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CAPITALIZATION OF R&D IN THE NATIONAL ACCOUNTS OF ISRAEL

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CAPITALIZATION OF R&D IN THE NATIONAL ACCOUNTS OF ISRAEL¹

In the following the capitalization of R&D in the national accounts of Israel is analyzed in a short updated version of a preliminary exercise presented in the framework of the Canberra II group on the Measurement of Non-financial Assets. The exercise has been performed to test the feasibility of using existing R&D statistics as a basis for estimates of R&D assets in the national accounts, implementing recommendations developed in the framework of the work of the Canberra II group during the last 4 years, and to examine the impact on the main aggregates on the accounts.

In most cases aggregate data were used, but in future work it will be possible to use more detailed estimates of R&D capital stocks and price indices to improve the estimates. Non-market R&D is included and shown as being used by the non-market producers of R&D, although the R&D in fact is put at the disposal of other units in the economy to be used in their production. This treatment is consistent with the treatment of roads and other infrastructure in the current SNA.

1 Bridge tables

The first step to arrive at estimates of capital formation in R&D using existing R&D statistics is to bridge between the series of gross domestic expenditure on research and development (GERD) prepared in the framework of R&D statistics, and the series of R&D output needed for the national accounts. It is important to mention that over the years the R&D statistics on expenditure have been more and more harmonized with the SNA, and in the 2002 edition of the Frascati Manual on R&D statistics only a few differences from SNA remain.

Simplified bridge tables between the two frameworks, including only the differences found to be important in practice, may be constructed. Bridging values between the two systems are prepared, mainly by reclassifying a few of the R&D expenditure items collected by R&D statisticians, and combining them with existing national accounts data.

The following main bridging values are needed:

1 Acquisition of "extramural" R&D to be used as input in R&D production

Acquisitions of R&D by producers of R&D are omitted from estimates on expenditure prepared in the framework of R&D statistics, and defined as "extramural" R&D, since the focus of the R&D statistics is on the measurement of total intramural R&D expenditure in the economy. However, the data on "extramural" R&D are collected separately in R&D statistics and may be used for bridging between the two systems.

2 Consumption of fixed capital owned by R&D producers and used in R&D production

Consumption of fixed capital is not included in the R&D expenditure prepared according to the Frascati manual, mainly due to practical measurement problems. However data on investment in fixed capital by R&D producers are collected by R&D statisticians and included in the expenditure. It is possible

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to prepare estimates of consumption of fixed capital using these data, combined with additional information from national accounts on similar fixed assets and implementing perpetual inventory methods.

3 Net operating surplus

Since R&D production is characterized by a high risk, the best solution seems to be to include average measures of net operating surplus, and not very detailed measures, which may fluctuate much. In the case of Israel the measure chosen was the average net operating surplus for the whole corporate R&D industry (ISIC classification 73).

4 Other taxes on production less other subsidies on production

The R&D statistics include some taxes are included in the current expenditures, such as payroll taxes. Data on other taxes may have to be added using data from the national accounts. Other subsidies on production are not deducted from the expenditure in R&D statistics, but shown as a financing source of the expenditure. In the case of Israel, this bridging value was not needed, since the relevant net taxes already were included in the expenditure collected in the framework of R&D statistics.

It should be mentioned that a bridge between the sector classification in the two systems should also be made. Such a bridge is already described and recommended in the current Frascati manual on R&D statistics. The important difference between the systems seems to be the difference in the classification of higher education institutions, which are separated in R&D statistics due to their special importance for R&D. This difference may relatively easily be overcome by making a subdivision of the R&D statistics for the Higher Education Sector between general government, NPI's and corporations. In the case of Israel, R&D is currently only performed in higher education institutions in the NPI sector, so that bridging is possible using aggregate data.

Table 1. Summary of simplified bridge table results for Israel
Year 2002 - at NIS million

	Gross Expenditure on R&D according to R&D statistics	Acquisitions from other R&D performers (a)	Capital expenditure	Consumption of fixed capital	Net Operating surplus	R&D domestic output
	(1)	(2)	(3)	(4)	(5)	(6)=(1)+(2)-(3)+(4)+(5)
Total	24,858	2,085	1,715	1,125	2,388	28,741
Business	18,512	1,997	1,310	701	2,388	22,288
Government	1,342	88	71	133		1,492
Non-profit institutions	955		12	20		963
Higher Education	4,049		322	272		3,999

(a) In R&D statistics named extramural R&D

GERD includes only intramural R&D

Acquisitions of R&D by NPI's and higher education assumed to be negligible

Estimates of R&D capital formation

In order to prepare estimates of R&D capital formation, the supply and use of R&D output were analyzed using the data obtained in the bridge tables. The impact of capitalization of market R&D was

examined separately, by making a distinction between R&D performed by the business sector and R&D performed by other sectors – government, non-profit institutions, and higher education institutions, which in the case of Israel all engage in non-market production. The distinction was made in estimates of fixed assets as well as in increase in stocks of work in progress.

The ability to separate exports of R&D and add imported R&D to the domestically produced R&D proved to be important in the case of Israel. The data on imports and exports of R&D were obtained from balance of payments data. Such detailed balance of payments data may currently not be very reliable, but the quality of the detailed data is expected to improve in the future, since a new survey on exports and imports of services has been undertaken. Estimates of R&D at constant prices are already published in the R&D satellite accounts prepared annually in Israel since 1989, and estimates for capital formation at constant 2000 prices were obtained from this source.

The time lag between the start of R&D projects and the use of the finalized R&D, which includes the time of production - the gestation lag - and the time passing before the finished R&D is used in production - the application lag – was assumed to be 2 years. This assumption was based on information from representatives for venture capital funds. All unfinished R&D was included as work in progress. Since exports are so prominent in the case of Israel, it seemed important not to include work in progress together with fixed capital formation. For other countries that produce most R&D for own use, the best practical solution may be to include work in progress as fixed capital formation.

Table 2. Supply and Use of R&D assuming R&D capitalized

Millions of NIS at current prices

	Supply			Use				
	Domestic production	Imports of R&D	Total	Gross fixed capital formation Market producers	Gross fixed capital formation of Non-Market producers	Intermediate consumption and increase in work in progress on R&D	Exports	Total
1991	3,431	221	3,651	1,287	1,418	294	652	3,651
1992	4,253	267	4,520	1,477	1,660	555	829	4,520
1993	5,141	355	5,496	2,004	1,947	587	957	5,496
1994	6,288	427	6,715	2,373	2,438	728	1,176	6,715
1995	7,466	465	7,931	3,006	2,865	755	1,305	7,931
1996	9,271	524	9,795	3,921	3,274	1,102	1,498	9,795
1997	11,335	627	11,962	4,622	3,889	1,582	1,869	11,962
1998	13,252	742	13,994	5,316	4,119	1,798	2,761	13,994
1999	18,027	852	18,879	6,970	4,614	3,893	3,402	18,879
2000	24,913	1,072	25,985	6,170	4,882	8,658	6,275	25,985
2001	27,050	1,030	28,080	9,150	5,112	8,153	5,665	28,080
2002	28,741	1,251	29,992	14,716	6,248	2,556	6,472	29,992
2003	27,090	1,205	28,296	13,633	6,346	802	7,514	28,296
2004	28,163	1,259	29,423	11,076	6,463	1,566	10,318	29,423
2005	31,776	1,418	33,194	12,859	6,632	4,197	9,505	33,194

Table 3. Supply and Use of R&D (a) assuming R&D capitalized

Millions of NIS at constant 2000 prices

	Supply			Use				
	Domestic production	Imports of R&D	Total	Gross fixed capital formation Market producers	Gross fixed capital formation of Non-Market producers	Intermediate consumption and increase in work in progress on R&D	Exports	Total
1991	10,477	674	11,150	3,751	3,847	1,560	1,992	11,150
1992	11,231	706	11,937	3,664	3,932	2,152	2,189	11,937
1993	11,975	826	12,801	4,438	4,016	2,118	2,229	12,801
1994	12,942	878	13,820	4,818	4,195	2,385	2,421	13,820
1995	13,534	843	14,377	5,388	4,332	2,292	2,365	14,377
1996	14,889	841	15,730	6,212	4,341	2,772	2,405	15,730
1997	16,055	887	16,942	6,387	4,522	3,385	2,647	16,942
1998	17,461	978	18,439	6,549	4,704	3,549	3,638	18,439
1999	19,168	906	20,074	7,631	4,615	4,210	3,618	20,074
2000	24,913	1,072	25,985	6,170	4,882	8,658	6,275	25,985
2001	25,732	980	26,712	8,516	4,871	7,935	5,389	26,712
2002	25,437	1,107	26,544	12,988	5,436	2,392	5,728	26,544
2003	24,460	1,088	25,548	12,713	5,369	681	6,784	25,548
2004	24,890	1,113	26,003	9,915	5,615	1,354	9,118	26,003
2005	26,042	1,162	27,204	10,421	5,624	3,369	7,790	27,204

The development over the years of the R&D capital formation reflects the structural changes that took place in Israel in the 1990's, with a transition to industries with high intensity of R&D. R&D capital formation grew from 1.9% of GDP in 1991 to 3-4% in recent years. Especially the market R&D capital formation expanded, and while market R&D amounted to only half of R&D in 1991, in recent years around two thirds of R&D capital formation has been in market R&D.

5 *Estimates of service lives and depreciation of R&D*

The estimation of the length of the economic service life of R&D is perhaps the biggest challenge. R&D could in principle have an infinite service life, since there is apparently no wear and tear of it, and one could even argue that new R&D in most cases is based on former R&D, so that there is an ever-growing stock of R&D. However, most researchers have concluded that R&D used in production becomes obsolete after a certain time and is replaced by newer R&D.

Panel data for single firms in Israel also seem to confirm that a pattern of constant replacement of R&D is present.

The original intention was to estimate service lives of R&D in Israel using existing panel data for business enterprises and the time series models used in the work of by Marta Ballester, Manuel Garcia-Ayuso, and Joshua Livnat (2000). However, some important variables for the models were not included in the panel data, and since the business surveys have been restructured in 1997, there were breaks in the

series, so that eventually the estimations were abandoned. Instead, an average depreciation rate of 0.15, derived from the results of the above-mentioned paper, was used. This depreciation rate was used for market as well as non-market R&D. In future work it will be important to perform additional attempts to estimate service lives, and to use industry specific depreciation rates, as pointed out by Ballester, Garcia-Ayuso, and Livnat.

6 Estimates of R&D capital stocks

The direct measurement of stocks of R&D is not possible in the major part of cases, since most R&D is own-account production, and evaluation is done on the basis of accumulated costs. This means that the estimation of R&D stocks will have to be done through the perpetual inventory method or other methods based on accumulated expenditure.

The necessary data for preparing estimates of R&D capital formation in Israel are available from 1991. Since the service lives used were relatively short – about 7 years, it was possible to estimate capital stocks for the years 1998 to 2005.

Table 4. R&D stocks
Millions of NIS at constant 2000 prices

	Private non-profit institutions	Higher education (non-market)	Government	Total non-market	Business	Total
1998	3,934	19,737	5,514	29,186	34,659	63,844
1999	4,167	20,111	5,764	30,042	37,456	67,499
2000	4,354	20,396	5,975	30,725	41,424	72,149
2001	4,576	20,706	6,309	31,591	43,156	74,747
2002	4,776	20,973	6,518	32,267	46,854	79,121
2003	4,944	21,480	6,947	33,371	54,454	87,825
2004	5,151	21,818	7,431	34,400	60,955	95,355
2005	5,375	22,242	7,876	35,493	64,483	99,975

The capital stocks of R&D in Israel have grown 56.6% from 1998 to 2005, faster than the growth of stocks of other fixed capital. The growth in R&D capital stocks of the business sector in those years was especially fast – 86%.

2 Net impact of capitalization of R&D on GDP

The net impact on GDP of capitalizing R&D was examined in 2 steps. First the impact of the capitalization of market R&D was estimated, and after that the addition of non-market R&D. For market

R&D, on the one hand the fixed capital formation in R&D had a large positive impact on GDP. In addition, accounting for all increase in work in progress on R&D, which should have been done even according to the present SNA, also added to GDP. On the other hand the impact was less than could be expected from data on R&D production, since exports and work in progress on R&D in start-ups were already accounted for.

Table 5. Net Impact of capitalization of Market R&D

	At current prices Millions of NIS					Impact of capitalization of R&D	
	Current GDP	Gross fixed capital formation Market producers	Increase in work in progress on market R&D	Less R&D in start-ups already included as work in progress	GDP after capitalization of market R&D	In Millions NIS at current prices	Percent of GDP
1995	283,038	3,006	688	391	286,341	3,303	1.2
1996	331,073	3,921	902	1022	334,874	3,801	1.1
1997	370,954	4,622	1581	1596	375,561	4,607	1.2
1998	411,946	5,316	1724	1950	417,036	5,090	1.2
1999	448,110	6,970	2377	4601	452,856	4,746	1.1
2000	493,311	6,170	6236	6673	499,044	5,733	1.2
2001	498,908	9,150	5849	10618	503,288	4,380	0.9
2002	517,975	14,716	353	7243	525,801	7,826	1.5
2003	524,187	13,633	-1474	4131	532,216	8,029	1.5
2004	548,936	11,076	-564	3672	555,776	6,840	1.2
2005	582,291	12,859	1874	6186	590,839	8,548	1.5

The addition of non-market R&D had an impact, since the non-market R&D was assumed to be owned and used by the non-market producers, in the activity of distributing R&D free of charge to other producers to be used in their production. This means that the cost of using the R&D – CFC or capital services (if it is decided to include cost of capital services in the SNA revision) of R&D – will be included in general government consumption expenditure. The production costs, which were formerly included as consumption expenditure, will now be included as capital formation and increase in work in progress on R&D.

Table 6. Net Impact of capitalization of all R&D on GDP

	At current prices Millions of NIS							Percent of GDP
	Current GDP	Gross fixed capital formation Market and Non-market producers	Less R&D of non-market producers already included as consumption expenditure	Depreciation of R&D of Non-market producers	Increase in work in progress on R&D	Less R&D in start-ups already included as work in progress	GDP after capitalization of all R&D	
	1	2	3	4	5	6	7=1+2-3+4+5-6	8=7/1*100-100
1998	411,946	9,435	4,275	3,810	1,880	1,950	420,846	2.2
1999	448,110	11,584	4,870	4,499	2,633	4,601	457,355	2.1
2000	493,311	11,052	5,436	4,609	6,790	6,673	503,653	2.1
2001	498,908	14,262	5,635	4,968	6,371	10,618	508,257	1.9
2002	517,975	20,964	6,454	5,563	471	7,243	531,276	2.6
2003	524,187	19,979	6,621	5,913	-1,199	4,131	538,129	2.7
2004	548,936	17,539	6,473	5,957	-554	3,672	561,733	2.3
2005	582,291	19,492	6,483	6,302	1,725	6,186	597,141	2.6

The total impact on GDP is relatively large for Israel, and amounts to 2-3% in recent years. Two thirds are due to the market R&D and a third to non-market R&D.

3 Capital formation compared to depreciation of R&D

Since capital formation in R&D has been growing relatively fast over the years, depreciation of the R&D capital stock will be lower than the capital formation in R&D in most years, so that the Net Domestic Product and Net National Income will also be affected by the capitalization of R&D. The table below shows the difference between R&D capital formation and depreciation and the impact of this difference on Net National Income. The actual impact on Net National Income is different, because the registration of R&D output has also been somewhat amended.

Table 7. Net fixed capital formation in R&D compared to NNI at market prices

	At current prices Millions of NIS					Percent of NNI	
	Current NNI	Gross fixed capital formation in R&D by Market and Non-market producers	Less Depreciation of R&D	R&D net fixed capital formation R&D	Actual addition to GDP less depreciation of R&D	Net fixed capital formation in R&D	Actual net addition
1998	335,270	9,435	8,031	1,404	869	0.4	0.3
1999	360,526	11,584	9,631	1,953	-386	0.5	-0.1
2000	393,781	11,052	10,822	229	-480	0.1	-0.1
2001	402,988	14,262	11,923	2,339	-2,574	0.6	-0.6
2002	411,482	20,964	13,526	7,438	-225	1.8	-0.1
2003	416,977	19,979	14,672	5,307	-730	1.3	-0.2
2004	440,723	17,539	16,171	1,368	-3,374	0.3	-0.8
2005	475,755	19,492	18,237	1,254	-3,387	0.3	-0.7

4 Conclusion

The exercise prepared for the Israeli economy first of all shows that it is feasible to prepare estimates of capital formation in R&D in the national accounts on the basis of existing R&D statistics. The estimation of R&D capital stocks and consumption of R&D capital is also feasible using the perpetual inventory method.

The impact of capitalizing market R&D amounts to about 1.5% of GDP in the case of Israel. Assuming non-market R&D is allocated to the non-market units producing it, the impact of non-market R&D is also important – in the case of Israel the impact amounts to about one percent in recent years. The treatment of non-market R&D in this way is consistent with the treatment of roads and other infrastructure in the current SNA. It is however, important to show R&D intended for use free of charge separately, since such R&D is used in production by other sectors. Although the individual use mostly cannot be identified, the information of the use by the economy as a whole is of importance for understanding the activity of both non-market and market producers over time.

It is also important to point out that the focus on R&D data in connection with work on bridge tables and capitalization of R&D would probably lead to an improvement of R&D estimates in the national accounts. An improvement of R&D data in the accounts seems to be important, whether R&D is capitalized or not. In any case, there is a need for separate data of a good quality on R&D in the national accounts to be used in research and policy making.

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