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

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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.)

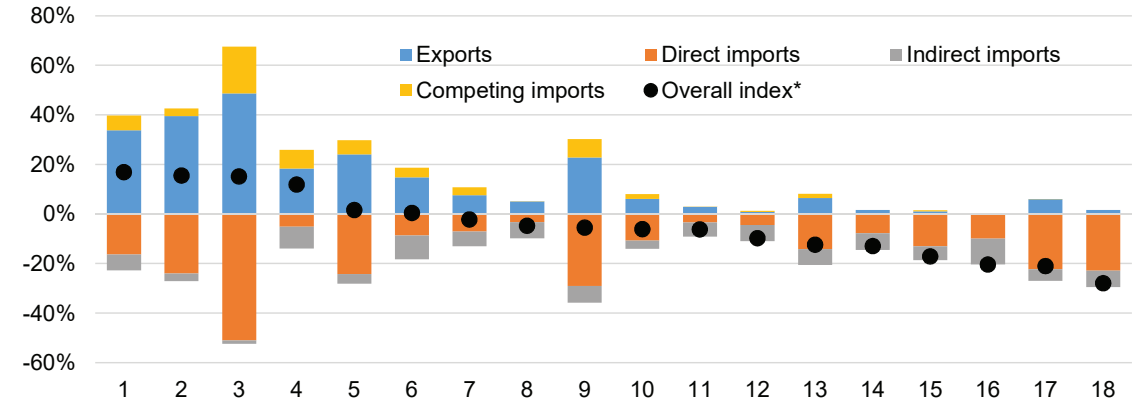
3 In a recent study, Brand and Barak (2022) found that appreciation does adversely impact manufacturing enterprises' domestic sales by increasing demand for competing imports. A. Barak and G. Brand (2022), "The Heterogeneous Effect of the Exchange Rate on Manufacturing Firms in Israel," Bank of Israel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

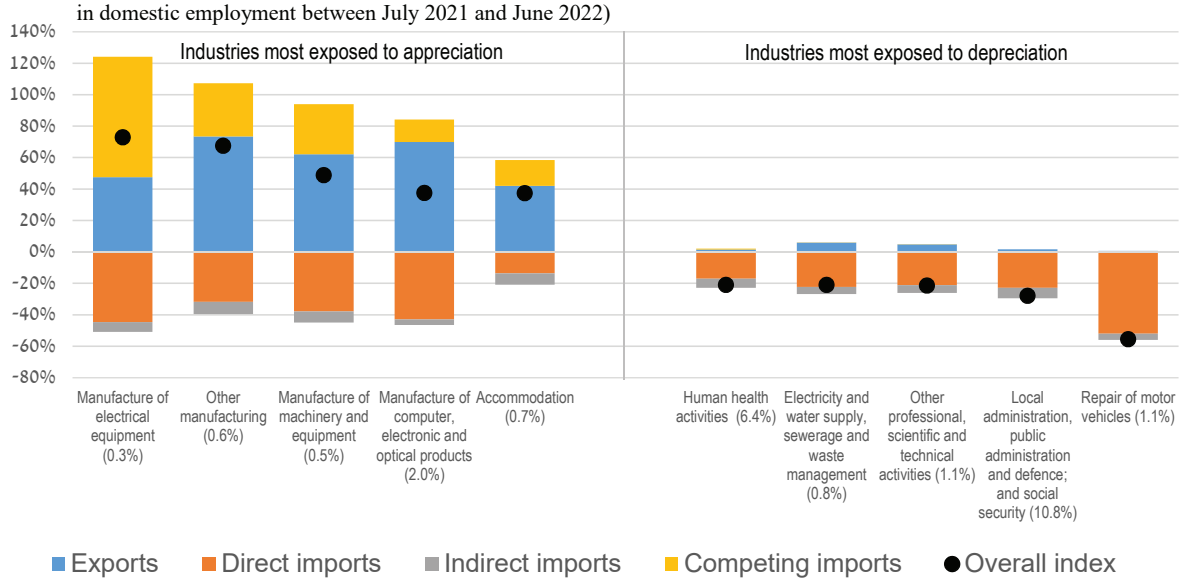
C.4 Other industries

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.

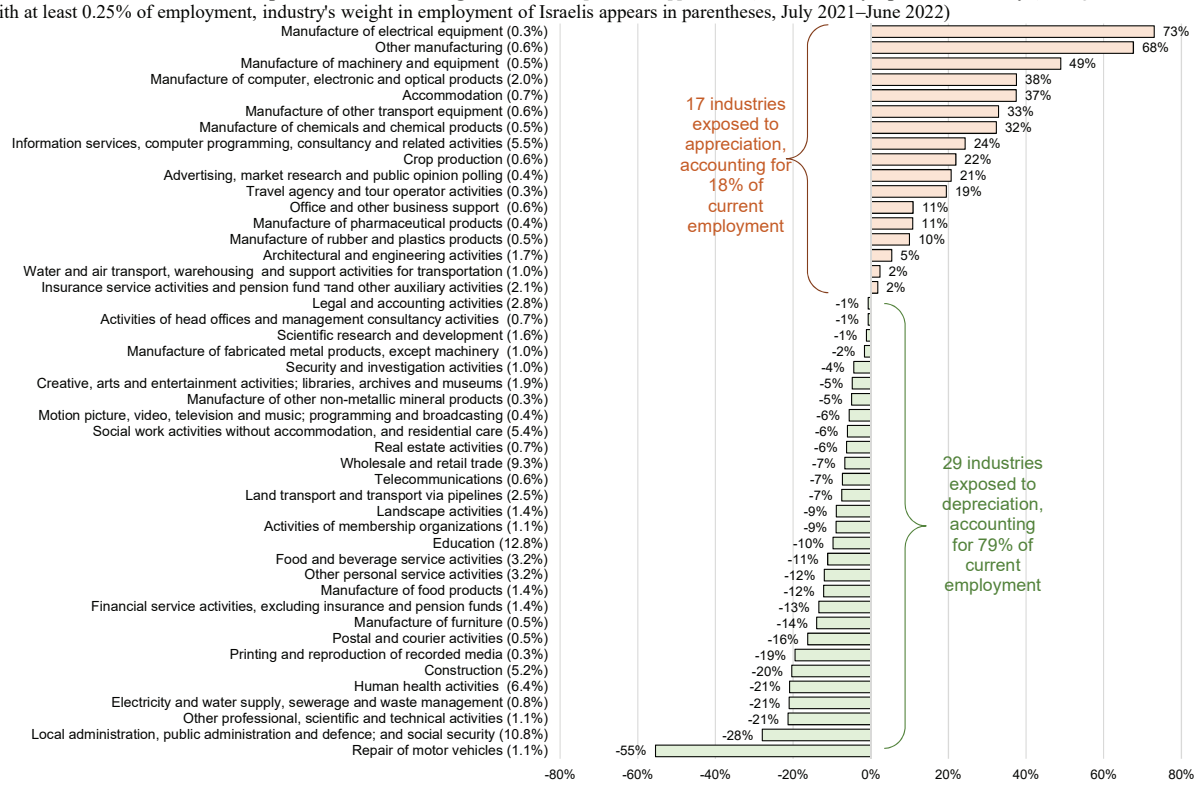
Figure 2
Total index of industry exposure to the exchange rate (a positive sign [+] denotes impairment due to appreciation) and contribution of components in the most-exposed industries
(For industries that account for more than 0.25% of employment. In parentheses next to industry name: weight of industry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

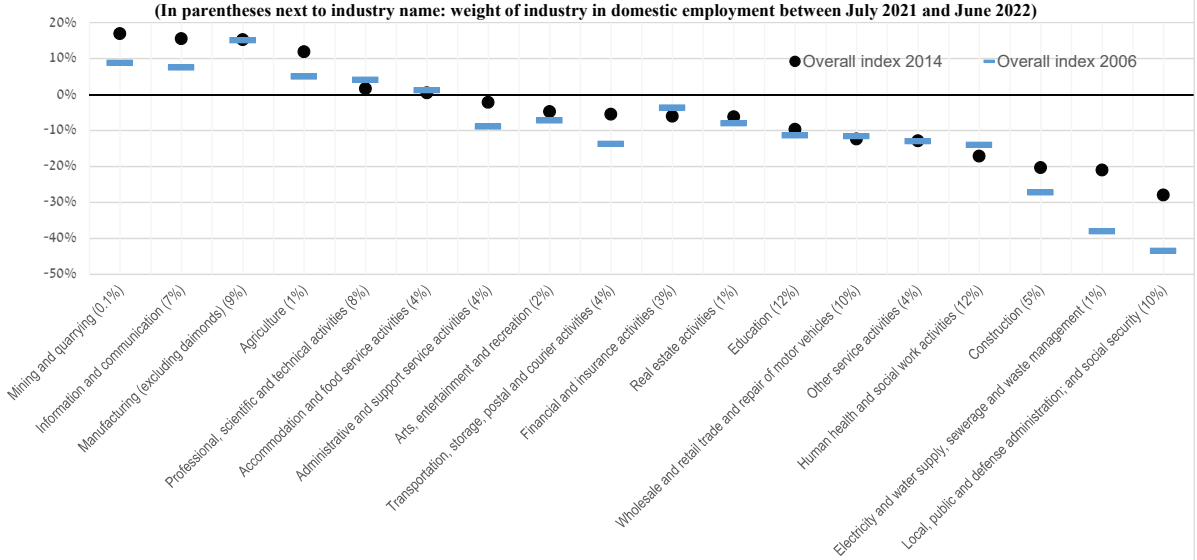
C.5 Changes in exposure relative to 2006

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.

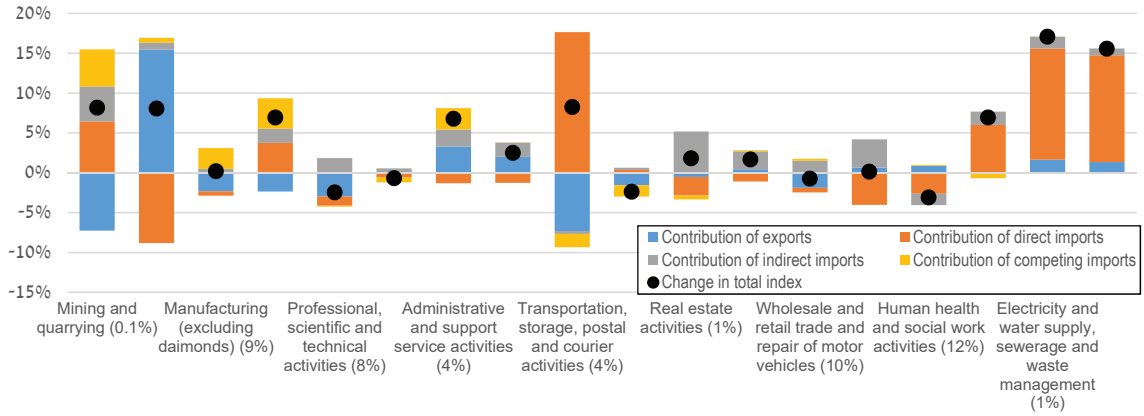
The exposure of agriculture (which accounts for a very small share of employment) also grew due to the combination of an increase in competing imports and a declining share of (directly and indirectly) imported inputs. Much the same happened in mining and manufacturing, another industry of negligible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

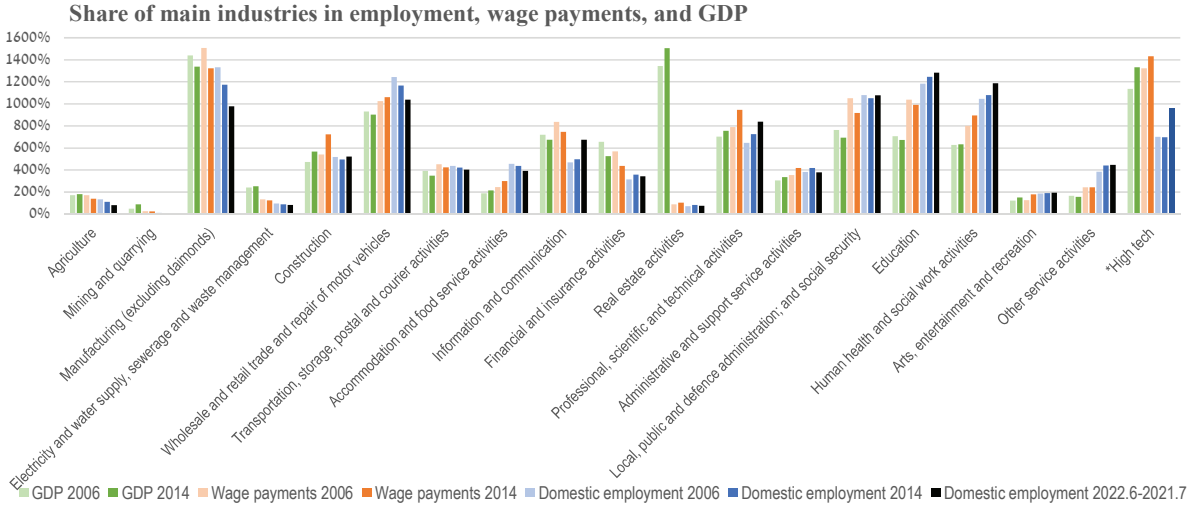
that the share of employment in industry O in 2006 was identical to its weight in the most recent period (approximately 10 percent). In the other industries, we divided the share of employment commensurate with their share of employment excluding industry O in 2006.

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.