Ásgeir Daníelsson: Sustainability and Methods for Economic Accounting for Exploitation of Wild Fish Stocks

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Economic accounting for natural resources

- UN conference in 1992 called for the environmental assets to be included in the national accounts and for preparation of satellite accounts for the supply and use of environmental assets.
- SNA 1993 introduced framework for national accounting for environmental assets (SEEA).
- Nordisk Ministerråd (1996), Nordiska naturresurs- och miljöräkenskaper-delrapport 1. TemaNord 1996:563. (also published by Eurostat in 1996).

Economic accounting for natural resources

- SNA 1993 introduced framework for national accounting for environmental assets (SEEA).
- Another version of SEEA 2003.
- Draft of Integrated Environmental and Economic Accounting for Fisheries (2004) Series F, No.97 (ST/ESA/STAT/SER.F/97).
- There are “pilot studies” (e.g. for fisheries in Norway and Iceland) but very little has happened in terms of official environmental statistics on the value of fish stocks and the cost of exploiting them.

Economic accounting for natural resources

- Reasons why there has been slow development in this area:
- 1) There is a large degree of uncertainty concerning the physical size of the stocks of natural resources (e.g. fish stocks).
- 2) There are methodological and practical problems involved in estimating the monetary value of the natural resources and the cost of exploiting them (e.g. joint production in most fisheries).
- 3) There is insufficient understanding of the value of using economic criteria when deciding on the use of natural resources.

Why economic accounting for fish stocks?

- Even if the uncertainty is great the authorities must decide on the use of the natural resources.
- For efficient use of natural resources it is necessary to use economic criteria.
- Here in Iceland there has been general agreement that decisions on exploitation of fish stocks (quotas) should be based on economic criteria.
- Three working groups on quota rules for cod.
- Quota rules for other species have not been proposed, mainly because of biological uncertainty. (There is biological quota rule for capelin).

Why economic accounting for fish stocks?

- Economic accounting for fish stocks should be seen as a tool to bring together, on a regular basis, the available biological and economic information.
- It should be used in macroeconomic decision-making. Even if the importance of fishing in the Icelandic economy has declined the value of the quota shares is probably around half of the annual GDP and around a third of the fixed capital in Icelandic firms (according to national account data).
- I believe that economic accounting for fish stocks will also be useful for management of fisheres.

Sustainability vs. optimality criteria

- Sustainability is central in the proposed methodology of economic accounting for the environment and for the natural resources.
- Fisheries economists used to discuss different sustainable catch levels and stock sizes (up to some, often large risk factors.)
- Fisheriese economics discusses methods to choose among the many sustainable levels of catch levels and stock sizes the alternative which is optimal in some economic sense.
- In the cases of far too many fish stocks sustaining the present state is very far from being optimal.

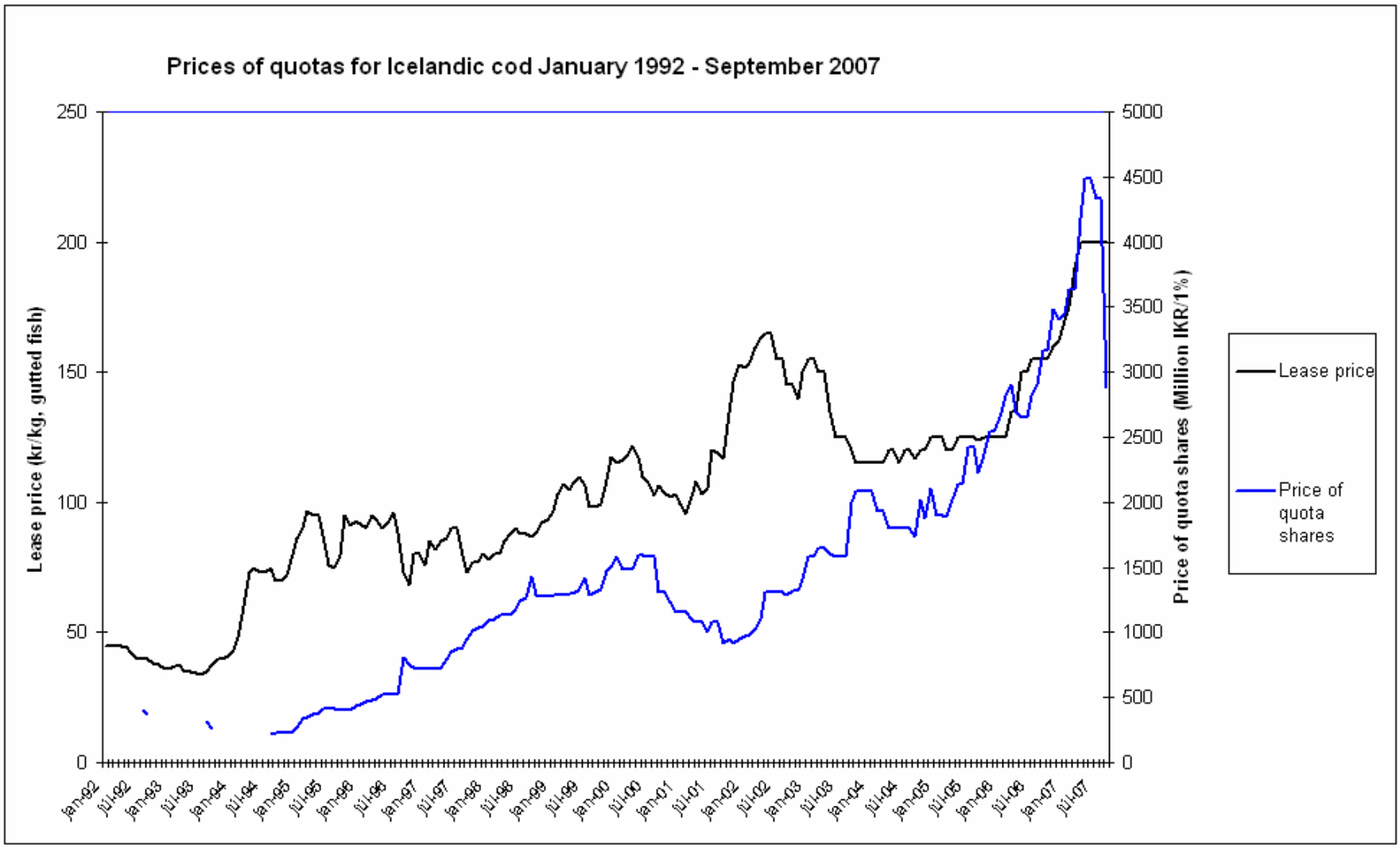
Estimating the value of fish stocks

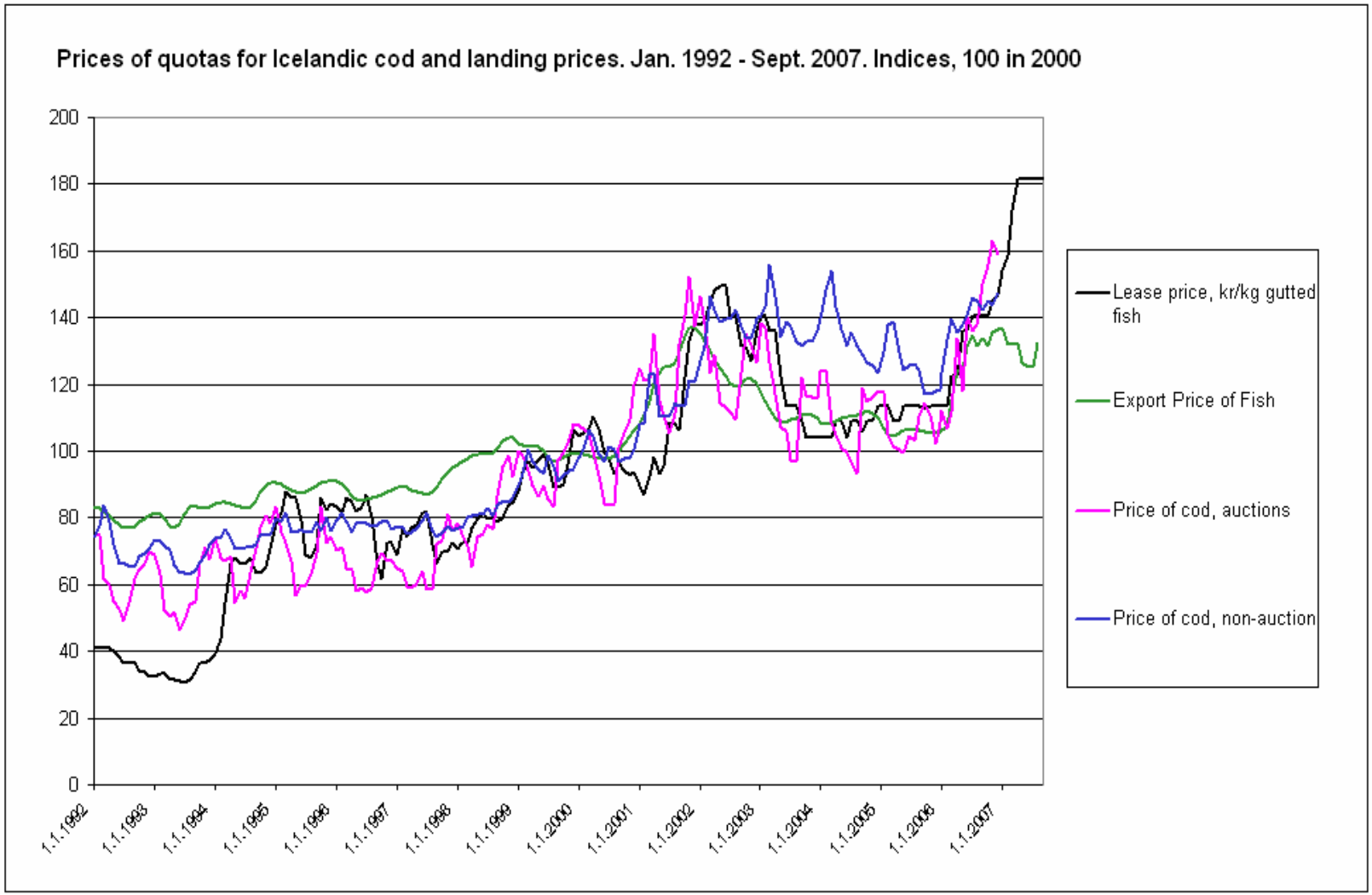
- Here in Iceland we have the possibility of estimating the value of fish stocks at current prices by simply observing the price of quota shares.
- These prices are important but there are caveates:
- 1) Impossible to estimate fixed price value of the quota shares
- 2) As the prices of quota shares depend on the management of the stock the fisheries managers need some independent measures to base their decisions.

Estimating the value of fish stocks

- 3) As investors (and managers in the firm) need accounting data for evaluating the shares the managers of fisheries need independent estimates of the cost and revenue from fishing to evaluate the costs and the benefits from the fisheries.

Estimating the value of fish stocks




Prices of quotas for Icelandic cod and landing prices. Jan. 1992 - Sept. 2007. Indices, 100 in 2000
200
180
160
140
120
100
80
60
40
20
0
1.1.1992
1.1.1993
1.1.1994
1.1.1995
1.1.1996
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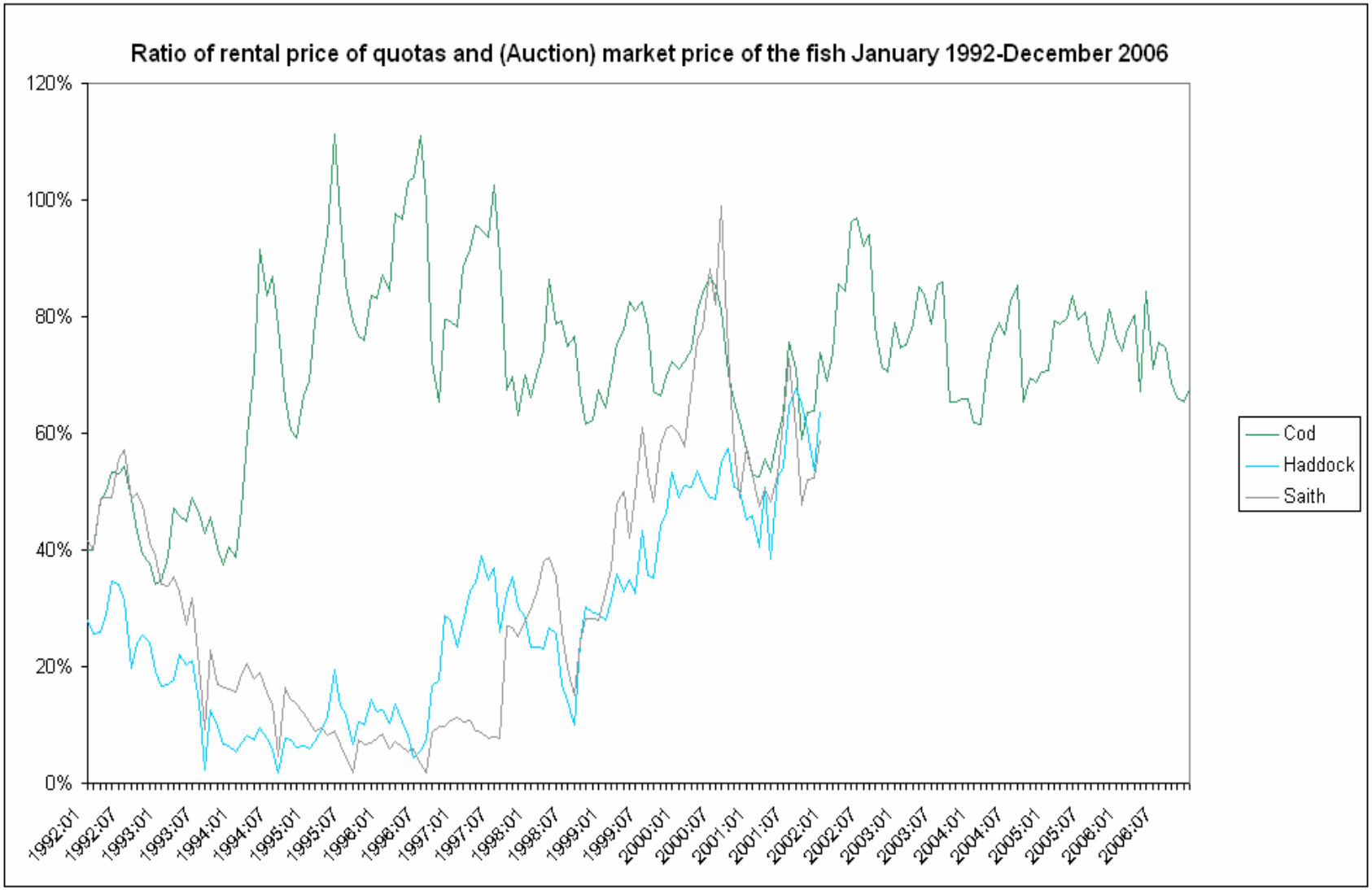
1.1.2005
1.1.2006
1.1.2007
Lease price, kr/kg gutted fish
Export Price of Fish
Price of cod, auctions
Price of cod, non-auction


Ratio of rental price of quotas and (Auction) market price of the fish January 1992-December 2006
120%
100%
80%
60%
40%
20%
0%
1992:01
1992:07
1993:01
1993:07
1994:01
1994:07
1995:01
1995:07
1996:01
1996:07
1997:01
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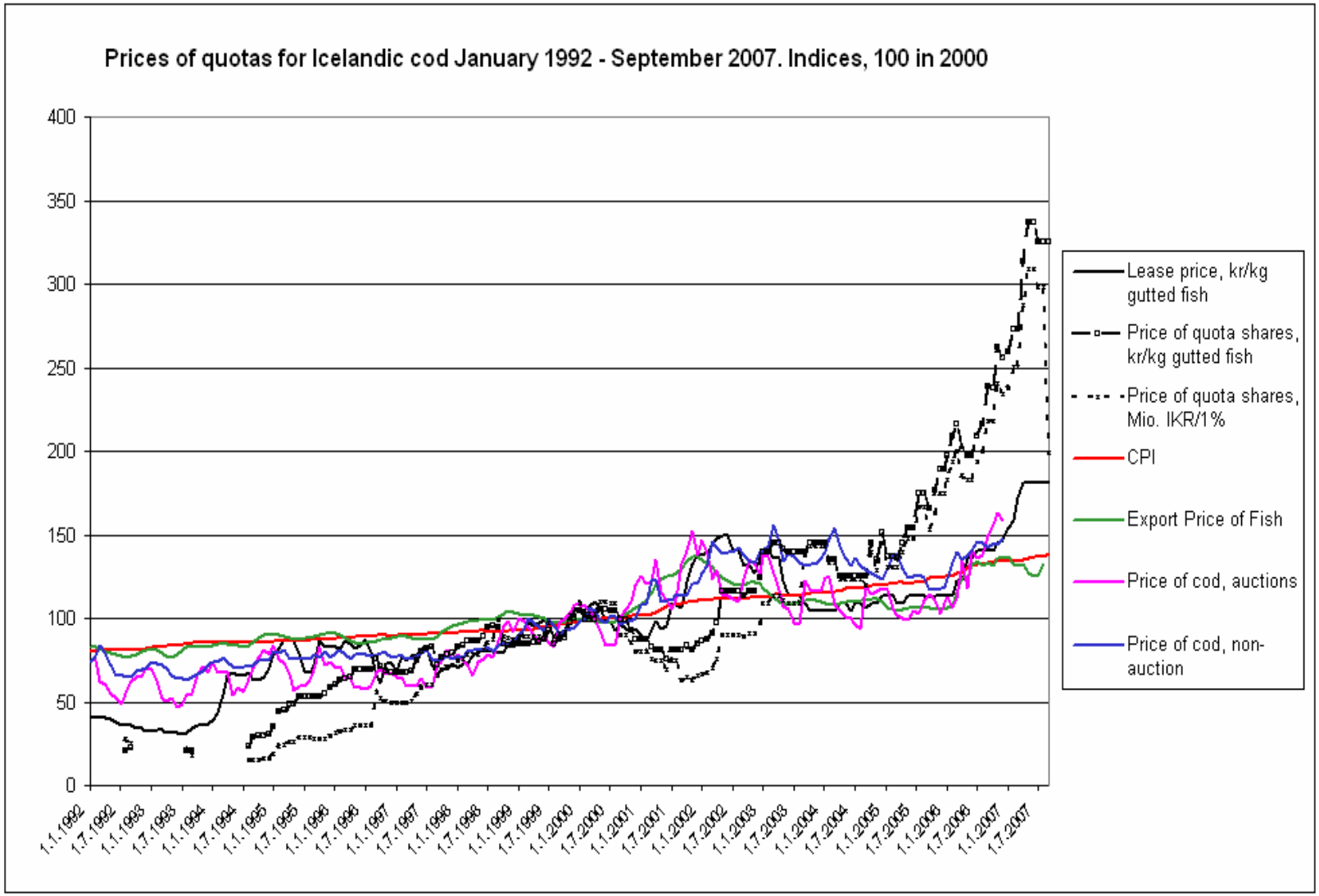
2003:07
2004:01
2004:07
2005:01
2005:07
2006:01
2006:07
Cod
Haddock
Saith


Prices of quotas for Icelandic cod January 1992 - September 2007. Indices, 100 in 2000
400
350
300
250
200
150
100
50
0
1.1.1992
1.7.1992
1.1.1993
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1.7.2005
1.1.2006
1.7.2006
1.1.2007
1.7.2007
Lease price, kr/kg gutted fish
Price of quota shares, kr/kg gutted fish
Price of quota shares, Mio. IKR/1%
CPI
Export Price of Fish
Price of cod, auctions
Price of cod, non-auction

Asset values of access rights

Value of all access rights. Valued at the end of year prices of quota shares							
Unit: milli. IKR	1994	1995	1996	1997	1998	1999	**2006**
Cod	32,240	62,000	86,304	131,846	151,200	180,600	**356,664**
Haddock	4,160	5,760	8,820	12,096	9,996	11,931	
Saith	3,600	3,360	3,400	5,267	6,300	7,670	
Redfish	6,160	10,400	14,950	20,800	22,100	21,450	
Catfish	0	0	1,463	2,165	2,106	2,143	
Greenland halibut	4,416	3,036	3,036	4,830	4,600	4,784	
Plaice	1,351	1,459	1,601	1,656	1,932	2,254	
Shrimp	6,500	21,420	24,000	33,000	25,650	15,600	
Nephops	1,186	970	924	970	1,187	1,404	
Herring	1,380	3,500	8,030	8,800	7,060	5,320	
Capelin	5,500	6,000	15,000	19,000	22,750	26,500	
Total	66,493	117,905	167,527	240,430	254,881	279,656	
Echange rate of USD	68.77	65.33	66.86	71.54	69.49	72.27	
Fixed capital in fishing	100,148.00	101,071.00	106,575.00	109,637.00	112,236.00	113,538.00	**135,010**
GDP	440,286.00	454,013.00	487,509.00	526,322.00	588,367.00	632,399.00	**1,162,930**

Estimating the value of fish stocks

- Estimate the value of the stock on the basis of unchanged biological size of the stock and unchanged economic conditions. (Optimal if these variables follow random walk.)

- Estimate the value of the stock on the basis of an bioeconomic model.

Rent from fishing

Table II. Rent in million ISK estimated from survey data.
All revenues and costs related to trade in quotas excluded

	1992	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Cod	1,605	2,883	4,008	3,792	2,111	1,978	4,742	5,697	4,826
Haddock	-301	-716	-1,461	-1,163	-1,203	-653	-841	-536	-99
Saithe	116	-296	-527	-642	-505	-447	-231	-63	67
Redfish	495	487	-25	218	438	-36	460	324	397
Catfish					-245	-222	-245	-169	-120
Greenland halibut	391	678	-259	-1,012	-975	-439	166	252	407
Plaice	12	-134	-186	-194	-263	-309	-143	-88	24
Herring		-33	493	841	1,183	627	49	1	47
Capelin		-504	-565	-804	-295	312		-1,174	-1,023
Nephrops			-24	-32	-62	-40	-31	-56	-68
Shrimp	-1,017	-909	-728	1,271	1,462	-54	-948	-905	-523
Other	331	214	54	210	350	-528	137	-474	-332
Total	1,630	1,670	783	2,484	1,997	188	3,116	2,809	3,603

Asset values estimated from annual profits ("sustainable" profits)

Table III. Asset values in billion Icelandic Kronors (ISK)

	1992	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Cod	20.1	36.0	50.1	47.4	26.4	24.7	59.3	71.2	60.3
Haddock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Saith	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Redfish	6.2	6.1	0.0	2.7	5.5	0.0	5.7	4.1	5.0
Catfish					0.0	0.0	0.0	0.0	0.0
Greenland halibut	4.9	8.5	0.0	0.0	0.0	0.0	2.1	3.1	5.1
Plaice	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Herring		0.0		10.5	14.8	7.8	0.6	0.0	0.6
Capelin		0.0	0.0	0.0	0.0	3.9		0.0	0.0
Nephrops			0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shrimp	0.0	0.0	0.0	15.9	18.3	0.0	0.0	0.0	0.0
Other	4.1	2.7	0.7	2.6	4.4	0.0	1.7	0.0	0.0
Total	36.9	53.3	50.8	79.1	69.4	36.4	69.4	78.4	72.1

Estimating the value of fish stocks

- To estimate the value of a fish stock from accounting data we need
- 1) Accounting information from the fishing firms on their revenues and costs
- 2) We need a bioeconomic model for forecasting the development of the stock.
- 3) We need an economic model for forecasting revenues (benefits) and costs from fishing today and in the future when the stock size has changed.
- 4) We need to solve for the optimal (in our view) policy/harvest path.

Estimating the value of fish stocks

- There are different ways to formulated the objective function.
- One possibility is to maximize the sum of discounted profits.
- Another possibility is to maximize the sum of discounted welfare measured by the sum of consumer surplus and profits.
- We can introduce aversion to risk and fluctuations in income and employment.
- In the calculations below it is assumed that the aversion to (and cost of) fluctuations in harvest and employment is such that a harvest function of the form $H_t^* = \alpha \cdot H_{t-1} + (1-\alpha) \cdot \lambda \cdot S_t$ is optimal.

Different methods to caculate depletion costs

- Depletion cost based on change from some present state (sustainability):
- Depletion cost$_t$=Profit/rent per ‘000 tonnes $\times \left(S_{t+1|t+1} - S_{t|t}\right)$
- Depletion cost based on valuation based on optimal use:
- Depletion cost$_t$= $V_t\left(S_{t|t}\right) - V_t\left(S_{t+1|t}\right)$
- The difference between using $S_{t+1|t}$ and $S_{t+1|t+1}$.

Different methods to caculate depletion costs

Inefficiency cost$_t$ = $R_t^{opt} - R_t^{act}$

$$= i \cdot \left[V_t\left(S_{t|t}\right) - \pi_t\left(H^*_{t|t}\right)\right] - \pi_t\left(H_{t|t}\right) + Cost_t^d$$

If the optimal policy is to maximize welfare inefficiency cost may be negative.

Different approaches to estimating depletion costs

Table V. Depletion cost for Icelandic cod using different methods, billions of IKR.

	1992	1993	1994	1995	1996	1997	1998	1999	2000
Annual rent approach (maintenance cost)									
Depletion cost I	0.1	0.5	0.7	-2.6	-2.5	-0.8	-1.1	6.1	3.7
Depletion cost II	0.1	0.0	-1.4	-1.4	-1.0	-1.1	-1.7	-1.7	-1.1
Change in asset values approach									
Depletion cost III	1.2	4.8	3.8	3.8	-16.7	-4.7	-3.4	20.0	19.2
Depletion cost IV	1.4	-0.2	-7.3	-7.3	-7.2	-6.9	-5.1	-4.4	-4.5

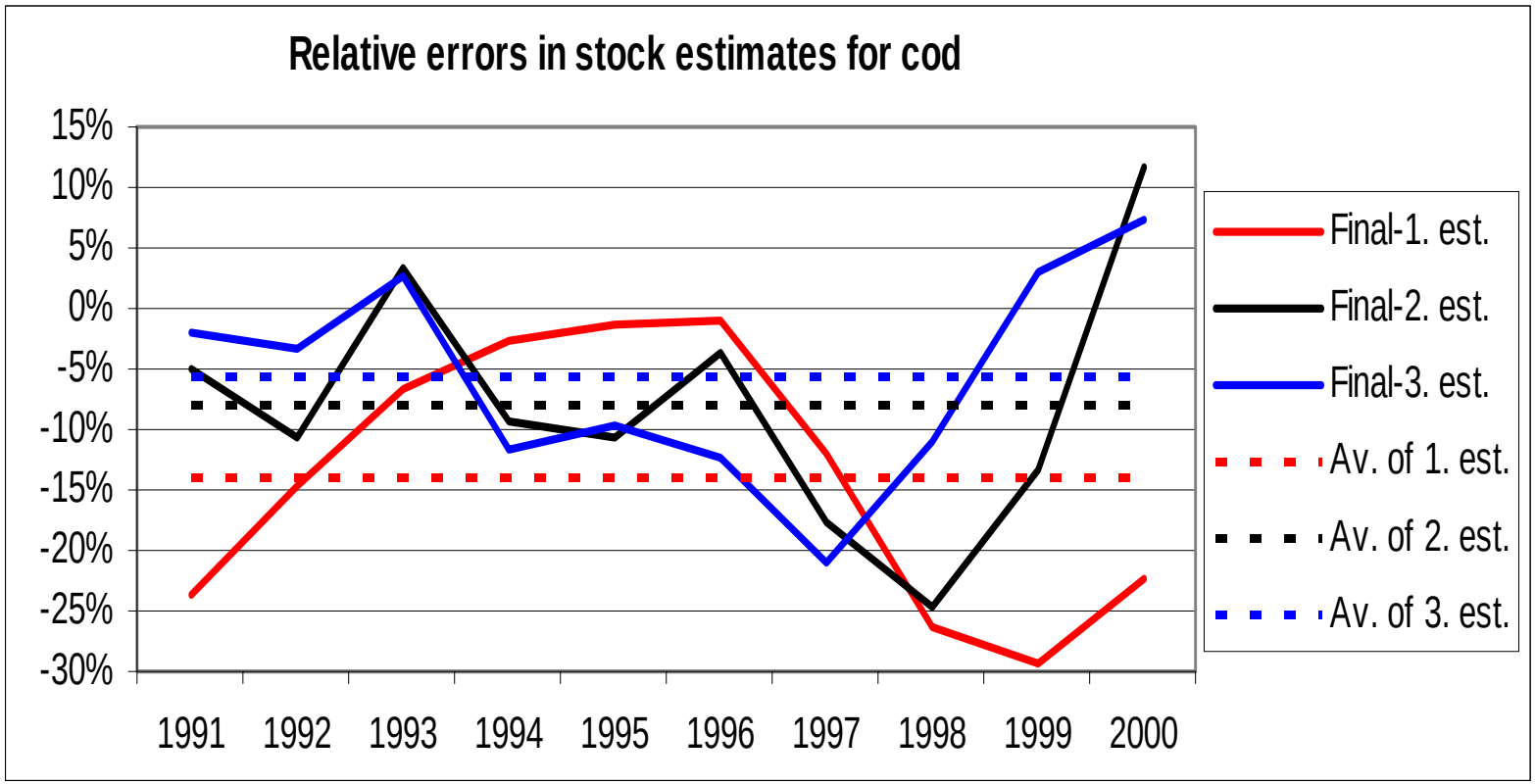
Physical accounts for cod

Physical accounts for Icelandic cod, 1992 to 2000. Unit: '000 tons.									
	1992	1993	1994	1995	1996	1997	1998	1999	2000
Opening stock	640	630	590	560	675	889	975	1.031	756
Forecasted growth	257	254	242	233	266	314	328	336	286
Catch	-268	-252	-179	-169	-182	-203	-243	-260	-235
Depletion (-)	-11	2	63	64	84	111	85	76	51
Other changes in vol.	1	-42	-93	51	130	-25	-29	-351	-230
Closing stock	630	590	560	675	889	975	1.031	756	577
Opening stock as estimated in 2001	547	580	577	553	672	786	710	709	527
Opening stock as estimated in 2007	546	589	574	553	668	783	717	730	588

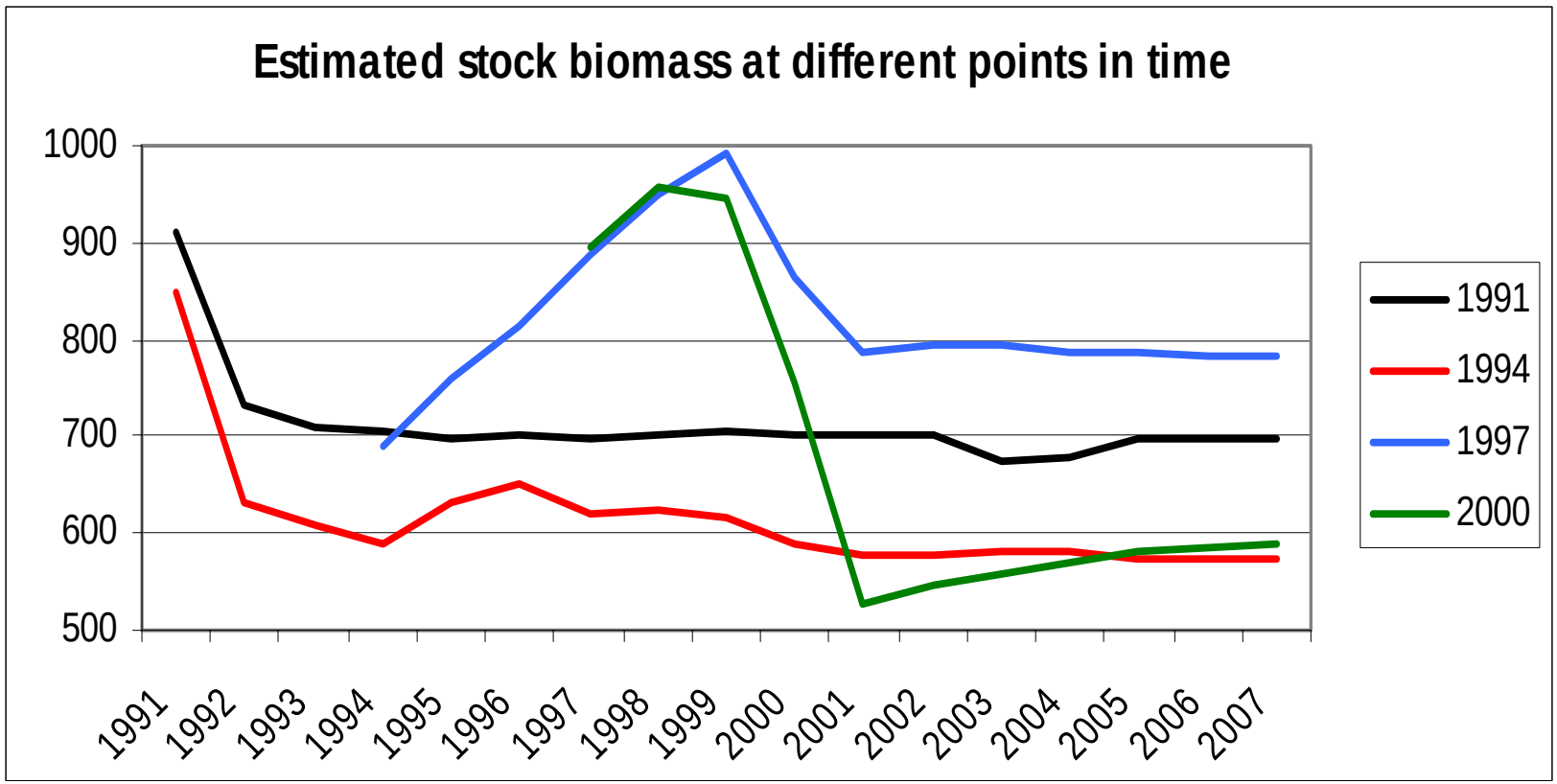
Monetary accounts for cod

Monetary accounts for Icelandic cod, 1992 to 2000. Unit: billions of IKR.									
	1992	1993	1994	1995	1996	1997	1998	1999	2000
Opening stock	128	150	171	174	139	113	138	142	165
Depletion cost (-)	-1	0	7	7	7	7	5	4	4
Other changes in volume of asset	0	-5	-11	5	10	-2	-2	-24	-24
Closing stock at previous year's prices	127	145	167	186	156	117	141	122	145
Holding gain/loss	23	26	7	-47	-43	20	1	42	
Closing stock	150	171	174	139	113	138	142	165	
Inefficiency cost	7	9	2	3	2	0	1	1	3
Fixed capital in fishing	71	74	79	76	79	76	75	73	72
GDP	400	412	439	451	484	524	579	623	672

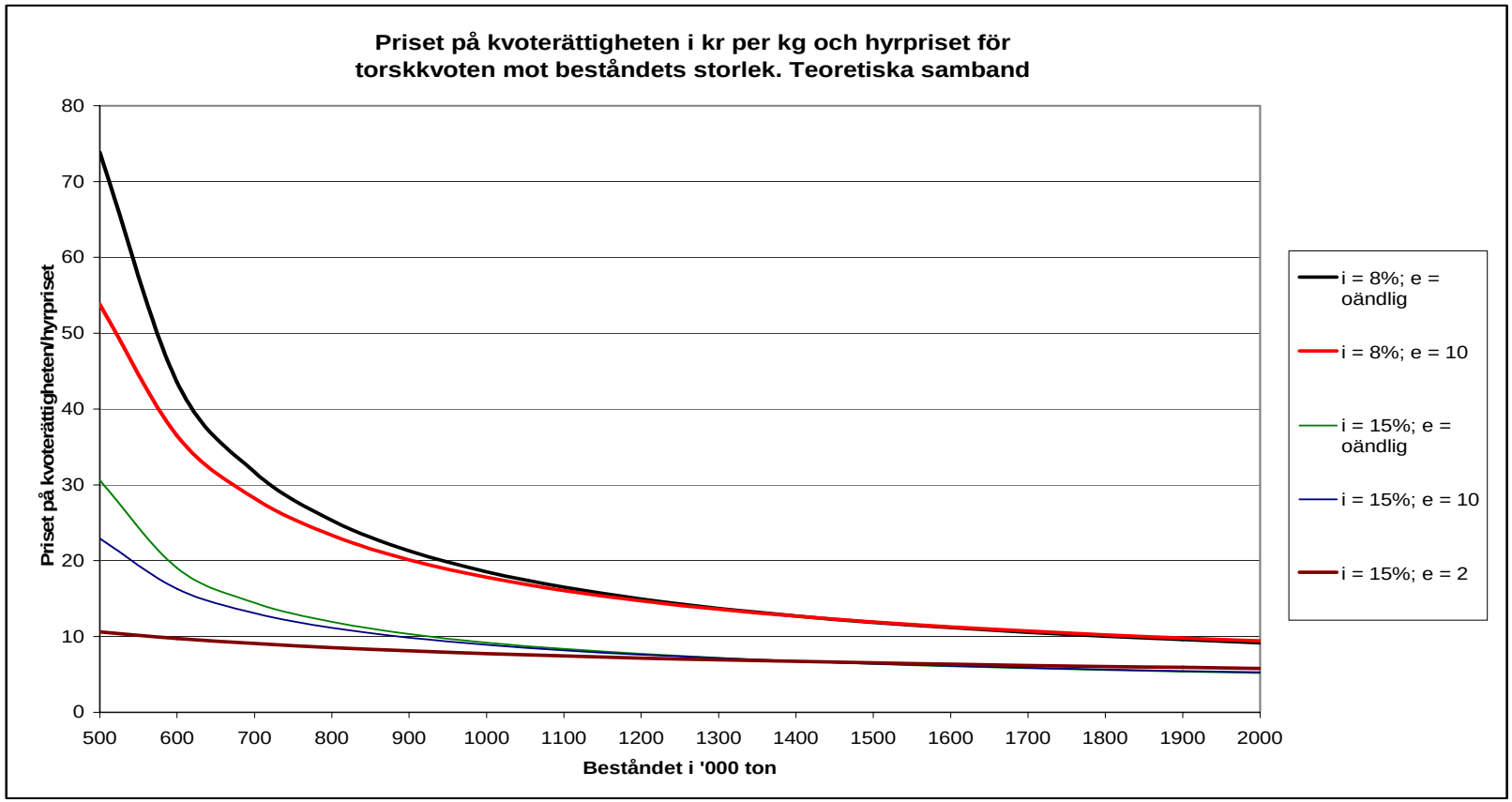
Forecast errors = Estimate in 2007 – Estimate at time t (1. est), t+1 and t+2



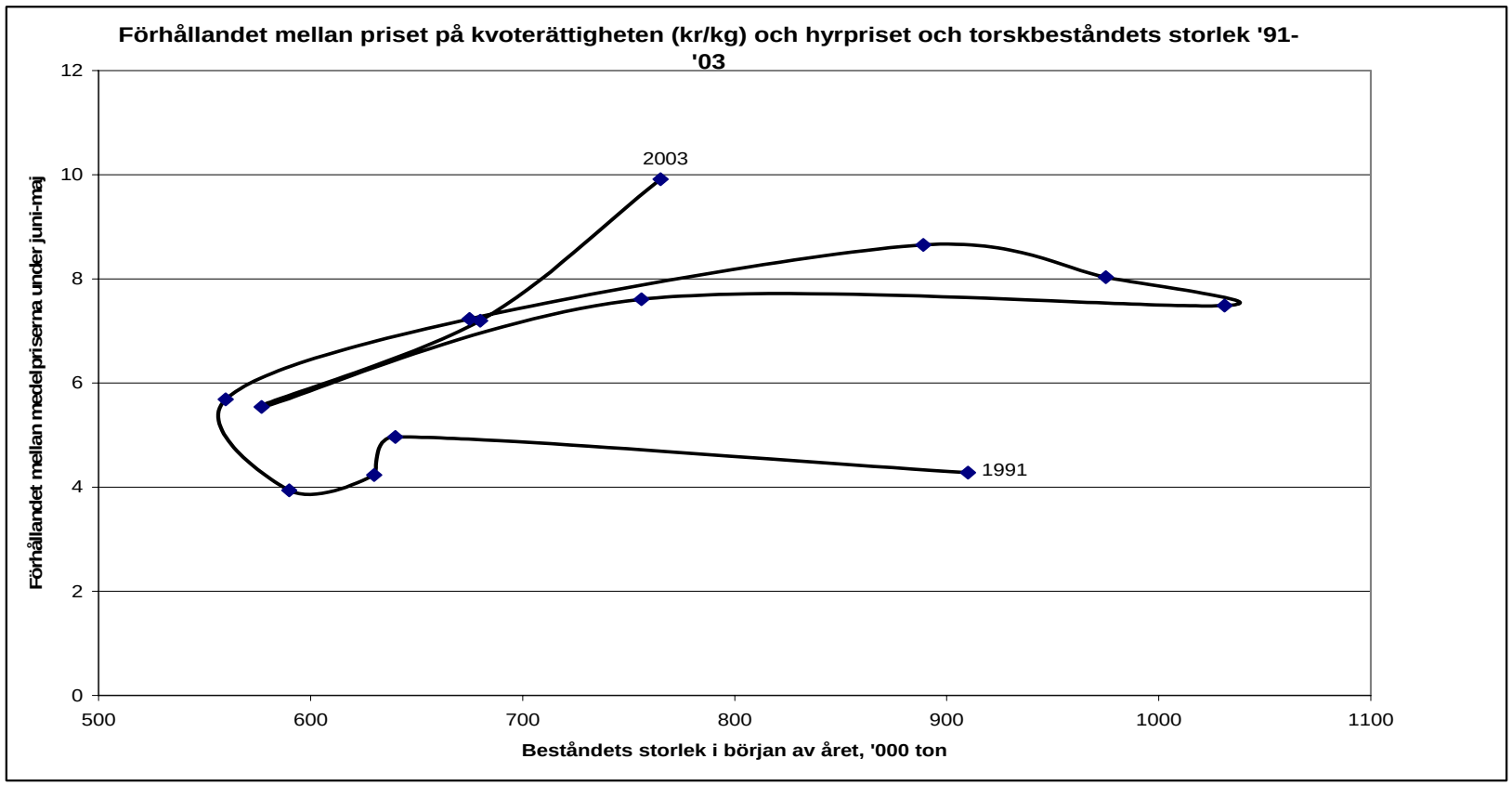
Estimated and forecasted stock biomass for cod in the years 1991, 1994, 1997 and 2000



Priset på kvoterättigheten i kr per kg och hyrpriset för torskkvoten mot beståndets storlek. Teoretiska samband

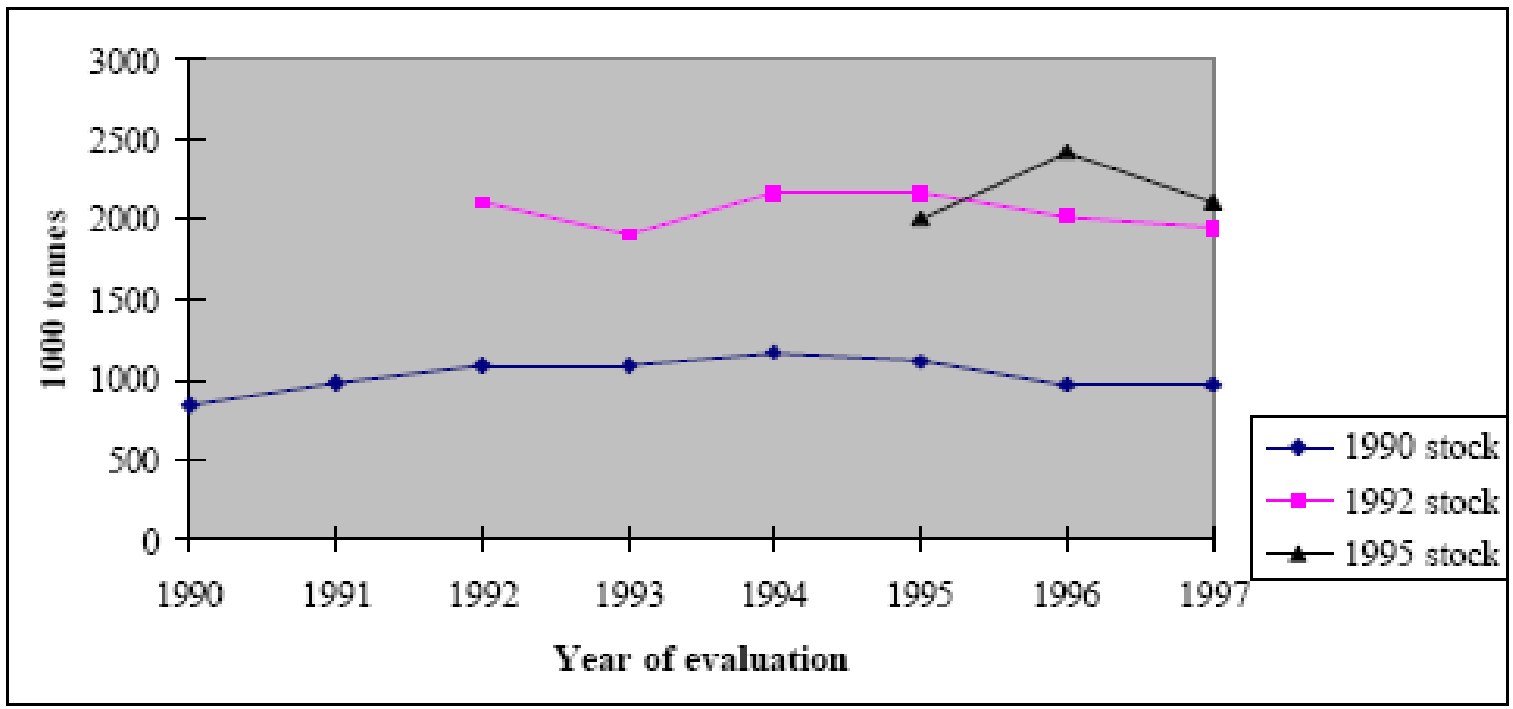


Förhållandet mellan priset på kvoterättigheten (kr/kg) och hyrpriset och torskbeståndets storlek 1991-2003



From Handbook on National Accounting: Integrated Environmental and Economic Accounting for Fisheries

Figure V.1 Variation in estimates of North-arctic cod stock sizes



From Handbook on National Accounting: Integrated Environmental and Economic Accounting for Fisheries

Table V.2 Size of North-arctic cod stocks depending on the year of evaluation

(thousands of tonnes)

	Year of evaluation												
Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1985	1,020	1,380	1,450	1,000	990	1,000	1,010	1,010	1,010	1,000	1,000	1,000	1,010
1986		1,880	1,790	1,300	1,220	1,250	1,290	1,300	1,240	1,240	1,270	1,240	1,250
1987			1,500	1,170	1,020	1,060	1,120	1,130	1,120	1,120	1,100	1,080	1,060
1988				900	690	750	810	830	820	830	800	780	820
1989					680	770	870	930	900	1,020	970	910	920
1990						830	980	1,080	1,080	1,170	1,110	970	960
1991							1,220	1,420	1,560	1,690	1,690	1,520	1,510
1992								2,100	1,910	2,170	2,170	2,020	1,940
1993									2,340	2,620	2,840	2,720	2,510
1994										2,280	2,410	2,620	2,340
1995											2,000	2,430	2,100
1996												2,540	2,040
1997													1,940

Sources: International Council for the Exploration of the Sea (ICES) and the Institute of Marine Research

From Handbook on National Accounting: Integrated Environmental and Economic Accounting for Fisheries

Table V.4 Resource rent of North-arctic cod based on data from the Norwegian National Accounts

(Million kroner)

	1990	1991	1992	1993	1994	1995	1996
Output	5,257	6,247	6,115	6,126	7,539	8,275	9,116
Intermediate consumption	2,119	2,232	2,243	2,341	2,682	2,900	2,928
Compensation of employees	1,272	1,442	1,529	1,478	1,627	1,812	1,884
Consumption of fixed capital	1,723	1,650	1,634	1,760	1,685	1,554	1,538
Normal return on capital	1,851	1,726	1,748	1,860	1,785	1,660	1,626
Resource rent	-1,708	-803	-1,039	-1,313	-240	349	783

Table V.6: Labour costs from survey data and the corresponding resource rent

(Million kroner)

	1990	1991	1992	1993	1994	1995	1996
Labour costs calculated with survey data (Lc)	1,931	2,313	1,709	1,783	2,829	3,170	3,199
Resource rent (Lc)	-2,367	-1,674	-1,219	-1,618	-1,442	-1,009	-532