e^{ny^{\$}_{t,t+n}} = e^{ny_{t,t+n}+nx_{t,t+n}} \frac{S_t}{F_{t,t+n}}$$

should be equal to 0), S_t is the effective exchange rate for time t, and $F_{t,t+n}$ is the forward exchange rate set in forward contracts at times t and $t+1$.

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