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Spillover-effekter af danske virksomheders energiforskning og øvrige forskning

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SUMMARY: *In recent years there has been a drastic increase in public research subsidies earmarked for private energy research in Denmark. The purpose of this article is to investigate whether relatively high subsidies to private energy research can be justified by higher external spillover effects from private energy research compared to other private research. Estimation of spillover effects are carried out using an unbalanced panel of more than a thousand Danish private companies observed over the period 1999 to 2007. Our results suggest that the external rate of return due to external knowledge spillovers account for approximately a seventh of overall social return of private research. We reject that there are higher spillover from private energy research as compared to other types of private research. Instead the results suggest that external spillover effects of energy research may be lower than for other types of private research. This implies that subsidies earmarked for private energy research should not be an element in a first best policy to reduce CO_2-emission.*

1. Indledning

Danmark har frem mod 2020 forpligtet sig til at reducere udledningen af drivhusgasser, og der er et ønske om på længere sigt at blive mindre afhængig af fossile brændsler. Teknologisk udvikling inden for vedvarende energi og andre teknologier, der udleder mindre CO_2, kan gøre det billigere at nå disse mål.

Umiddelbart kan det derfor forekomme fornuftigt, at en stigende del af de offentlige midler til forskning øremærkes til energiforskning. Finanslovsbevillingerne til energiforskning er næsten seksdoblet siden 2003, til godt 900 mio. kr. i 2010. Ud over disse bevillinger finansierer elforbrugerne også energiforskning med omkring 180 mio. kr. via det såkaldte PSO-tillæg (Public Service Obligation) til elprisen. Stigningen i de nationale bevillinger til energiforskning har især haft karakter af forøgelser af de offentlige programmidler, som er gået til tilskud til privat forskning og strategiske forskningsprogrammer. Fra at udgøre omkring halvdelen af den samlede offentlige bevilling frem til midten af 00erne, er programmidlernes andel af den offentlige støtte til energiforskning steget til at udgøre 90 pct. eller 800 mio. kr. i 2010, jf. De Økonomiske Råd (2011). En stigende del af programmidlerne går til støtte af energiforskning i private virksomheder og synes at være motiveret ud fra erhvervsøkonomiske hensyn, idet energiteknologi vurderes som et fremtidigt vækstområde. I denne artikel præsenteres en empirisk analyse, som belyser, hvorvidt det er hensigtsmæssigt at øremærke støtte til privat forskning på energiområdet.[1]

Forskning og udvikling af vedvarende energi og andre teknologier, der udleder mindre CO_2, dæmpes især af to markedsfejl, som kan berettige regulering. Den første markedsfejl er, at udledning af CO_2 er gratis for udlederne. Hvis der ikke er nogen afgift på udledning af CO_2, vil der heller ikke være noget incitament til at udvikle og anvende teknologi med lav udledning af CO_2. Den anden markedsfejl er, at forskende virksomheder ikke får det fulde afkast af deres indsats, fordi der ved forskning typisk er positive spillover-effekter til andre virksomheder, som også kan nyde godt af den nye viden. Der kan korrigeres for disse markedsfejl ved at indføre en CO_2-afgift (eller omsættelige CO_2 kvoter) og ved at give et give tilskud til virksomhedernes forskning svarende til de positive eksterne spillover-effekter ved deres forskning.

En CO_2-afgift vil i sig selv give et incitament til at forske i renere teknologier, hvilket er dokumenteret i en række empiriske undersøgelser, jf. f.eks. Popp (2002), Newell mfl. (1999) og Johnstone mfl. (2010). Med en optimal CO_2-afgift er privat forskning i teknologier, som udleder mindre CO_2, ikke specielt understimuleret i forhold til anden privat forskning. I så fald er der ingen grund til at øremærke subsidier til privat forskning på energiområdet, med mindre der er særligt høje spillover-effekter af privat energiforskning sammenlignet med anden forskning, jf. f.eks. Jaffe mfl. (2005a), Popp mfl. (2009) og OECD (2010).

En række undersøgelser har belyst effekten på teknologisk udvikling og samfundsøkonomisk velfærd af henholdsvis en CO_2-afgift og støtte til forskning i situationer, hvor disse instrumenter ikke begge er til rådighed, jf. Schneider og Goulder (1997), Popp (2006) samt Fischer og Newell (2008). Disse analyser peger i retning af, at forskningssubsidier til vedvarende energi isoleret set er et dyrt virkemiddel, mens en CO_2-afgift er et betydeligt bedre (second best) virkemiddel, når man kun kan anvende ét instrument til at løse begge markedsfejl. Øremærkede subsidier til energiforskning er så-

1. Resultaterne af analysen er anvendt i forbindelse med kapitel II i De Økonomiske Råd (2011). I den forbindelse vil forfatterne gerne takke formandskab og sekretariat for sparring i forbindelse med de præsenterede analyser. Derudover takkes Carter Bloch fra Center for Forskningsanalyse for råd og programkode i forbindelse med beregning af mål for spillovers mellem virksomheder.

ledes et dårligt alternativ til en CO_2-afgift. Intuitionen bag dette er, at selv om støtte til forskning i energiteknologi kan bidrage til at udvikle renere teknologi, så er CO_2-afgifter en forudsætning for, at virksomheder og forbrugere ønsker at bruge den renere teknologi.

I denne artikel præsenteres en empirisk analyse af spillover-effekter af danske virksomheders forskning med henblik på at undersøge, om der er større spillover-effekter af privat energiforskning sammenlignet med anden privat forskning. I givet fald vil det være hensigtsmæssigt at give særligt høje subsidier til privat energiforskning. Analysen er baseret på et ubalanceret panel af mere end 1.000 forskende danske virksomheder for perioden 1999 til 2007. Analysen bekræfter, at der er positive interne og eksterne afkast (spillover-effekter) af virksomhedernes forskning målt i forhold til effekten på virksomhedernes værditilvækst. Effekten svarer til et samfundsøkonomisk afkast af forskning på omkring 28 pct., hvoraf omkring en syvendedel kan tilskrives eksterne spillover-effekter til andre virksomheder. Estimationsresultaterne tyder imidlertid ikke på, at der er større spillover-effekter og dermed højere samfundsøkonomisk afkast af energiforskning sammenlignet med anden forskning. Faktisk synes det modsatte at være tilfældet. Der er således tegn på, at spillover-effekten af energiforskning er lavere end spillover-effekten af anden privat forskning. Implikationen af dette er, at det ikke er hensigtsmæssigt at øremærke midler til støtte for privat energiforskning, som sigter mod at mindske udledningen af CO_2, så længe der er muligheder for at beskatte udledningen af CO_2 på et hensigtsmæssigt niveau.[2]

I den empiriske analyse anvendes overordnet set samme metode til at vurdere effekten af forskning som anvendt i Forsknings- og Innovationsstyrelsen (2010) og Bloch og Marino (2008). I førstnævnte analyse estimeres dog udelukkende effekten af forskning for virksomhederne selv, mens der ikke indgår spillover-effekter. I forhold til disse tidligere danske undersøgelser bidrager vores analyse med en beregning af det eksterne afkast og dermed det samfundsøkonomiske afkast af forskningen på baggrund af de estimerede parametre. Endvidere undersøges, om der er forskelligt samfundsøkonomisk afkast af virksomhedernes energiforskning sammenholdt med anden privat forskning. Endelig korrigeres der i analysen for, at arbejdskraft med forskelligt uddannelsesniveau har forskellig produktivitet. Dette er vigtigt, hvis virksomheder med meget forskning også har mange højtuddannede blandt deres ikke-forskende personale. Uden korrektion for uddannelsesniveau vil der i så fald være en tendens til, at virksomhedernes eget afkast af forskning bliver overvurderet, jf. Hall mfl. (2009).

2. Analysen af spillover-effekter vedrører udelukkende effekter af forskning udført i virksomheder. Analysen belyser således ikke, om der er større eller mindre samfundsøkonomisk afkast af offentlig energiforskning sammenholdt med anden offentlig forskning på universiteter mv.

I det følgende afsnit præsenteres den empiriske model. I afsnit 3 beskrives de anvendte data. Estimationsresultater er givet i afsnit 4, og afsnit 5 opsummerer.

2. Udgangspunkt for analyse af afkast og spillover-effekter af FoU

Der findes rimelig gængse metoder til at undersøge det privatøkonomiske afkast og spillover-effekter af virksomhedernes forskning, jf. Hall mfl. (2009) samt Hall og Mairesse (1995). I dansk sammenhæng er for nyligt estimeret spillover-effekter af FoU, jf. Bloch og Marino (2008). Inden for denne litteratur tages normalt udgangspunkt i en Cobb-Douglas produktionsfunktion:[3]

$$Y_{it} = Ae^{\lambda t} K^{\alpha}_{i,t\text{-}1} L^{\beta}_{it} R^{\gamma}_{i,t\text{-}1} S^{\eta}_{i,t\text{-}1} e^{\varepsilon_{it}} \tag{1}$$

Fodtegnene i og t henviser til hhv. virksomhed og tid. Y er output (målt ved værditilvæksten), A er en konstant, λ opfanger teknologiske ændringer over tid i totalfaktorproduktiviteten, K er fysisk kapital og L er arbejdskraft. R er virksomhedens FoU-kapital, som er resultat af egen forskning, og S (spillover) er et mål for den videnskapital, som virksomheden er i stand til at tilegne sig fra andre virksomheders FoU-kapital. Spillover variablen for en given virksomhed er beregnet som en vægtet sum af FoU kapitalen i andre virksomheder. Spillover af viden kan forekomme på forskellige måder. For eksempel kan forskere udveksle viden gennem deres netværk, forskere kan skifte arbejdsplads og i den forbindelse tilføre deres nye virksomhed viden, som er kendt i den gamle virksomhed. En virksomhed kan også trække på viden, som er dokumenteret i form af patenter, artikler eller indlejret i en anden virksomheds produkter. Den konkrete beregning af spillover-effekten (dvs. valg af vægte) beskrives senere. Parametrene α, β, γ og η er produktionselasticiteter af de forskellige input i produktionsfunktionen. Konstant skalaafkast i forhold til virksomhedens egne input vil implicere at $\alpha + \beta + \gamma = 1$.[4]

I litteraturen estimeres afkast af forskning typisk under ét og ikke opdelt på forskellige typer af forskning, jf. Hall mfl. (2009). I modsætning til dette testes det i nærværende analyse, om privatøkonomiske afkast og spillover-effekterne er ens for ener-

3. Denne produktionsfunktion kan potentielt kritiseres for at være relativt restriktiv i forhold til f.eks. en CES funktion. Det er dog valgt, at anvende Cobb-Douglas funktionen dels fordi det gør det nemmere at sammenligne resultaterne med tidligere danske og udenlandske studier, og dels fordi det er relativt nemt at udvide modellen, så det på en enkelt måde kan undersøges, om en høj andel af energiforskning har betydning for afkast og spillover-effekter af forskning.

4. I den empiriske litteratur testes/pålægges denne restriktion ofte som en test/restriktion af konstant skalaafkast. Der kan imidlertid argumenteres for, at virksomhedens videnkapital R i så fald ikke kan tolkes som »viden« i den gængse økonomiske forstand, hvor »viden« er noget, der kan bruges igen og igen (dvs. at viden er et ikke-rivaliserende input i virksomhedens produktion). I de estimationer, der præsenteres i denne artikel, pålægges ingen restriktioner på de estimerede parametre.

giforskning og anden forskning. Hvis dette er tilfældet (eller hvis der er lavere afkast og spillover-effekter af energiforskning), er der ikke nogen speciel grund til at støtte energiforskning frem for anden forskning.

For at vurdere om energiforskning har speciel betydning for afkastet af egen forskning eller for spillover inkluderes to brøkled, der angiver, hvor stor en del af virksomhedens samlede forskningskapital, som vedrører energiforskning (R^E), samt hvor meget af den samlede spillover-effekt, som vedrører spillover fra andre virksomheders energiforskning (S^E):

$$Y_{it} = Ae^{\lambda t} K^{\alpha}_{i,t\text{-}1} L^{\beta}_{it} \left(R_{i,t\text{-}1}\right)^{\gamma} \left(\frac{R^E_{i,t\text{-}1} + R_{i,t\text{-}1}}{R_{i,t\text{-}1}}\right)^{\varphi} \left(S_{i,t\text{-}1}\right)^{\eta} \left(\frac{S^E_{i,t\text{-}1} + S_{i,t\text{-}1}}{S_{i,t\text{-}1}}\right)^{\mu} e^{\varepsilon_{it}} \qquad (2)$$

Udtrykket $\frac{S^E + S}{S}$ er mellem 1 (intet energibidrag i spillover-effekten) og 2 (hele spillover-effekten er fra energiforskning). Det vil sige, at $\left(\frac{S^E + S}{S}\right)^{\mu} = 1$, hvis $S^E = 0$ eller $\mu = 0$. Brøkledet får således ingen betydning for produktionsfunktionen for virksomheder, hvor der ikke indgår energiforskning i spillover-effekten. Hvis $\mu > 0$ betyder det, at energiforskning har ekstra positiv spillover-effekt sammenlignet med anden forskning. Hvis $\mu < 0$ betyder det, at energiforskning har mindre spillover-effekt sammenlignet med anden forskning. Udtrykket $\frac{R^E + R}{R}$ har en analog tolkning i forhold til virksomhedens egen forskningskapital.

Det bemærkes, at parametrene μ og φ ikke kan tolkes på samme måde som produktionselasticiteterne (α, β, γ og η), men fortegnet på μ og φ afgør om effekten af energiforskning er højere eller lavere end af anden forskning. Tolkningen af μ og φ kan bedst illustreres ved et eksempel: Hvis det antages, at μ =1 og S^E udgør 10 pct. af den samlede spillover, bliver $\left(\frac{S^E + S}{S}\right)^{\mu} = 1{,}1^1 = 1{,}1$. Det svarer til en 10 pct. stigning i den samlede spillover-effekt. Dvs. at der er en procentvis stigning i spillover på 10μ, når $\left(\frac{S^E}{S}\right)$ vokser med 0,1 (f.eks. fra 0 til 0,1). Denne tolkning gælder approksimativt for plausible størrelser af S^E og μ.[5]

Modellen estimeres efter almindelig *ln*-transformation:

$$\begin{aligned} ln(Y_{it}) &= a_B + \lambda_t + \alpha ln\, K_{i,t\text{-}1} + \beta ln\, L_{it} + \\ &\gamma ln\left(R_{i,t\text{-}1}\right) + \varphi ln\left(\frac{R^E_{i,t\text{-}1} + R_{i,t\text{-}1}}{R_{i,t\text{-}1}}\right) + \eta ln\left(S_{i,t\text{-}1}\right) + \mu ln\left(\frac{S^E_{i,t\text{-}1} + S_{i,t\text{-}1}}{S_{i,t\text{-}1}}\right) + \varepsilon_{it} \end{aligned} \qquad (3)$$

5. Det er tilfældet, hvis μ ikke er stor (numerisk mindre end 2) og S^E udgør en lille del af den samlede S.

Her er de teknologiske fremskridt over tid i totalfaktorproduktiviteten specificeret som årsdummier (λ_t). Konstantleddet a_B er specificeret som forskellige konstanter for forskellige brancher. En mere fleksibel specifikation af konstanten fås ved at lade konstantleddet være individuelt (a_i) svarende til »fixed effects« modellen, hvor de individuelle konstanter kan kontrollere for uobserveret (tidsinvariant) heterogenitet.

Produktionsfunktionen i ligning (2) er en af flere mulige specifikationer til at undersøge om produktionselasticiteten til forskningsspillover er forskellig for energi sammenlignet med anden forskning. Som supplement til ligning (2) estimeres også følgende variant af en produktionsfunktion:

$$Y_{it} = Ae^{\lambda t} K^{\alpha}_{i,t\text{-}1} L^{\beta}_{it} R^{\gamma}_{i,t\text{-}1} \left(S^{O}_{i,t\text{-}1}\right)^{\eta} \left(S^{E}_{i,t\text{-}1}\right)^{\mu} e^{\varepsilon}{}_{it} \qquad (4)$$

I stedet for at medtage samlet spillover for de enkelte virksomheder (S) er der i ligning (4) medtaget en opdeling af samlet spillover (S) i S^E og spillover fra anden forskning (S^O), dvs. $S = S^E + S^O$. Det er imidlertid en potentiel ulempe ved ligning (4) i forhold til ligning (2), at ligning (4) ikke i praksis tillader en forskellig elasticitet til virksomhedens egen energiforskningkapital (R) i forhold til virksomhedens samlede eller øvrige forskningskapital.[6] På dette punkt er specifikationen i ligning (4) derfor mere restriktiv sammenholdt med ligning (2). Det bemærkes, at tolkningen af parametrene η og μ er forskellig i model 2 og 4.

2.1. Korrektion for kvalitet af arbejdskraft og double counting

Det er vigtigt, at korrigere for kvaliteten af arbejdskraft ved beregning af afkast af forskning. Virksomheder med meget forskning kan være virksomheder, som også i øvrigt har mange højtuddannede. Hvis der ikke tages højde for dette, vil der være en tendens til, at virksomhedernes eget afkast af forskning bliver overvurderet, fordi højtuddannede er mere produktive, jf. Hall mfl. (2009). Selv om dette problem er erkendt, er det tilsyneladende ikke standard i analyser af afkast til forskning.[7]

Kvalitetskorrigeringen af L er baseret på metoden anvendt i De Økonomiske Råd (2010), hvor personer med forskelligt uddannelsesniveau er vægtet i forhold til gennemsnitslønnen for pågældende uddannelseskategori ud fra en antagelse om, at forskellige gennemsnitslønninger afspejler forskelle i produktiviteten/kvaliteten af ar-

6. I princippet kunne R også opsplittes i to dele (R^E og R^O) i ligning 4. Det er imidlertid kun en lille del af de forskende virksomheder, som har både energiforskning og anden forskning. Derfor ville en sådan version af ligning 4 kun kunne estimeres for et begrænset sample af virksomheder.

7. I Hall mfl. (2009) refereres til tre fransksprogede artikler, som undersøger betydningen af at korrigere for forskellige kvaliteter af arbejdskraft. Disse finder, at elasticiteten til egen FoU kapital reduceres væsentligt, når der tages højde for forskellige kvaliteter af arbejdskraft. Der korrigeres ikke for kvalitet af arbejdskraft i tidligere danske analyser af effekter af forskningen, jf. i Bloch og Marino (2008) samt Forsknings- og Innovationsstyrelsen (2010).

bejdskraften, jf. f.eks. Timmer mfl. (2007). Der er beregnet gennemsnitslønninger for fem forskellige uddannelseskategorier (lang videregående, mellemlang videregående, kort videregående, faglærte og ufaglærte) inden for hvert år i den betragtede periode. Beregningen af gennemsnitslønninger er foretaget for alle ansatte i enheder med mere end 10 beskæftigede (inklusive virksomheder uden forskning). Konkret er L vægtet op til ufaglærte (dvs. at en person med lang videregående uddannelse vægter mere end en ufaglært). Mere konkret er det kvalitetskorrigerede arbejdskraftindeks L beregnet som:

$$L_{it} = \bar{L}_{i0t} + \sum_{f=1}^{F-1} \frac{w_{fBt}}{w_{0Bt}} \bar{L}_{ift} \tag{5}$$

hvor $f = 0,\ldots,F$ er et indeks for arbejdskraftens kvalitet målt ved uddannelsesniveau, $\bar{L}_{ift}$ er antallet af ansatte med uddannelsesniveau f i virksomhed i i år t. Referencegruppen, $\bar{L}_{i0t}$, er ufaglærte, mens w_{fBt} er gennemsnitslønnen for beskæftigede med uddannelse f i branche B i år t.

Virksomhedens investeringer i FoU består især af udgiften til arbejdskraften, der udfører forskningen (forskere, teknikere og andet). Det er vigtigt at korrigere det anvendte mål for L for den arbejdskraft, der anvendes til forskning, da arbejdskraften til forskning ellers indgår både i R og L. En sådan »double counting« vil kunne give sig udslag i bias i de estimerede parametre, jf. Hall mfl. (2009). Korrektionen for double counting foretages normalt ved at trække antal FoU-årsværk fra det samlede antal årsværk beskæftiget i virksomheden. Da vi har kvalitetskorrigeret antallet af årsværk, skal også antallet af FoU-årsværk kvalitetskorrigeres inden de trækkes fra. Fra de anvendte spørgeskemaundersøgelser om virksomhedernes forskningsindsats kender vi antallet af forskningsmedarbejdere fordelt på »forskere«, »teknikere« og »andet«. Det er antaget, at disse tre kategorier af forskningsmedarbejdere har henholdsvis en lang videregående uddannelse, kort videregående uddannelse (f.eks. laborant) og er faglærte (f.eks. en kontoruddannelse). Variablen L i modellen er således både korrigeret for kvalitet (uddannelsesniveau) og double counting.

2.2. Beregning af FoU kapital og spillover-effekter

Ved estimation af afkastet af FoU (og spillover-effekter) antages normalt, at investeringer i FoU (IR) bidrager til at øge beholdningen af videnskapital (R). Videnskapitalen beregnes på et givet tidspunkt som en funktion af tidligere års investeringer i FoU ud fra den såkaldte »perpetual inventory method«, jf. Hall mfl. (2009):

$$R_{it} = (1 - \delta)\ R_{i,t\text{-}1} + IR_{it} \tag{6}$$

Analogt er forskningskapitalen relateret til energiforskning beregnet ved:

$$R^E_{it} = (1 - \delta)\ R^E_{i,t\text{-}1} + IR^E_{it} \tag{7}$$

Her angiver R_{it} videnskapitalen (ultimo) perioden, mens δ er afskrivningsraten. Denne er valgt til 15 pct., hvilket typisk anvendes i andre lignende studier.[8] Forskningskapitalen i det første år, hvor vi har observationer for den pågældende virksomhed (1995 eller senere, jf. databeskrivelsen i afsnit 3) baseres på niveauet af investeringen i det pågældende år, samt en antagelse om, at virksomheden i årene inden har haft en konstant realvækst i forskningsudgiften svarende til g. For virksomheder, der første gang optræder i data i 1995, er den samlede forskningskapital og forskningskapitalen vedrørende energi således opgjort ved:

$$\begin{aligned} R_{i,95} &= \frac{IR_{i,95}}{g + \delta} \\ R^E_{i,95} &= \frac{IR^E_{i,95}}{g + \delta} \end{aligned} \tag{8}$$

Parameteren g er sat til 7 pct., som svarer til den gennemsnitlige vækstrate i den private sektors samlede reale forskningsudgifter for perioden 1970 til 2001.

Spillover-kapitalen måles normalt ved en vægtet sum af FoU-kapitalen for andre virksomheder, hvor vægtningsmatricen er givet ved a_{ji}:

$$S_{it} = \sum\nolimits_{j \neq i} a_{jt}\, R_{jt} \tag{9}$$

Analogt kan spillover-effekten fra energiforskning beregnes som en vægtet sum af andre virksomheders energiforskning (samme vægtningsmatrice er anvendt):

$$S^E_{it} = \sum\nolimits_{j \neq i} a_{jt}\, R^E_{jt} \tag{10}$$

8. Den typisk anvendte afskrivningsrate på videnkapital (på 15 pct.) synes at være valgt relativt ad hoc. Efterfølgende undersøgelser har dog vist, at det ikke har stor betydning for beregning af forskningsafkast, om afskrivningen er højere eller lavere, jf. Hall mfl. (2009).

I tidligere undersøgelser er der anvendt en række forskellige vægtningsmatricer, jf. Hall mfl. (2009) og Griliches (1992).[9] En mulighed er, at S og S^E beregnes som summen af henholdsvis R og R^E for alle andre virksomheder, dvs. svarende til at $a_{ij} = 1$. Dette er imidlertid ikke hensigtsmæssigt. For det første forekommer det mest plausibelt, at spillover til andre virksomheden ikke er ens, men afhænger af f.eks. geografisk eller teknologisk nærhed, branchetilknytning eller andet. For det andet vil S og S^E i praksis være ens for alle virksomheder i et givet år, hvis $a_{ij} = 1$. Der bliver således ingen variation mellem virksomheder i et givet år, hvilket kan gøre det vanskeligt empirisk at identificere parametrene til S og S^E.

Konkret er valgt at afprøve tre forskellige vægtningsmatricer baseret på

– a. Geografi
– b. Forskningsprofil (fordeling af forskning på forskningsområder)
– c. Geografi og forskningsprofil

Ad a: Det antages her, at der er spillover-effekter mellem virksomheder, som ligger i samme region. En række empiriske undersøgelser tyder på, at spillover er større for virksomheder, som ligger tæt på hinanden, jf. f.eks. Autant-Bernard mfl. (2007), Jaffe mfl. (1993) og Jaffe mfl. (2005b). Konkret antages, at $a_{ij} = 1$ for alle virksomheder lokaliseret i den samme region, mens $a_{ij} = 0$ for alle virksomheder lokaliseret i forskellige af de 5 regioner i Danmark. Med denne vægtningsmatrice vil der ikke være spillover mellem virksomheder i forskellige regioner. Den geografisk (stærkt) afgrænsede vægtningsmatrice understøttes af Mairesse og Mulkay (2008), som finder, at der er spillover-effekter fra virksomheder inden for en radius af 100 km, men ikke fra virksomheder, som er lokaliseret i en afstand på mellem 100 og 200 km.

Ad b: Her anvendes en vægtningsmatrice, som afspejler nærheden i forskningsprofiler mellem virksomheder. Nærheden i forskningsprofiler beregnes konkret som den parvise korrelation mellem virksomhedernes forskningsområder. Tilgangen blev oprindelig anvendt af Jaffe (1986), men bliver stadig betegnet som »best practice«, jf. Bloom mfl. (2007). I den oprindelige anvendelse blev forskningsprofiler defineret i forhold til teknologiklasser for virksomhedernes patenter. Her følges tilgangen i Bloch og Marino (2008), som definerede forskningsprofiler i forhold til virksomheders fordeling af deres forskning på 15 forskellige forskningsområder (hvor energiforskning udgør et af områderne). Konkret er den parvise korrelation mellem forskningsområder i virksomhederne beregnet som:

9. Der er studier, som søger at identificere mekanismer til spredning af viden, jf. Autant-Bernard mfl. (2007). Det er dog en type forskning, som kun kan give indikationer – modsat håndfaste konklusioner – på, hvordan viden spredes. Som udtrykt af Krugman (1991): »Knowledge flows are invisible, they leave no paper trail by which they may be measured and tracked«.

$$a_{ij} = \frac{\sum_{k=1}^{K} s_{ik} s_{jk}}{\left(\sum_{k=1}^{K} s_{ik} s_{jk}\right)^{1/2} \left(\sum_{k=1}^{K} s_{jk} s_{jk}\right)^{1/2}} \tag{11}$$

Hvor K er antallet af forskningsområder, s_{ik} er andelen af virksomheds i's forskning inden for forskningsområde k. Her er $0 \leq a_{ij} \leq 1$, hvor værdien nul svarer til, at virksomhederne har helt forskellig forskningsprofil, mens værdien 1 angiver at virksomhederne har identisk forskningsprofil.[10]

Ad c: Her antages, at der er spillover-effekter mellem virksomheder med nærhed i forskningsprofiler, som også geografisk ligger tæt på hinanden. Konkret er vægtningsmatricen beregnet som i ligning (11) med den tilføjelse, at $a_{ij} = 0$ for virksomheder i forskellige geografiske regioner.

Forskellige vægtningsmatricer kan afspejle forskellige spredningsmekanismer for viden. En vægtningsmatrice baseret på geografisk nærhed er således konsistent med en spredningsmekanisme, hvor viden blev spredt ved at forskere skifter arbejdsplads (givet at arbejdsmarkedet for forskere er delvist lokalt afgrænset på kort sigt) eller at viden bliver spredt gennem mere personlige (geografisk lokale) netværk. Vægtningsmatricen baseret på korrelation i forskningsprofiler er forenelig med en mekanisme, hvor spredning af viden foregår inden for forskellige forskningsfelter, f.eks. ved faglige netværk med forskere inden for samme forskningsområder eller spredning af faglig viden til fagfæller i tidsskrifter eller gennem konferencer mv.

3. Beskrivelse af data

Oplysningerne, der danner baggrund for analysen af afkastet til forskning, er baseret på data fra opgørelsen af Erhvervslivets forskningsstatistik, indhentet af Center for Forskningsanalyse – og fra 2007 af Danmarks Statistik. Denne statistik kortlægger omfanget af dansk erhvervslivs forskning og udviklingsarbejde i form af bl.a. udgifter til virksomhedens egen forskning og antallet af forskningsmedarbejdere. Analysen, hvor udgifter til virksomhedens forskning skal opdeles i energi og anden forskning, tager udgangspunkt i indberetninger af forskning fra årene 1995, 1997, 1998, 1999, 2001,

10. Korrelationen i forskningsprofiler (a_{ij}) vil f.eks. være én mellem to virksomheder, som kun forsker inden for energi. Korrelationen vil også være én for to virksomheder, som har spredt deres forskning helt jævnt ud på alle 15 forskningsområder. Carter Bloch har været behjælpelig med SAS-kodning til at beregne korrelationer i forskningsprofiler.

2003, 2005 og 2007, hvor der foreligger oplysninger om virksomhedernes forskning fordelt på forskellige forskningsområder.[11]

Det er ikke alle virksomheder, der indgår i opgørelsen af den danske forskningsaktivitet, dels fordi det er frivilligt at besvare spørgeskemaet, og dels fordi opgørelsen delvist er stikprøvebaseret. Mere præcist får virksomheder med mere end 249 ansatte, virksomheder inden for branchen »Forskning og udvikling« samt virksomheder, der tidligere har indberettet forskningsudgifter på mindst 10 mio. kr., alle tilsendt et spørgeskema. Forskningsaktiviteten i mellemstore og små virksomheder indhentes på stikprøvebasis ud fra kriterier vedrørende størrelse og branche, hvilket betyder, at oplysninger om forskning ikke nødvendigvis findes for de samme virksomheder i alle år, og dermed at panelet er ubalanceret. Dette vanskeliggør opgørelsen af virksomhedernes videnskapital, der er beregnet som en funktion af tidligere års investeringer ud fra »perpetual inventory method«, jf. afsnit 2.2.

For at kunne opgøre virksomhedernes FoU-kapital er foretaget en lineær interpolation af forskningsudgifter for virksomheder, der optræder flere gange i undersøgelserne, men ikke i en sammenhængende periode. For at gøre opgørelsen mere præcis er endvidere anvendt oplysninger fra Erhvervslivets forskningsstatistik for årene 2002, 2004 og 2006. Disse indeholder oplysninger om virksomhedernes samlede forskning, men ingen fordeling på forskningsområder (fordelingen på forskningsområder er i disse år interpoleret).

Oplysninger om virksomhedens værditilvækst, kapital og arbejdskraft er hentet fra den generelle firmastatistik for perioden 1999-2007. Virksomhedernes værditilvækst er deflateret med en fælles prisdeflator for private byerhverv, kapital er deflateret med de gennemsnitlige investeringspriser, mens videnskapital er deflateret med en generel deflator for værditilvæksten. Selve estimationen udføres for perioden 2000-2007, da nogle variable indgår med deres laggede værdi i produktionsfunktionen (se ligning 3). Derudover er der, til brug ved kvalitetskorrigering af arbejdskraften, indhentet oplysninger om uddannelsesniveau for medarbejdere i de virksomheder, der har indberettet forskningsaktivitet. Disse oplysninger er hentet i registre i Danmarks Statistik. Det endelige datasæt består af i alt 4.238 observationer fordelt på 1.029 forskellige virksomheder, der i gennemsnit optræder fire gange i samplet. Omkring 75 pct. af arbejdskraf-

11. Der findes oplysninger fra forskningsstatistikken i ulige årstal tilbage til 1991. Oplysninger fra 1991 og 1993 er dog udeladt af analysen, fordi virksomhederne i disse år kun skulle fordele deres forskningsudgifter på ned til 5 forskellige forskningsområder, dvs. at spørgeformen er ikke sammenlignelig med de senere år. Virksomhederne skal angive den procentvise fordeling af deres forskning på forskellige forskningsområder (herunder energiforskning). Virksomhederne kan indberette procentandele, som summer til mere end 100 pct., hvis virksomhedens forskning overlapper mellem forskellige forskningsområder. For at korrigere for dette overlap er der her anvendt reskalerede andele, som summer til 100 pct. Reskaleringen er foretaget for ca. 5 pct. af observationerne.

ten i datasættet er beskæftiget i industribrancher, og datasættet indeholder forskningsoplysninger fra virksomheder, der repræsenterer knap 40 pct. af den samlede danske industribeskæftigelse. Det endelige datasæt samt de variable, der indgår i analysen, er nærmere beskrevet i bilag 1.

4. Estimationsresultater

Formålet med analysen er at undersøge, om der er større eller mindre privat afkast og spillover af privat udført FoU på energiområdet end privat FoU på andre områder. For at sammenligne estimationsresultaterne med tidligere undersøgelser fokuseres i første omfang på resultater fra estimationer, hvor der ikke skelnes mellem energiforskning og øvrig forskning (ligning 1). Efterfølgende gennemgås resultaterne af estimation med særlig fokus på effekten af energiforskning (ligning 2).

4.1. Estimationsresultater uden særlig effekt af energiforskning

I tabel 1 vises estimationsresultater for hver af de tre forskellige mål for spillover, dels ved almindelige poolede regressionsmodeller og dels ved fixed effects (FE) modeller, som udnytter panelstrukturen i data ved at tillade virksomhedsspecifikke konstantled.

Fokuseres i første omgang på parametrene til virksomhedens egne input (*K, L* og *R*) er disse signifikante og relativt konstante på tværs af de forskellige estimerede modeller. Summen af disse tre produktionselasticiteter (0,97 til 1,02) er tæt på 1, hvilket svarer til konstant skalaafkast i forhold til virksomhedens egne input. Summen af produktionselasticiteterne er lidt større i de poolede estimationer sammenlignet med fixed effects modellerne. Dette ses ofte når man sammenligner poolede og fixed effects modeller, jf. Hall mfl. (2009).[12]

Overordnet set er der relativt beskedne forskelle i de estimerede parametre til forskningskapital og spillover-kapital, når man sammenligner resultaterne fra de poolede modeller med de tilhørende fixed effects modeller. Fixed effects modellerne er mere fleksible end poolede modeller, fordi de tager højde for uobserveret (tidsinvariant) he-

12. Inden for den empiriske litteratur vedrørende estimation af produktionsfunktioner og afkastet af forskning anses konstant skalaafkast af virksomhedens egne input (*K, L* og *R*) generelt som en ønskværdig egenskab og som tegn på en god empirisk model. Jf. fodnote 4 kan der dog sættes spørgsmålstegn ved, om videnkapital *R* i så fald kan tolkes som »viden« i den gængse økonomiske forstand, hvor »viden« er ikkerivaliserende i produktionen. Den estimerede positive parameter til videnkapital indikerer, at videnkapital også (delvist) omfatter en form for viden, som er rivaliserende. Det kunne f.eks. være tilfældet, hvis omfanget af virksomhedens egen forskning er korreleret med virksomhedens kapacitet til at indsamle, bearbejde og omsætte ny viden skabt af ekstern forskning (både offentlig og privat).

Tabel 1. Estimation af $ln(Y_{it})$.

Nummer	1			2			3			4			5			6		
Type	OLS			OLS			OLS			FE			FE			FE		
Spillover	Reg			Forsk.profil			Forsk.profil&reg			Reg			Forsk.profil			Forsk.profil&reg		
	koef.		*t*	koef.		*T*	koef.		*t*	koef.		*t*	koef.		*t*	koef.		*t*
$ln\ (K_{t\text{-}1})$	0,13	**	16,4	0,13	**	16,1	0,13	**	16,3	0,10	**	8,7	0,10	**	8,5	0,10	**	8,6
$ln(L)$	0,76	**	63,0	0,76	**	62,9 0,76	**	63,1	0,74	**	36,4	0,74	**	36,5	0,74	**	36,5	
$ln\ (R_{t\text{-}1})$	0,12	**	17,9	0,13	**	18,9	0,13	**	18,4	0,13	**	11,5	0,14	**	12,4	0,14	**	12,2
$ln\ (S_{t\text{-}1})$	0,04	**	4,8	0,00	0,2	0,03	**	4,3	0,05	**	3,6	0,01		0,7	0,03	**	2,9	
year01	0,03		1,1	0,02	0,9	0,02	0,9	0,02		1,3	0,01		0,9	0,01		0,8		
year02	0,05	*	2,1	0,05	*	2,1	0,05	*	2,1	0,04	*	2,1	0,03	*	2,0	0,04	*	2,0
year03	0,04		1,6	0,04		1,5 0,03		1,4	0,03		1,6	0,03		1,3	0,02		1,2	
year04	0,05	*	2,0	0,05	*	2,2 0,04		1,9	0,02		1,3	0,03		1,7	0,03		1,4	
year05	0,06	**	2,6	0,07	**	2,7	0,06	*	2,4	0,04		1,9	0,04		1,9	0,04		1,8
year06	0,06	*	2,2	0,07	*	2,5	0,06	*	2,2	0,05		1,9	0,05	*	2,2	0,05	*	2,1
year07	0,13	*	4,1	0,13	**	4,0	0,13	**	4,1	0,11	*	4,1	0,11	**	4,0	0,11	**	4,1
Konstant																		
(basis)	4,14	**	31,5	4,66	**	22,7	4,33	**	40,8	4,19	*	18,6	4,76	**	18,0	4,55	**	28,4
Konstanter	19 brancher			19 brancher			19 brancher			FE			FE			FE		
N observationer	4.238			4.238			4.236			4.238			4.238			4.236		
R^2 overall	0,9146			0,9140			0,9146			0,9096			0,9085			0,9090		
R^2 within										0,2438			0,2433			0,2445		
N virksomheder										1.029			1.029			1.028		
p (year$_i$=0)	0,0047			0,0032			0,0040			0,0093			0,0128			0,0073		
Sigma_*u*										0,374			0,378			0,377		
Sigma_*e*										0,294			0,294			0,294		
Rho										0,618			0,624			0,622		

* Angiver at parameteren er signifikant på et 5-pct. niveau. ** Angiver at parameteren er signifikant på et 1-pct. niveau. *t*-værdier er beregnet ud fra robuste s.e.

terogenitet mellem virksomhederne. Der lægges derfor mest vægt på resultaterne fra fixed effects modellerne.[13]

Produktionselasticiteten til forskningskapital er på 0,12 til 0,14 i de estimerede modeller. Størrelsen af produktionselasticiteten svarer til det, der er fundet i tidligere undersøgelser. Således finder Hall mfl. (2009) i en nylig survey, at elasticiteterne til forskningskapital er inden for intervallet 0,01 til 0,25, men med 0,08 som et typisk niveau. I en nylig analyse baseret på danske data finder Bloch og Marino (2008) produktionselasticiteter svarende til 0,13, mens analyser præsenteret i Forsknings- og Innovationsstyrelsen (2010) finder elasticiteter til forskningskapital på 0,05 til 0,13.

Elasticiteten til forskningskapital kan bruges til at beregne nettoafkastet af forskning (ρ) :[14]

$$\rho = \gamma \cdot \frac{Y}{R} - \delta \qquad (12)$$

I estimationssamplet er medianen af Y/R = 2,9, og forskningskapitalen blev beregnet med en årlig afskrivning af viden (δ) på 15 pct. For elasticiteter til forskningskapital på mellem 0,12 og 0,14 svarer dette til et privat nettoafkast af forskning på 20 til 25 pct. Dette kan måske forekomme at være et relativt højt afkast af en investering, men flere udenlandske studier peger i retning af et endnu højere afkast af forskning, jf. Hall mfl. (2009).

Det estimerede afkast af forskning kan være et overkantsskøn i forhold til det forventede afkast inden en investering i forskning foretages. I estimationssamplet er ikke medtaget virksomheder med negativ værditilvækst. I det omfang tidligere investeringer i forskning har været fejlslagne kan det lede til konkurs eller eventuelt negativ værditilvækst. Disse virksomheder vil ikke indgå i samplet, dvs. der er risiko for at nogle dårlige FoU-investeringer ikke medtages i beregningen af afkastet af forskning. Der kan endvidere argumenteres for, at det gennemsnitlige (ex post realiserede) afkast af privat forskning også skal være relativt højt, da der må formodes at være en betydelig risiko ved at investere i forskning (dvs. høj risikopræmie).

13. I forbindelse med denne analyse kan der dog argumenteres for, at der kan være tidsafhængige målefejl ved opgørelsen af spillover, som potentielt kan give bias især i fixed effects modellerne. Som beskrevet tidligere er S_{t-1} en vægtet sum af forskningskapitalen i andre virksomheder, som er tilgængelige i data i de pågældende år. Da oplysninger om forskningsindsatsen er baseret på et ubalanceret panel vil ændringer i S_{t-1} både kunne afspejle ændringer i virksomhedernes forskningsindsats (som vi ønsker at belyse) og ændringer, som skyldes, at det ikke er de samme virksomheder, som er med i beregningen af S_{t-1} i de forskellige år. Den potentielle bias fra dette må formodes at være større i fixed effects modeller, hvor parametrene er identificeret ved tidsvariationen i variablene inden for de enkelte virksomheder, end i de poolede regressioner, som i højere grad er identificeret ved variationen mellem virksomheder.

14. Pr. definition er $\gamma = \rho^b(R/Y)$, hvor ρ^b er den marginale produktivitet af FoU-kapital. Givet visse antagelser kan ρ^b tolkes som det marginale interne afkast (brutto), jf. Hall mfl. (2009).

Estimationerne i tabel 1 er baseret på en kvalitetskorrigeret opgørelse af beskæftigelsen, hvor personer med forskellige grader af uddannelse er vægtet højere end ufaglærte. Hvis der i stedet benyttes et ikke-kvalitetskorrigeret mål for beskæftigelsen findes lidt højere produktionselasticitet af forskning (0,14 til 0,15). Den højere produktionselasticitet er formentlig biased, fordi virksomheder med megen forskning også typisk har relativt mange højtuddannede, jf. Hall mfl. (2009).

Parametrene til målet for spillover er signifikante i modellerne, hvor der anvendes det enkle geografiske mål for spillover (model 1 og 4) og hvor det geografiske mål for spillover kombineres med et mål for korrelationen i forskningsprofiler mellem virksomhederne (model 3 og 6). Parametrene til spillover variablen i disse modeller er mellem 0,03 og 0,05. Dette harmonerer udmærket med tidligere undersøgelser, hvor elasticiteten til spillover variablen typisk er omkring 0,05 til 0,09, jf. Hall mfl. (2009). Det er dog vanskeligt at sammenligne parametre til spillover variabler for forskellige studier, da der er stor forskel på, hvordan spillover variablen er beregnet. I Bloch og Marino (2008), som også er baseret på danske data, er estimeret en parameter til spillover variablen (baseret på en vægtningsmatrice med korrelation mellem forskningsprofiler) på 0,06, dvs. lidt højere end fundet her.[15]

Parametrene til spillover variablen er ikke signifikante i modellerne (2 og 5), hvor spillover-effekten alene er baseret på korrelation i forskningsprofil. Dette peger i retning af, at spillover-effekten er geografisk afgrænset.

Et udtryk for det samfundsøkonomiske nettoafkast ved én virksomheds forskning kan beregnes som virksomhedens eget afkast ved forskning adderet med summen af afkastet af øget ekstern forskning for alle modtagere af spillover fra pågældende virksomhed, jf. Hall mfl. (2009):

$$\frac{\delta Y_i}{\delta R_i} + \sum_{j \neq i} a_{ij} \frac{\delta Y_j}{\delta S_j} - \delta = \gamma \cdot \frac{Y_i}{R_i} + \eta \cdot \sum_{j \neq i} a_{ij} \frac{Y_j}{S_j} - \delta \qquad (13)$$

I ligning (13) angiver det andet led den eksterne gevinst til andre virksomheder.

I de to modeller, hvor spillover variablen er beregnet ud fra region og korrelation i forskningsprofiler (estimationsmodel 3 og 6), er det samfundsøkonomiske afkast på

15. Modellen i Bloch og Marino (2008) er specificeret noget anderledes end den her estimerede model: I deres model er den afhængige variabel omsætning i stedet for værditilvækst, men materialeforbrug indgår ikke som input. Arbejdskraften er ikke korrigeret for double counting eller forskelle i sammensætningen på uddannelseskategorier. Endvidere er spillovervariablen beregnet ud fra et enkelt års investeringer i forskning i stedet for forskningskapitalen i de enkelte virksomheder. Endelig er deres model estimeret under en antagelse om konstant skalaafkast for alle input (inklusive spillovervariablen), hvor der her er anvendt en mindre restriktiv formulering.

henholdsvis 25 og 28 pct., beregnet ud fra medianværdierne. Heraf kan ca. 4 pct.point kan tilskrives de eksterne spillover-effekter.[16] Det svarer til, at det eksterne afkast udgør en sjettedel til en syvendedel af det samfundsøkonomiske afkast af forskning. I de to modeller estimeret med regionale spillover fås en smule højere eksternt afkast af spillover svarende til mellem en femtedel og en fjerdedel.[17] Det eksterne afkast (og dermed det samlede samfundsøkonomiske afkast) af forskningen er lidt mindre end det, der typisk findes i udenlandske studier (hvor der dog også kan være stor variation i afkastet til ekstern spillover-kapital), jf. Hall mfl. (2009).

Beregningen af det eksterne afkast af virksomhedernes forskning kan være et underkantsskøn. I analysen indgår således ikke virksomheder, som ikke selv har udført forskning. Der er derfor flere virksomheder end de medtagne, som potentielt kunne have nydt godt af en given virksomheds forskning. Et potentielt fravær af virksomheder med mislykkede investeringer i forskning kan dog trække i modsat retning.

Et andet mål for den økonomiske betydning af den estimerede parameter til spillover-effekten (S) kan findes ved at sammenligne størrelsen af S^{η} for forskellige niveauer af S. I model 6 i tabel 1 estimeres η til 0,0255. 10-pct. fraktilen og 90-pct. fraktilen for S for den pågældende variant af spillover variablen er på henholdsvis 676.575 og 12.716.634 (jf. bilag 1) svarende til, at værdien af $S^{0,0255}$ er på henholdsvis 1,409 og 1,519. Det svarer til, at der er en forskel i værditilvæksten på ca. 8 pct. mellem virksomheder tilgodeset med forholdsvis høj spillover (90 procent fraktilen) sammenlignet med virksomheder med forholdsvis lav spillover (10 pct. fraktilen). Dette tal kan sammenholdes med en tidligere dansk analyse af produktivitetseffekten ved at tilhøre en geografisk afgrænset erhvervsklynge. Produktivitetsfordelen ved at tilhøre en klynge tilskrives således ofte positive videnseksternaliteter. Konkret er fundet en positiv effekt på produktiviteten på 9 pct. ved at tilhøre en klynge, jf. Madsen mfl. (2003).[18] Produktivitetsforskellene mellem virksomheder tilgodeset med henholdsvis høj og med lav spillover forekommer dermed at være af nogenlunde plausibel størrelse. Dette underbygger størrelsen af det eksterne afkast ved privat forskning angivet ovenfor.[19]

16. Der er i samplet nogle store virksomheder med meget lidt forskning. For disse virksomheder bliver værdien af $\gamma(Y_i/R_i)$ meget stor. Det vil give en urealistisk høj gennemsnitlig værdi for det privat- og samfundsøkonomiske afkast. Derfor er anvendt medianværdier af det privatøkonomiske og det eksterne afkast af forskning.

17. I de to modeller estimeret med regionale spillover (model 1 og 4) er medianværdien af det samfundsøkonomiske afkast på henholdsvis 26 og 29 pct., hvoraf henholdsvis 5 og 7 pct.point kan tilskrives eksterne spillover-effekter (henholdsvis godt 6 og 7 pct.).

18. Klynger er her defineret ved en høj koncentration af beskæftigede i en kommune inden for samme branche. Produktivitetseffekten er beregnet i forhold til en dummyvariabel for hvorvidt en virksomhed ligger i en klynge.

19. De tilsvarende tal for model 1, 3 og 4 er på henholdsvis 10,7 pct., 8,4 pct. og 14,0 pct. Modellerne baseret på rene regionale spillover (model 1 og 4) giver således relativt høje produktivitetsforskelle.

4.2. Estimationsresultater med separat betydning af energiforskning

I tabel 2 vises estimationsresultaterne, når der inkluderes de to brøkled, som angiver, hvor meget energiforskning udgør af virksomhedens egen forskning og af spillover variablen. Det fremgår af tabel 2, at parameteren til $\left(\frac{R^E + R}{R}\right)$ er insignifikant i alle modeller, og at *t*-værdierne er meget lave. Det vil sige, at en høj andel af energiforskning ikke har nogen betydning for produktionselasticiteten eller afkastet af virksomhedens egen forskning. Hvis virksomhederne er gode til at vurdere det fremtidige afkast af forskellige typer af forskning, bør der i princippet heller ikke være forskel i det private afkast af forskellige typer forskning.

Det fremgår af tabel 2, at parameteren til $\left(\frac{S^E + S}{S}\right)$ er negativ i alle modeller, men kun signifikant i to tilfælde (model 1 og 6).

Selv om modellerne ikke giver anledning til en meget stærk konklusion vedrørende spillover-effekten af energiforskning er der intet, der tyder på højere spillover-effekter af energiforskning sammenlignet med anden forskning.

Den negative parameter til $\left(\frac{S^E + S}{S}\right)$ er på ca. -0,9 i model 1 (hvor spillover er defineret som et regionalt fænomen alene). Tolkningen af parameteren til dette brøkled er anderledes end tolkningen af produktionselasticiteterne. I estimationssamplet er 90 pct. fraktilen af $\left(\frac{S^E + S}{S}\right)$ på 1,076, jf. bilag 1. Da $1{,}076^{-0{,}9} = 0{,}96$ svarer dette til, at der er en 4 pct. reduktion i bidraget fra spillover, når dette indeholder en meget høj andel af energi. Der er således tale om relativt små effekter økonomisk set.

Samlet set peget estimationerne i tabel 2 på, at der ikke er højere privat afkast eller højere spillover-effekter af energiforskning sammenlignet med anden forskning. Faktisk tyder resultaterne vedrørende spillover-effekten på, at der snarere er lidt lavere spillover-effekter af energiforskning.

4.3. Supplerende estimationer

Der er udført en række supplerende estimationer med henblik på at teste robustheden af hovedresultatet om, at der ikke er større spillover-effekter af energiforskning sammenholdt med anden forskning. Resultaterne af disse supplerende estimationer beskrives kort nedenfor. Estimationsresultaterne er ikke gengivet, men kan i de fleste tilfælde findes i Bjørner og Mackenhauer (2011).

Der er foretaget estimationer under antagelse om konstant skalaafkast for virksomhedens input K og L (dvs. givet restriktionen $\alpha + \beta = 1$). Baggrunden for denne formulering er, at videnskapitalen R kan anses for et ikke-rivaliserende gode. Ikke overraskende ændrer denne restriktion størrelsen af de estimerede produktionselasticiteter (α, β, γ og η), men parameteren til brøkleddet $\left(\frac{S^E + S}{S}\right)$ er fortsat negativ i alle modeller og signifikant negativ i fire af de seks estimerede modeller.

Tabel 2. Estimation af $ln(Y_{it})$ med separate effekter af energiforskning.

Nummer	1			2			3			4			5			6		
Type	OLS			OLS			OLS			FE			FE			FE		
Spillover	Reg			Forsk.profil			Forsk.profil&reg			Reg			Forsk.profil			Forsk.profil&reg		
	koef.		*t*	koef.		*T*	koef.		*t*	koef.		*t*	koef.		*t*	koef.		*t*
$ln\ (K_{t-1})$	0,13	**	16,4	0,13	**	16,1	0,13	**	16,3	0,10	**	8,7	0,10	**	8,6	0,10	**	8,6
$ln(L)$	0,76	**	63,0	0,76	**	63,0	0,76	**	63,3	0,74	**	36,4	0,74	**	36,2	0,74	**	36,5
$ln\ (R_{t-1})$	0,12	**	17,5	0,13	**	18,7	0,12	**	18,2	0,13	**	11,5	0,14	**	12,0	0,13	**	12,1
$ln\ ((RE_{t-1}+R_{t-1})/R_{t-1})$	-0,01		-0,1	-0,01		-0,1	0,05		0,7	-0,12		-0,8	-0,08		-0,5	-0,02		-0,2
$ln\ (S_{t-1})$	0,03	**	3,5	0,00		0,0	0,03	**	3,9	0,04	**	2,9	0,00		0,2	0,02	**	2,3
$ln\ ((SE_{t-1}+S_{t-1})/S_{t-1})$	-0,87	*	-2,4	-0,08		-0,3	-0,19		-1,2	-0,66		-1,4	-0,29		-0,8	-0,34	*	-2,0
year01	0,03		1,1	0,02		0,9	0,02		0,9	0,02		1,2	0,02		1,0	0,01		0,9
year02	0,05	*	2,3	0,02	*	2,1	0,05	*	2,2	0,04	*	2,2	0,04	*	2,0	0,04	*	2,1
year03	0,05	*	2,0	0,03		1,5	0,04		1,4	0,04	*	2,0	0,03		1,5	0,03		1,4
year04	0,05	*	2,3	0,02	*	2,3	0,04		1,9	0,03		1,6	0,03		1,8	0,03		1,5
year05	0,06	*	2,6	0,03	**	2,7	0,06	*	2,4	0,04		1,9	0,04	*	2,0	0,04		1,9
year06	0,06	*	2,3	0,03	*	2,5	0,06	*	2,3	0,05	*	2,0	0,06	*	2,3	0,05	*	2,2
year07	0,14	**	4,3	0,03	**	4,0	0,13	**	4,2	0,12	**	4,2	0,11	**	4,1	0,11	**	4,2
Konstant (basis)	4,32	**	29,6	4,70	**	18,1	4,35	**	39,2	4,35	**	18,7	4,89	**	16,0	4,63	**	27,3
Konstanter	19 brancher			19 brancher			19 brancher			FE						FE		
N observationer	4.238			4.238			4.236			4.238			4.238			4.236		
R^2 overall	0,9147			0,9140			0,9146			0,9098			0,9087			0,9092		
R^2 within										0,2442			0,2434			0,2452		
N virksomheder										1.029			1.029			1.028		
$p\ (year_i = 0)$	0,0024			0,0034			0,0035			0,0071			0,0105			0,0057		
sigma_*u*										0,374			0,376			0,376		
sigma_*e*										0,294			0,294			0,294		
Rho										0,618			0,621			0,621		

* Angiver at parameteren er signifikant på et 5-pct. niveau. ** Angiver at parameteren er signifikant på et 1-pct. niveau. *t*-værdier er beregnet ud fra robuste s.e.

Hovedparten af virksomheder med energiforskning udfører også miljøforskning (isoleret set er der dog flere virksomheder, som udfører miljøforskning, end virksomheder, som udfører energiforskning). Det er derfor undersøgt, om den negative parameter til andelen af energiforskning i virkeligheden skal tilskrives, at der er en lavere spillover-effekt af miljøforskningen. Denne model er estimeret ved at erstatte R^E og S^E med variablene R^{E+M} og S^{E+M}, som angiver egen forskning og spillover andel for summen af energiforskning og miljøforskning. Parametrene til $\left(\frac{S^{E+M}+S}{S}\right)$ er fortsat negative, men næsten altid numerisk mindre sammenholdt med de tilsvarende parametre i tabel 2. Dette tyder på, at det er energiforskningen snarere end miljøforskningen, som er drivende for den negative parameter. Dette bekræfter således, at der synes at være lavere spillover af energiforskning.

Der er også estimeret modeller svarende til ligning (4), hvor spillover-kapitalen er opdelt i energi- og øvrig spillover-kapital. I disse modeller fås generelt en signifikant positiv parameter til øvrig spillover kapital, mens der fås en negativ parameter til energi spillover-kapitalen, der også er signifikant i flere tilfælde. Den negative parameter til energi spillover-kapitalen indikerer, at der ikke blot kan være mindre, men ligefrem negativ spillover fra energiforskning.

Endelig er estimeret modeller med en alternativ specifikation af spillover-kapitalen, hvor vægtningsmatricen er baseret på en kombination af branche og geografi. Her fås insignifikante parametre til spillover-kapitalen, som i fixed effects modellen er negativ. Selv om der typisk vurderes at være positive spillover-effekter af forskning, kan det ikke udelukkes, at der også kan være negative. En virksomheds forskning kan lede til produktinnovationer, som kan udkonkurrere produkter fra andre virksomheder, der producerer lignende produkter, jf. Bloom mfl. (2007). Dette kan potentielt være årsagen til, at der ikke identificeres positive signifikante spillover-effekter for virksomheder inden for samme branche og region, da disse også typisk konkurrerer på samme varemarkeder. Under alle omstændigheder fås en negativ insignifikant parameter til brøkledet, som angiver, om der er en anden effekt på spillover af energiforskning.

Alt i alt understøtter de forskellige robusthedscheck konklusionen om, at der ikke er højere spillover-effekter af energiforskning, og at der tværtimod er tegn på lavere spillover-effekt af energiforskning

5. Sammenfatning

Der er estimeret produktionselasticiteter til arbejdskraft, almindelig kapital, forskningskapital og forskellige mål for spillover baseret på forskningen i andre virksomheder. Estimationen er baseret på data på virksomhedsniveau for perioden 1999 til 2007. Virksomhedernes forskningskapital og spillover-effekter er dog baseret på oplysninger om virksomhedens udgifter til forskning tilbage til 1995. I modsætning til tidligere danske undersøgelser tager analysen både højde for double counting og for uddannelsesrelaterede forskelle i medarbejdernes produktivitet. Endvidere undersøges om afkast og spillover er højere for energiforskning sammenholdt med anden forskning. I givet fald vil dette kunne motivere øremærkede subsidier til privat forskning, som sigter mod at reducere den energirelaterede udledning af CO_2.

Analysen bekræfter, at der er positiv spillover af forskning. Forsøg med forskellige afgrænsninger af spillover-effekterne peger i retning af, at disse spillover-effekter er geografisk afgrænset. Analysen tyder ikke på, at der er større spillover-effekter og dermed større samfundsøkonomisk afkast af energiforskning sammenlignet med anden forskning. Faktisk tyder flere af de afprøvede modeller på, at den positive spillover-effekt er signifikant mindre for energiforskning sammenlignet med anden forskning.

Mere generelt giver de estimerede modeller resultater, som nogenlunde harmonerer med resultater fra tidligere undersøgelser. Parameteren til forskningskapital svarer til et nettoafkast af investering i forskning på 21-24 pct. Set i forhold til resultater fra den udenlandske litteratur forekommer dette at være et plausibelt afkast. Generelt må estimerede afkast af forskning ud fra sådanne typer af undersøgelser forventes at være overkantsskøn, da virksomheder med negativ værditilvækst ikke indgår i estimationerne. Dermed er der formentlig nogle forskningsfiaskoer, som ikke medtages i estimationerne. Det eksterne afkast af forskning er på omkring 4 pct., hvormed det samlede samfundsøkonomiske afkast af forskning er på ca. 25 til 28 pct. Af dette udgør det eksterne afkast således omkring en sjettedel til en syvendedel.

Analysen tager som nævnt højde for, at arbejdskraft med forskelligt uddannelsesniveau har forskellig produktivitet. Når der ikke tages højde for dette forhold, fås højere produktionselasticiteter og nettoafkast af virksomhedernes egen forskning. Denne opad bias skyldes formentlig, at virksomheder med megen forskning også generelt har en større andel af højtuddannede i den del af deres arbejdsstyrke, som ikke beskæftiger sig med forskning.

Implikationen af analysen er, at det vil være hensigtsmæssigt at støtte virksomhedernes forskning, men støtten bør ikke øremærkes privat energiforskning. En sådan øremærkning risikerer at lede til lavere vækst.

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Bilag 1. Beskrivelse af endeligt datasæt

Udgangspunktet for analysen af forskningsafkast er data fra Erhvervslivets forskningsstatistik for årene 1995, 1997, 1998, 1999, 2001, 2003, 2005 og 2007, hvor der foreligger oplysninger om fordelingen af egen forskning på forskningsområder. Disse oplysninger er suppleret med oplysninger om forskningsudgifter for årene 2002, 2004 og 2006, hvor der dog ikke foreligger oplysninger om fordeling af forskningen på forskningsområder. For at kunne opgøre virksomhedens FoU-kapital er foretaget lineær interpolation af udgifterne til egen forskning for virksomheder, der optræder flere gange i datasættene. For årene 2002, 2004 og 2006 er beregnet fordeling af forskningen på forskningsområder ud fra lineær interpolation, hvor dette har været muligt, med henblik på at kunne beregne investeringer i energiforskning i disse år.

For at en virksomhed kan indgå i analysen i et givet år skal der findes oplysninger om antallet af forskningsmedarbejdere i det betragtede år (til korrektion for double counting) og forskningsudgifter året inden (til beregning af virksomhedens forskningskapital ultimo perioden inden). Der skal således være oplysninger om virksomheden (enten faktiske eller interpolerede) i to på hinanden følgende år, for at FoU-data kan benyttes. I en række tilfælde findes ikke data i to sammenhængende år, og det er ligeledes nødvendigt at udelade en række observationer, fordi de ikke indeholder brugbare oplysninger om beskæftigelse, værditilvækst eller kapitalapparat (lagget) fra den generelle firmastatistik. Af disse grunde er der en reduktion i antallet af observationer på godt 40 pct. Derudover er der en reduktion i antallet af observationer, som skyldes at værditilvækst eller kapitalværdi er nul eller negativ (af hensyn til *ln*-transformationen). Brancher med meget få observationer er fjernet, og for at fjerne potentielt fejlbehæftede observationer er endvidere udeladt observationer, hvor forskningsudgiften pr. forskerårsværk er mindre end 100.000 kr. eller over 6 mio. kr. og oplysninger, hvor værditilvækst pr. årsværk er lavere end 25.000 kr. eller højere end 5 mio. kr. Dette giver et mindre frafald på 58 observationer. I estimationsperioden er der 4.238 brugbare observationer, hvoraf udgiften til forskning er ikke-interpoleret i 2.286 tilfælde. Dette antal svarer til 49 pct. af de oprindelige primære forskningsdata i estimationsperioden. Frafaldet er dog størst for mindre virksomheder med lidt forskning, hvorfor det endelige datasæt indeholder oplysninger om ca. 70 pct. af udgifterne til egen forskning i de fleste år.[20]

Tabel B1 indeholder en oversigt over variable benyttet i analysen samt beskrivende statistik for hver af disse. Den beskrivende statistik er opdelt i det samlede sample af observationer, samt observationer kun for virksomheder, som har energiforskning. Det

20. I årene 2002, 2004 og 2006, hvor fordelingen på forskningsområder skulle interpoleres, er frafaldet større. I disse år indeholder datasættet oplysninger svarende til henholdsvis 51 pct., 56 pct. og 61 pct. af udgifterne til egen forskning i de primære data.

fremgår, at virksomheder der har udført energiforskning er lidt større (flere medarbejdere og værditilvækst), men i forhold til værditilvækst pr. medarbejder og værditilvækst pr. enhed FoU-kapital er der ikke stor forskel.

Omkring 75 pct. af arbejdskraften i datasættet er beskæftiget i industribrancher, hvilket svarer til, at data indeholder omkring 140.000 årsværk årligt, der arbejder inden for industrien. Til sammenligning har den samlede beskæftigelse inden for industrien i Danmark i gennemsnit ligget på omkring 360.000 i perioden 2000-2007, jf. Danmarks Statistik. Det endelige datasæt indeholder altså forskningsoplysninger fra virksomheder, der repræsenterer knap 40 pct. af den danske industribeskæftigelse.

Tabel B1. Beskrivende statistik.

Variable	Antal obs.	Gennemsnit	Median	10 procent	90 procent
Alle virksomheder					
Værditilvækst[1], Y_t	4.238	181.598	57.565	7.504	350.610
Fysisk kapital[1], K_{t-1}	4.238	155.006	24.453	1.364	279.421
FoU-kapital[1], R_{t-1}	4.238	120.222	17.735	2.817	186.916
Bidrag til FoU-kapital, $(RE_{t-1}+R_{t-1})/R_{t-1}$	4.238	1,035	1,000	1,000	1,094
Arbejdskraft[2], L_t	4.238	368	149	17	770
Værditilvækst pr. medarbejder[1], Y_t-$/L_t$	4.238	497	391	254	794
Værditilvækst pr. FoU-kapital, Y_t-$/R_{t-1}$	4.238	8,5	2,9	0,4	17,8
Spillover (region)[1], S_{t-1}	4.238	25.761.738	10.424.181	3.750.240	63.176.244
Spillover (teknologi)[1], S_{t-1}	4.238	17.949.661	18.299.675	6.718.390	27.643.712
Spillover (teknologi og region)[1], S_{t-1}	4.238	5.532.691	3.994.844	676.575	12.716.634
Spillover fra energi (region), $(SE_{t-1}+S_{t-1})/S_{t-1}$	4.238	1,043	1,041	1,022	1,076
Spillover fra energi (teknologi), $(SE_{t-1}+S_{t-1})/S_{t-1}$	4.238	1,044	1,036	1,010	1,094
Spillover fra energi (teknologi og region), $(SE_{t-1}+S_{t-1})/S_{t-1}$	4.236	1,047	1,037	1,005	1,097
Virksomheder med energiforskning					
Værditilvækst[1], Y_t	888	220.944	88.823	14.344	567.860
Fysisk kapital[1], K_{t-1}	888	155.817	41.015	2.702	395.867
FoU-kapital[1], R_{t-1}	888	158.184	25.539	4.234	323.625
Bidrag til FoU-kapital, $(RE_{t-1}+R_{t-1})/R_{t-1}$	888	1,165	1,090	1,011	1,463
Arbejdskraft[2], L_t	888	527	252	37	1.255
Værditilvækst pr. medarbejder1, $Y_{t\text{-}}/L_t$	888	446	376	266	658
Værditilvækst pr. FoU-kapital, $Y_{t\text{-}}/R_{t-1}$	888	7,4	3,0	0,6	14,6
Spillover (region)[1], S_{t-1}	888	23.772.998	9.656.378	3.434.068	63.148.744
Spillover (teknologi)[1], S_{t-1}	888	17.642.026	18.300.358	6.669.617	27.771.598
Spillover (teknologi og region)[1], S_{t-1}	888	4.650.588	3.663.372	601.567	10.838.371
Spillover fra energi (region), $(SE_{t-1}+S_{t-1})/ S_{t-1}$	888	1,045	1,046	1,021	1,075
Spillover fra energi (teknologi), $(SE_{t-1}$+St-1)$/S_{t-1}$	888	1,069	1,053	1,028	1,135
Spillover fra energi (teknologi og region), $(SE_{t-1}+S_{t-1})/S_{t-1}$	888	1,077	1,059	1,016	1,151

Noter: (1) 1.000 kr., deflateret. (2) Antal kvalitetskorrigerede årsværk, yderligere korrigeret for double counting.

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Testing the Effect of a Short Cheap Talk Script in Choice Experiments

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SUMMARY: *The application of stated preference methods rests on the assumption that respondents act rationally and that their demand for the non-market good on the hypothetical market is equal to what their real demand would be. Previous studies have shown that this is not the case and this gap is known as hypothetical bias. The present paper attempts to frame the description of the hypothetical market so as to induce more "true market behaviour" in the respondents by including a short Cheap Talk script. The script informs respondents that in similar studies using stated preference methods, people have a tendency to overestimate how much they are willing to pay compared to their actual (true) willingness to pay. Applying a two-split sample approach to a Choice Experiment study focusing on preferences for reducing visual disamenities from offshore wind farms, the Cheap Talk script is found to reduce the demand for visual impact mitigation, but does not affect preferences significantly. Significant effects are found when relating the effect of the Cheap Talk script to the cost levels of the alternatives, in that female respondents are found to choose higher cost alternatives less frequently when presented with the Cheap Talk script.*

1. Introduction

Economic analysis of policies or specific projects often runs into the problem that policy/project related impacts have an influence on the supply of non-market goods. If the latent demand for the non-market goods is not complimentary to the demand for one or several market goods, an economic assessment of the impact (i.e. change in the supply) can only be elicited by directly asking the relevant population about their preferences for the change in the supply by carrying out a survey using Stated Preference Methods (SPM).

The application of SPM rests on the assumption that the respondents' hypothetical demand is equal to their real demand. However, tests of SPM suggest that hypothetical demand exceeds real demand, which is also known as hypothetical bias. List and Gallet (2001); Little and Berrens (2004); Murphy et al. (2005a). In order to reduce hypothetical bias, Cummings and Taylor (1999) proposed and found a reminder known as "Cheap Talk" (CT) to be effective. However, in subsequent studies the effectiveness of CT has proven to be ambiguous, Aadland and Caplan (2006); List (2001); Lusk (2003); Barrage and Lee (2010); Brown et al. (2003); List et al. (2006).

Focusing on two specific obstacles so far only found in the Contingent Valuation Method (CVM) CT literature of gender differences, Mahieu (2010); Barrage and Lee (2010) and bid range sensitivity, Brown et al. (2003); Murphy et al. (2005b), we test the effect of a short CT script using the SPM Choice Experiments (CE). Applying a two split sample approach, we find no significant effects of the CT on the Willingness to Pay (WTP) for moving offshore wind farms to larger distances from the coast. However, we are the first to find that in CE female respondents appear to be influenced by the CT, whilst male respondents are not. More specifically, we find that female respondents are only affected when asked to choose between alternative locations of offshore wind farms with high levels of associated costs. Additionally, the significant gender specific effect supports a growing literature with a specific focus on gender differences in information processing in SPM surveys, Ladenburg and Olsen (2010a).

The paper is structured as follows: First we give a short introduction to economic valuation using SPM, including a short review of the hypothetical bias mitigation literature and the hypotheses of the paper. Next follow the study design, econometric setup, results, discussion and a conclusion.

2. Economic Valuation Using Stated Preference Surveys

Economic valuation of non-market goods such as the environment and public services was introduced in the 1940's by Ciriacy-Wantrup (1947) and Hotelling, Mitchell and Carson (1989). Broadly speaking, valuation methods can be divided into two groups – Stated Preference Methods (SPM) and Revealed Preference Methods (RPM).[1] The distinction between RPM and SPM is made on account of the origin of the data. RPM are based on data derived from observed (i.e. actual) behaviour, and SPM are based on data derived from stated (i.e. hypothetical) behaviour, Freeman (1993); Mitchell and Carson (1989). Within the class of SPM, the Contingent Valua-

1. For examples of RPM and SPM studies in the Danish Journal of Economics (Nationaløkonomisk Tidsskrift), see Hasler et al. (2002), Bjørner and Lundhede (2003), Bech et al. (2004), and Nielsen (2010).

tion Method (CVM) is the most widely used, Batemann and Willis (1999). Choice Experiments (CE) however, have become increasingly popular during recent years, Bennett and Blamey (2001).

In CVM the aggregate value of a change in the supply or quality of a non-market good is estimated holistically, by presenting the individual with a precise scenario description of the hypothetical good and the relevant change in the supply. Based on information regarding the rules of provision, present and future access to the good and method of payment, the individual is asked to state their Willingness To Pay (WTP) for the good, Mitchell and Carson (1989).

CE builds on the theory proposed by Lancaster (1966), where it is not goods per se, but rather the bundle of attributes that they consist of, that give utility to the consumer. Consequently, demand for goods is derived from the demand for the attributes that the good consists of, Lancaster (1966); Rosen (1974). Accordingly, CE focuses on the utility that individuals derive from the different attributes which compose the good or service in question, Bennett and Adamowicz (2001). This is accomplished by presenting respondents with a set of alternatives. The alternatives define the good or service in terms of their key attributes, and different alternatives are described by varying levels of the attributes. By examining the trade-offs between attributes and attribute levels that are implicit in the choices made by respondents, it is possible to derive an estimate of the utility associated with the different attributes. If one of the attributes is measured in monetary units (i.e. costs), it is possible to derive estimates of respondents' WTP for the other attributes from the marginal rate of substitution between the monetary attribute and the other attributes, Louviere et al. (2000).

2.1 Hypothetical Bias

The application of Stated Preference Methods (SPM) rests on the assumption that the respondents act rationally and that their demand for the non-market good on the hypothetical market is equal to their real demand. However, tests of SPM suggest that hypothetical demand is not identical to real demand. This discrepancy between stated and real preferences is also known as hypothetical bias. On an average, level values estimated from hypothetical preferences in terms of WTP are found to be 2.6 to 3 times larger than the corresponding values based on real preferences, List and Gallet (2001); Murphy et al. (2005a); Little and Berrens (2004).

The above mentioned studies primarily include CVM-like experiments. However, in CE, hypothetical bias also seems to be present, Lusk and Schroeder (2004); List et al. (2006); Taylor et al. (2007); Johansson-Stenmann and Svedsätter (2008); Broadbent et al. (2008); Ready et al. (2010).[2]

2. For a broader review and a more theoretical discussion of the origin of hypothetical bias in CE, see Ladenburg and Olsen (2010b).

2.2 Mitigation of Hypothetical Bias

In an attempt to find a better framing of the description of the hypothetical market that would induce more "true market behaviour" in the stated preferences, compared to previous attempts such as budget and substitution reminders, Loomis et al. (1994), Neill (1995),[3] Cummings and Taylor (1999) were the first to propose a new type of reminder known as "Cheap Talk" (CT). The CT was tested in a CVM-like setup including four different types of public goods. Cummings and Taylor's (1999) CT script worked by informing the respondent that people in these kinds of surveys have a tendency to overestimate how much they are willing to pay compared to their actual (true) WTP, and why the researcher thinks this might occur. The potential hypothetical bias is thus explicitly described to respondents prior to stating their preferences in terms of WTP. Using a three split sample (real payments, hypothetical payments and hypothetical payments with CT) hypothetical bias was established for three of the four goods. In these cases CT was tested in an independent and hypothetical treatment and found to remove the hypothetical bias.

The effect of CT has been tested extensively in subsequent CVM studies with less success. Aadland and Caplan (2006), List (2001) and Lusk (2003) find that CT only influences the preferences of specific sub-groups such as inexperienced respondents. Samnaliev et al. (2003), Nayga et al. (2006) and Blumenschein et al. (2008) find that CT does not effectively reduce WTP. Aadland and Caplan (2006) and Carlsson and Martinsson (2006) find that the CT actually increases WTP. In addition Morrison and Brown (2009) even find that CT has too strong an influence on the stated preferences, in that hypothetical WTP is significantly over-calibrated.

Furthermore, the effectiveness of CT has been found to be sensitive to the bid range applied and the gender of the respondents. Brown et al. (2003) and Murphy et al. (2005b) find that CT only has an effect on the respondents who are presented with bid levels in the higher end of the bid range in dichotomous choice and referendum CVM surveys. However, both of these studies find that hypothetical bias is present across the entire bid range applied and not just the higher end. This implies that CT fails to eliminate hypothetical bias at the lower end of the bid range. Regarding the gender sensitivity, Barrage and Lee (2010) and Mahieu (2010) find that only female respondents are influenced by the CT.

There are relatively few studies testing CT in Choice Experiments (CE) where the effectiveness of the CT seems to be is mixed. More specifically, Carlsson et al. (2005) and List et al. (2006) both use relatively short CT scripts in CE surveys and find evidence that CT reduces hypothetical bias to some extent. However, in List et al.

3. Despite of the apparent lack of effect, several researchers still recommend including these reminders in stated preference surveys, Bateman et al. (2002). A recent study finds that a substitute and income reminder jointly with a short Cheap Talk script reduce hypothetical demand, Whitehead and Cherry (2007).

(2006) CT seems to decrease the internal consistency of respondents' preferences. In Carlsson et al. (2005) 7 out of 10 attributes were valued significantly lesser by respondents provided with a CT script than those not provided with one. Somewhat in contrast, Kjær et al. (2005) find that CT only reduces demand for one of five health attributes. In a more recent study, Carlsson et al. (2008) find CT to be ineffective in a CE survey.[4] Finally, Ladenburg and Olsen (2010b) find an indication that the effect of the CT in a CE has diminishing effects (over the six choice sets each respondent evaluates) on the total economic value associated with re-establishing a stream in urban Copenhagen.

2.3 Hypotheses

Despite CT having previously been analysed in CE, the issues of how the CT works and who is affected by it are still relatively unexplored in the literature. We therefore shed light on two reported hypothetical bias mitigation problems of CT found in the CVM literature; gender specific effects and bid range sensitivity. These issues have not been addressed in the CE literature. We do this through the following hypotheses.

The CT is applied to reduce the hypothetical demand for reduction in the visual disamenities from offshore wind farms. Accordingly, the following main hypothesis is set up.

$H1_0$: Preferences are independent of the treatment.

Following the results in Barrage and Lee (2010) and Mahieu (2010) and the paper by Ladenburg and Olsen (2010b) we test if rejection/acceptance of H1 is conditional on the gender of the respondent.

$H2_0$: Preference independence is not conditional on gender.

Similarly, rejection and acceptance might also be conditional on the costs (price vector) in the choice sets, Brown et al. (2003); Murphy et al. (2005b).

$H3_0$: Preference independence is not conditional on the bid range.

3. Study Design

The analysis of the effect of a short CT is based on a survey using a nationwide internet panel consisting of approximately 17,000 people. The CT experiment was completed using a valuation survey concerning the preferences for reducing the visual impacts from offshore wind farms, which was carried out in July 2006.[5] The

4. See Ladenburg and Olsen (2010a) for a more detailed discussion of CT and its potential limitations in CE.
5. Though the topic is the same as in Ladenburg and Dubgaard (2007; 2009), the studies are quite different in the valuation setup. See Ladenburg (2009) for a comparison.

experiment was conducted using a two split sample design, in which one half of the respondents were presented with a scenario description not including a CT script (NON-CT sample) and the other half with a scenario description including a CT script (CT sample). The respondents in the two samples were drawn randomly (and independently of each other) from the internet panel[6] and were not given any information regarding the participation in the NON-CT and CT experiment. The criteria for the two samples were that respondents had to be older than 15 years.

With exception of the inclusion of the CT, all other aspects of the questionnaire were kept identical for the two samples. The CT script is presented below.

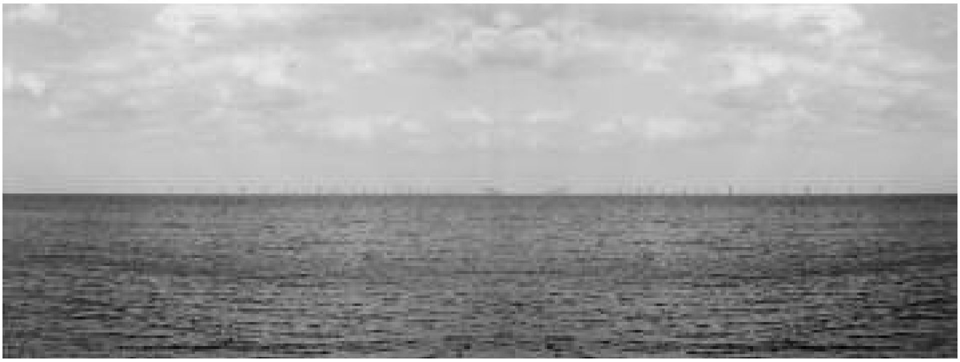
"Please pay attention to that the annual cost is the amount your household will have to pay if the chosen alternative was to be implemented. Previous willingness to pay studies have demonstrated that people seem to overrate how much they are willing to pay. Therefore, consider thoroughly how the annual extra costs will affect your budget, so that you are completely certain that you actually are willing to pay the annual costs associated with the alternative that you choose".

Initially, the desired sample size was set to 350 respondents in each sample. To obtain these sample sizes, 623 and 619 respondents in the NON-CT and CT samples respectively were emailed a questionnaire. Of these, 386 and 355 completed the questionnaire. Removing protest answers (see the end of this section for a description of the definition of protest answers), the effective sample sizes were 367 and 338 respondents which gave an effective response rate of 58.9 percent and 54.6 percent for the NON-CT and CT samples, respectively.

In the survey, each respondent was given six choice sets, which were represented by a status quo alternative (offshore wind farms located at 8 km with no extra costs to the household) and two hypothetical wind farm locations. In the hypothetical alternatives, the offshore wind farms could be located at 12, 18 and 50 km, representing reduction in the visual impacts compared to 8 km, where a wind farm located at 50 km would not be visible from the coast. As a payment vehicle, an annual fixed increase in the household electricity bill was used. The payment vehicle was chosen over a marginal increase in the electricity price in order to minimise biases in WTP associated with respon-

6. Unfortunately, the characteristics of all the people on the internet panel were not available at the time of the survey. It is therefore not possible to assess the potential level of selection effects in the survey. However, as put forward in Table 1, we cannot reject that the respondents in the two samples are identical with regard to a large number of socio demographic characteristics. The selection problem in relation to testing the effect of the CT between the two samples thus appears to be of a lesser concern. However, Table 1 also suggests that our samples are overrepresented with regard to people from high income households and higher levels of education when compared to the Danish population.

Alternative 1 *Distance to the Coast 8 km* *Increase in costs 0 DKK.*



Alternative 2 *Distance to the Coast 12 km* *Increase in costs 400 DKK.*

Alternative 3 *Distance to the Coast 50 km* *Increase in costs 1400 DKK.*

I prefer Alternative 1 ( ) Alternative 2 ( ) Alternative 3 ( )

Figure 1. Choice Set Example.

dents' uncertainty regarding their annual electricity consumption. This uncertainty was stressed by participants of a focus group interview. The annual increase could take the values 100, 400, 700 and 1400 Danish Kroner (DKK) per household per year. With three hypothetical distances and four prices, a total of 12 (3×4) alternatives were constructed (full factorial design). Following Kuhfeld (2005), the alternatives were arranged into choice sets so that there would be a minimum overlap and minimum correlation in attributes within each choice set. Given the full factorial design, level balance in which each attribute level is represented an equal number of times, Huber and Zwerina (1996) was also obtained. As the example choice set presented in Figure 1 illustrates, each location of the wind farms were visualised for each alternative.[7]

Besides the visualisations in the choice sets, the respondents were also provided with a map, showing the location of existing offshore wind farms and the expected location of the future offshore wind farms, which in total would have a capacity of 3600 MW.

All respondents who chose the status quo in all of the choice sets, were given a follow-up question in order to get a deeper understanding of the preferences governing the serial choice of the status quo alternative (i.e. no preferences for reducing the visual disamenities). Respondents answering that their primary reason was that they prefer the wind turbines to be located at a larger distance but did not want to pay a higher electricity bill were classified as protest zero bidders, as were those respondents stating that they could not relate to paying a higher electricity bill. These respondents were classified as protesters because their primary reason for choosing the status quo alternative was due to the setup of the survey and not their preferences as such. To reduce protest bias in the stated preferences, the 17 and 19 protest respondents found in the NON-CT and CT samples respectively were excluded from the analysis. Based on a χ^2-test, the propensity to be a protester was found not to depend on whether the respondents were presented with a CT or not. The exclusion of the protest respondents accordingly only shifts the demand curves slightly outwards (an increase in WTP) in both samples and does not influence the conclusion of the paper. For a more detailed presentation of protest zero bidding see Meyerhoff and Liebe (2008) or Bonnichsen and Ladenburg (2009).

4. Choice and Econometric Framework

4.1 Random Utility Model

Assuming utility-maximising behaviour of the individual, the choices made are analysed using the Random Utility Model (RUM), McFadden (1974). The RUM states

7. In the original survey the visualizations were larger to give the respondents a better feeling of the visual impacts. Each choice set thus covered an area on the computer screen equivalent to an entire A4 page.

that the true but ultimately unobservable utility U for individual n conditional on choice i can be broken down into two components, an observable systematic component V and the unobservable random component, the error term ε:

$$U_{ni} = V_{ni}(x_{ni}, S_n, \beta) + \varepsilon_{ni},$$

where the observable component V_{ni} is a function of the attributes of the alternatives x_{ni}, characteristics of the individuals S_n and a set of unknown preference parameters β. The observable component V_{ni} is assumed to be a linear function:

$$V_{ni} = \alpha ASC_{ni} + \beta x_{ni},$$

where α and β denote vectors of preference parameters associated with the specific alternatives ASC_{ni}, and the attributes of the alternatives x_{ni} respectively. The characteristics of the individuals are left out for simplicity. In the present application the alternative specific constant (ASC) is labelled ASC23. The variable thus represents the joint utility of moving offshore to larger distances than 8 km, all else being equal (i.e. the joint utility of alternative 2 and 3). Assuming a specific parametric distribution of the error term allows a probabilistic analysis of individual choice behaviour:

$$P_{ni} = Prob(V_{ni} + \varepsilon_{ni} \geq V_{nj} + \varepsilon_{nj}) \; \forall i, j \in C, j \neq i,$$

where P_{ni} is the probability that individual n's utility is maximised by choosing alternative i from choice set C. The researcher chooses the distribution of the error term and different distributions result in models with different properties, Ben-Akiva and Lerman (1985).

4.2 Econometric Specifications

The parametric analysis applies Conditional Logit (CL) and Random Parameter Error Component Logit (RPECL) models. The models rely on McFadden's RUM, McFadden (1974) described earlier.

Conditional Logit

If the error terms are assumed to be independently and identically Gumbel distributed, then this results in a Conditional Logit (CL) specification for the probability of individual n choosing alternative i:

$$P_{ni} = \frac{e^{V_{ni}}}{\sum_{j \in C} e^{V_{ni}}},$$

where the scale parameter is normalised to 1, and omitted. The CL model imposes several restrictive assumptions in that it does not allow for random taste variation, for unrestricted substitution patterns and for correlation in unobserved factors over time, Train (2003). The model also suffers from having to adhere to the restrictive independence of irrelevant alternatives (IIA) property.

Error Component Logit

In the Error Component Logit (ECL) model, an additional error component is incorporated in the CL model to capture any remaining alternative specific effects in the stochastic part of utility, Scarpa et al. (2005). The additional error component has zero-mean and is a normally distributed random parameter assigned only to alternatives two and three. Following Meyerhoff and Liebe (2009), the utility function of the ECL specification can be written as:

$$U_{ni} = V_{ni} + E_{ni} + \varepsilon_{ni},$$

where V_{ni} is the systematic component of utility, E_{ni} are the error components and ε_{ni} is the same Gumbel distributed error term from the CL. When the error components are associated with alternative two and three, the utility functions can be written as:

$$U_{SQ} = \beta_{SQ} + \varepsilon_{SQ},$$
$$U_2 = \alpha ASC_{23} + \beta x_2 + E_{23} + \varepsilon_2,$$
$$U_3 = \alpha ASC_{23} + \beta x_3 + E_{23} + \varepsilon_3,$$

where subscripts 2 and 3 indicate alternatives two and three and the subscript *SQ* indicates the status quo. By including the additional error components E_{23}, the IIA restriction is eliminated and any remaining systematic effect of choosing a non status quo alternative relative to the status quo is captured by the ASC23, Scarpa et al. (2005).

Random Parameter Error Component Logit

To further extend the ECL model, the RPECL specification is applied. The RPECL specification allows for taste heterogeneity in preferences by specifying some or all attribute coefficients as random reflecting the heterogeneity of individuals' preferences. The model also does not exhibit the restrictive IIA property and it allows for correlation in unobserved utility over alternatives and time, Train (2003); Hensher and Greene (2003). The specification can be generalised to allow for the panel structure (repeated choices by the same respondent) of Choice Experiment (CE) data. In other words, the RPECL model allows for the utility coefficients to vary over respondents, but remain constant over choice occasions for each respondent, Train (2003). Here individual *n*'s true utility for the *i*th alternative in choice situation *t* can be written as:

$$U_{ni} = V_{ni}\,(ASC23_{ni},\ \alpha,\ x_{ni},\ \beta,\ \beta_n) + E_{ni} + \varepsilon_{ni},$$

where β_n denotes individual specific random parameters while α and β denote the fixed parameters of the *ASC*23 and the attributes of the alternative. Again, the characteristics of the individuals are left out for simplicity. The model is specified with the *ASC*23 and the price coefficient being fixed and all other coefficients being normally distribute.[8] Assuming that the error term is still Gumbel distributed, the probability of individual *n* choosing alternative *i* can be written:

$$P_{ni} = \int \left(\frac{e^{V_{ni} + E_{ni}}}{\sum_{j \in C} e^{V'_{nj} + E_{nj}}} \right) \phi(\beta | b,\ W)\, d\beta\,,$$

where $\phi(\beta|b, W)$ is the normal density with mean β and covariance W. This probability can be described as an integral of the standard CL function evaluated at different values of β with the density function as a mixing distribution, Train (2003).

With the assumption that the unobserved heterogeneity in preferences follows a normal distribution, several models have been tested with regard to identifying the potential level of correlation in the unobserved heterogeneity in the preference for reducing the visual impacts from offshore wind farms. A model allowing for full correlation was initially estimated, but the estimated mean parameters were insignificant and had reversed the sign. As a consequence, only the variables controlling for wind farms located 18 and 50 km from the coast (Distance 18 km and Distance 50 km) were allowed to correlate, see Section 5.2 for a more detailed description. Additionally, several definitions of the error component have also been tested, but all models indicated that only correlation patterns in the variance between the two non status

8. Other distributions, such as a uniform, triangular and lognormal distribution have also been tested, but the choice of distribution does not improve the model or change the conclusions of the paper.

Table 1. Comparison of Respondent Characteristics between Samples.

	Sample				Sample		
	NON -CT	CT	χ^2-test$^{(a,b)}$		NON -CT	CT	χ^2-test
Gender				*Visible windmills on land from residence or summer residence*			
Male	187	168	0.74				
Female	180	170					
Age				Yes	88	76	0.64
16-24	55	49		No	279	262	
25-34	57	53		*Visible windmills on sea from residence or summer residence*			
35-44	64	64	0.95				
45-54	82	72					
55-64	72	60		Yes	19	16	0.79
≥65	37	40		No	348	322	
Household gross income/year (DKK)				*Frequency of visits to the beach in the summer*			
< 200.000	64	45		Weekly or more often	136	101	
200.000-399.999	97	87		1-3 times a month	140	134	
400.000-599.999	92	80	0.39	Every second month	43	52	0.28
≥ 600.000	85	95		Every six months	24	28	
Not available	29	31		Almost never	21	22	
Education				Do not know	3	1	
Primary/high school	41	49		*Frequency of visits to the beach in the winter*			
Vocational	18	22					
Upper vocational	62	54		Weekly or more often	38	32	
Short academic (<3 years)	49	45	0.62	1-3 times a month	108	79	
Middle academic (3-4 years)	98	89		Every second month	85	85	0.38
Long academic (>4 years	68	60		Every six months	49	56	
Other	31	19		Almost never	84	85	
				Do not know	3	1	
N	367	338			367	338	

Notes: (^{a}) The χ^2-test is carried out by testing if the distribution (defined by the grouping of each variable) of the respondents in the NON-CT and CT samples come from the same distribution, can be rejected. (^{b}) A comparison with Statistics Denmark shows that the two samples are representative with regard to gender and age, but that high income households and highly educated persons are overrepresented compared to the Danish population.

quo alternatives were significant. Meyerhoff and Liebe (2009); Boxall et al. (2009); Bonnichsen and Ladenburg (2010).

4.3 Deriving Estimates of Willingness to Pay

The focus of attention, when testing the CT, is the potential difference in preferences/WTP for reducing the visual disamenities from offshore wind farms. When a respondent chooses an alternative they are making a trade-off between the distance to the coast of the offshore wind farms and an annual fixed increase in the household electricity bill and thus the respondent's preferences are implicitly revealed. By including a monetary attribute it is possible to estimate WTP for the non-monetary attributes, i.e. the distance of the offshore wind farm to the coast. This is done by scaling the coefficient of interest with the coefficient representing the marginal utility of price and multiplying with –1, Louviere et al. (2000):

$$WTP_x = -\frac{\beta_x}{\beta_{price}},$$

where β_x is the coefficient of the attribute of interest and β_{price} price is the price coefficient.

5. Results

5.1 Comparison of Sample Characteristics

When conducting experiments and comparing samples to test for effects such as in the present study, it should be determined whether or not the respondents in the two experimental samples are significantly different. In Table 1, the characteristics of the respondents in the NON-CT and CT samples are compared.

Testing the differences in the characteristics of the respondents in the samples, suggests that it cannot be rejected that the respondents on average are similar. Accordingly, a difference in preferences between the two samples can with a higher level of certainty be ascribed to the effect of the CT. However, when comparing the sample characteristics with the statistics from Statistics Denmark, the samples are not entirely representative with regards to the level of education and income. People with higher levels of education and income are thus overrepresented in the two samples when compared to the Danish population.

5.2 Parametric Analysis of the Effect of the Cheap Talk

The effect of the CT is tested by applying both a Conditional Logit (CL) and a Random Parameter Error Component Logit (RPECL) model. In the models, we include two dummy variables controlling for locating offshore wind farms at 18 km (DISTANCE 18 km) and 50 km (DISTANCE 50 km) from the coast. In addition an alternative specific constant controlling for alternative 2 and 3 (*ASC*23) is also included. Accordingly, *ASC*23 is a dummy variable controlling for the preferences for moving offshore wind farms beyond 8 km from the coast, i.e. at 12, 18 or 50 km from the coast. Consequently, the parameters, $\beta_{DISTANCE\ 50\ km}$ and $\beta_{DISTANCE\ 50\ km}$ are estimated relative to the *ASC*23 parameter and not to a location at 8 km. By including the two DISTANCE 18 km and DISTANCE 50 km dummy variables, this means that $\beta_{DISTANCE\ 18\ km}$ and

Table 2. Conditional Logit and Random Parameter Error Component Logit Models.

	NON-CT sample		CT sample	
	CL Coefficient [Stand Error]	RPECL Coefficient [Stand Error]	CL Coefficient [Stand Error]	RPECL Coefficient [Stand Error]
Parameters				
Distance 18 km				
All	0.35701*** [0.08712]	0.46014** [0.17540]	0.14689^{NS}[0.09238]	0.19134^{NS} [0.17512]
Male	0.41134** [0.12048]	0.59464* [0.27939]	0.01824^{NS} [0.12727]	0.08780^{NS} [0.27167]
Female	0.29716* [0.12625]	0.34990^{NS} [0.24214]	0.10555^{NS} [0.13481]	0.25912^{NS} [0.25356]
Distance 50 km				
All	0.53061*** [0.08357]	0.77858***[0.15089]	0.44604***[0.08703]	0.70507***[0.13635]
Male	0.58756*** [0.11599]	0.89055***[0.23601]	0.48431***[0.12083]	0.74773***[0.17922]
Female	0.46894*** [0.12065]	0.67761***[0.19724]	0.40825** [0.12594]	0.63194* [0.24568]
ASC23				
All	-0.01235^{NS}[0.07886]	0.47424^{NS} [0.35315]	0.11528^{NS} [0.08224]	0.46316^{NS} [0.35307]
Male	-0.04615^{NS}[0.10999]	0.63227^{NS} [0.55071]	0.00111^{NS} [0.11475]	0.48992^{NS} [0.49435]
Female	0.03031^{NS}[0.11331]	0.35338^{NS} [0.46158]	0.25978^{NS} [0.11873]	0.54010^{NS} [0.51987]
COST (DKK/year)				
All	-0.00170***[0.00009]	-0.00284***[0.00017]	-0.00190***[0.00010]	-0.00303***[0.00015]
Male	-0.00158***[0.00013]	-0.00278***[0.00022]	-0.00155***[0.00015]	-0.00249***[0.00016]
Female	-0.00185***[0.00014]	-0.00292***[0.00026]	-0.00235***[0.00017]	-0.00399***[0.00037]
Standard deviation				
Distance 18 km				
All	–	1.96123***[0.22446]	–	1.75308***[0.19268]
Male	–	2.04680***[0.32990]	–	2.23964***[0.28945]
Female	–	1.89001***[0.33571]	–	1.14985***[0.34384]
Distance 50 km				
All	–	1.07586***[0.17288]	–	0.70093* [0.30445]
Male	–	1.28395***[0.33987]	–	0.59581^{NS} [0.46219]
Female	–	0.83343* [0.36981]	–	1.17521* [0.56998]

Continues...

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	NON-CT sample		CT sample	
	CL Coefficient [Stand Error]	RPECL Coefficient [Stand Error]	CL Coefficient [Stand Error]	RPECL Coefficient [Stand Error]
Parameters				
Off-diagonal element in the Choleski matrix				
Distance 18 km: 50km				
All		0.57508** [0.17956]		0.26624^{NS} [0.18735]
Male		0.53221^{NS} [0.30609]		0.55897* [0.23176]
Female		0.63005***[0.23226]		0.31382^{NS} [0.44695]
Error component parameters				
σ_{23}				
All		5.29269***[0.48176]		5.29949***[0.48694]
Male		5.88219***[0.79667]		5.20266***[0.68143]
Female		4.78623***[0.59426]		5.52913***[0.71252]
$N_{\text{respondents}}$	367; 187; 180	367; 187; 180	338; 168; 170	338; 168; 170
$LL(0)a$	-2419; -1233; -1187	-2419; -1233; -1187	-2228; -1107; -1121	-2228; -1107; -1121
$LL(\beta)b$	-1438; -730; -705	-1391; -704; -687	-1275; -678; -581	-1251; -656; -575
Pseudo-R^2	0.405; 0.407; 0.406	0.425; 0.429; 0.421	0.428; 0.388; 0.482	0.439; 0.407; 0.487

Notes: ^{NS} indicates no significance, * significance at 95% level, ** at 99% level and *** at 99.9% level. *a* $LL(0)$ is the initial log likelihood for a model where all parameters are restricted to zero. *b* $LL(\beta)$ is the final log likelihood for a model including all of the parameters of interest.

$\beta_{DISTANCE\ 50\ km}$ should be interpreted as the stated utility the respondents gain by locating an offshore wind farm at 18 km and 50 km from the shore relative to a location at 12 km.[9] In Table 2 the results from the parametric analysis of the effect of the CT are presented.

Generally (across samples and models) the respondents have expressed significant preferences for moving offshore wind farms further away from the coast ($\beta_{DISTANCE\ 18\ km}$ and $\beta_{DISTANCE\ 50\ km}$ are all greater than zero) and negative preference for an increase in the annual electricity bill ($\beta_{\mathrm{COST}} < 0$). With regard to the alternative specific constant, the estimate for *ASC*23 is positive in both models, which suggests that the respondents on average have preferences for reducing the visual disamenities from offshore wind farms located at 8 km. However, β_{ASC23} is not significant. If we move on to the estimated standard deviations, the unobserved heterogeneity in the preferences appear to be relatively identical between the two samples, though differences in the estimated Choleski matrix in Table 2 seem to be evident. With regard to the estimated covariance between the two alternatives representing a reduction in the visual impacts relative to the status quo alternative, it strongly indicates positive and significant correlation between the two alternatives.

Due to potential scaling differences, it is important to remember that the estimates might not be directly comparable, Swait and Louviere (1993). A direct preference comparison can be made by examining the estimated level of WTP for the variables (and the respective estimated variance in the WTP) controlling for the distance to the shore of offshore wind farms in the models. This is shown in Table 3. WTP is calculated as outlined in Section 4.3.

If we start with the full samples, WTP generally seems to higher in the NON-CT samples compared to the CT samples, independent of the choice of econometric model. Even though we observe differences of 99-132 DKK, 42-76 DKK and –64-14 DKK for $WTP_{DISTANCE\ 18\ km}$, $WTP_{DISTANCE\ 50\ km}$ and WTP_{ASC23}, respectively, the differences in WTP are not significant on a 95 percent level of confidence. However, in the CL model, the higher WTP for locating the wind farms at 18 km in the NON-CT samples is significant on a 90 percent level. Accordingly, we cannot reject hypothesis H1 on a 95 percent level. Similar results appear to be evident, when we move to the gender specific models. In the case of female respondents $\Delta WTP_{DISTANCE\ 18\ km}$ is 55-116 DKK, $\Delta WTP_{DISTANCE\ 50\ km}$ 73-79 DKK and ΔWTP_{ASC23} –94-14 DKK. For male respondents $\Delta WTP_{DISTANCE\ 18\ km}$ is 143-179 DKK, $\Delta WTP_{DISTANCE\ 50\ km}$ 20-59 DKK

9. Models in which the ASC23 is dropped and replaced with a dummy variable controlling for wind farms at 12 km or in which the distance is specified linearly (including the ASC23), have also been tested. However, compared to the present model, the tested models have lower log-likelihood values at the point of model convergence. The results from these model regressions are available from the authors upon request.

Table 3. Comparison of Estimated Marginal WTP/household/year in DKK.

	Conditional Logit			Random Parameter Error Component Logit		
	NON-CT sample	CT sample		NON-CT sample	CT sample	
	W*TP* [95% CI][(a)]	*WTP* [95% CI][(a)]	Δ*WTP*[(b)] [S. E.]	*WTP* [95% CI][(a)]	*WTP* [95% CI][(a)]	Δ*WTP*[(b)] [S. E.]
Distance 18 km						
All	210***[107-312]	77^{NS}[-19-173]	132$^{NS,(c)}$[72]	162*[39-286]	63^{NS}[-51-178]	99^{NS}[86]
Male	261**[107-415]	118^{NS}[-45-281]	143^{NS}[114]	214*[15-413]	35^{NS}[-179-250]	179^{NS}[149]
Female	160*[25-296]	45^{NS}[-68-158]	116^{NS}[90]	120^{NS}[-48-287]	65^{NS}[-63-193]	55^{NS}[107]
Distance 50 km						
All	312***[212-411]	235***[143-327]	76^{NS}[69]	275***[172-377]	233***[145-320]	42^{NS}[69]
Male	372***[221-524]	313***[155-472]	59^{NS}[112]	320***[157-483]	300***[158-442]	20^{NS}[110]
Female	253***[122-384]	174**[68-280]	79^{NS}[86]	232***[101-362]	158**[40-277]	73^{NS}[90]
*ASC*23						
All	-7^{NS}[-98-84]	61^{NS}[-21-143]	-68^{NS}[62]	167^{NS}[-75-410]	153^{NS}[-74-379]	14^{NS}[169]
Male	-29^{NS}[-168-110]	1^{NS}[-145-146]	-30^{NS}[103]	227^{NS}[-159-614]]	197^{NS}[-188-581]	31^{NS}[278]
Female	16^{NS}[-102-135]	111*[19-203]	-94^{NS}[77]	121^{NS}[-186-427]	135^{NS}[-117-388]	14^{NS}[203]
*ASC*23 + Distance 18 km						
All	202***[124-281]	138***[61-215]	64^{NS}[56]	330*[78-581]	216^{NS}[-28-460]	114^{NS}[179]
Male	231***[115-348]	119^{NS}[-4-252]	113^{NS}[90]	441*[24-858]	232^{NS}[-190-654]	209^{NS}[303]
Female	177**[72-282]	156**[67-245]	21^{NS}[70]	241^{NS}[-68-549]	200^{NS}[-75-475]	40^{NS}[211]
*ASC*23 + Distance 50 km						
All	304***[230-378]	296***[226-366]	8NS[52]	442***[220-664]	385***[170-601]	57^{NS}[158]
Male	343***[234-453]	314***[194-443]	29NS[83]	548**[190-905]	497**[128-865]	51^{NS}[262]
Female	270***[170-369]	285***[202-367]	-15NS[66]	353*[76-629]	294*[52-536]	59^{NS}[187]
LR-test statistics (*df*)	5.51(4)$^{NS,(d)}$	2.13(4)$^{NS,(d)}$	1.97(5)$^{NS,(e)}$	5.74(8)$^{NS,(d)}$	6.75(8)$^{NS,(d)}$	15.57 (9)$^{NS,(e,c)}$

Notes: ^{NS} indicates no significance, * significance at 95% level, ** at 99% level and *** at 99.9% level. ([a]) 95% confidence intervals (CI) are estimated using the Delta Method in accordance with Greene (2008) and Hanemann and Kanninen (1999). ([b]) An asymptotic two sided t-test of the significance of the differences in WTP. NS indicates no significant difference in WTP. ([c]) Significant on a 90% level. ([d]) The estimated scale parameter is insignificant. ([e]) The estimated scale parameter is significant.

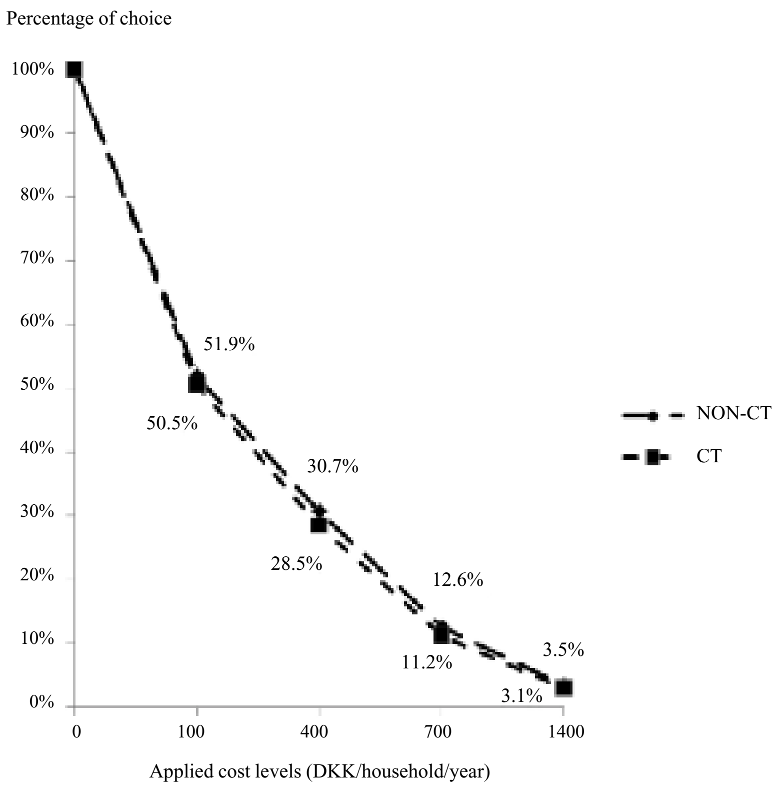

Figure 2. Cumulative probability function of choosing an alternative; all respondents.

and ΔWTP_{ASC23} –30-31 DKK. Again, despite the relatively high difference in WTP, particularly for locating offshore wind farms at 18 km, the differences are not significant.

Accordingly, hypothesis H2 is rejected. These results are confirmed in the Likelihood Ratio test (LR-test) of equality in preferences shown at the bottom of Table 3. In the test, we estimate a joint model, whilst controlling for potential scale equality, and carry out an LR-test to see if we can reject an overall equality in the preferences between the NON-CT and CT samples, Swait and Louviere (1993). The test statistics are all insignificant for both the CL and RPECL models on a 95 percent level of confidence. The results are independent of gender. However, it should be mentioned, that in the case of female respondents in the RPECL, we reject equality of preference on a 90 percent level of confidence.

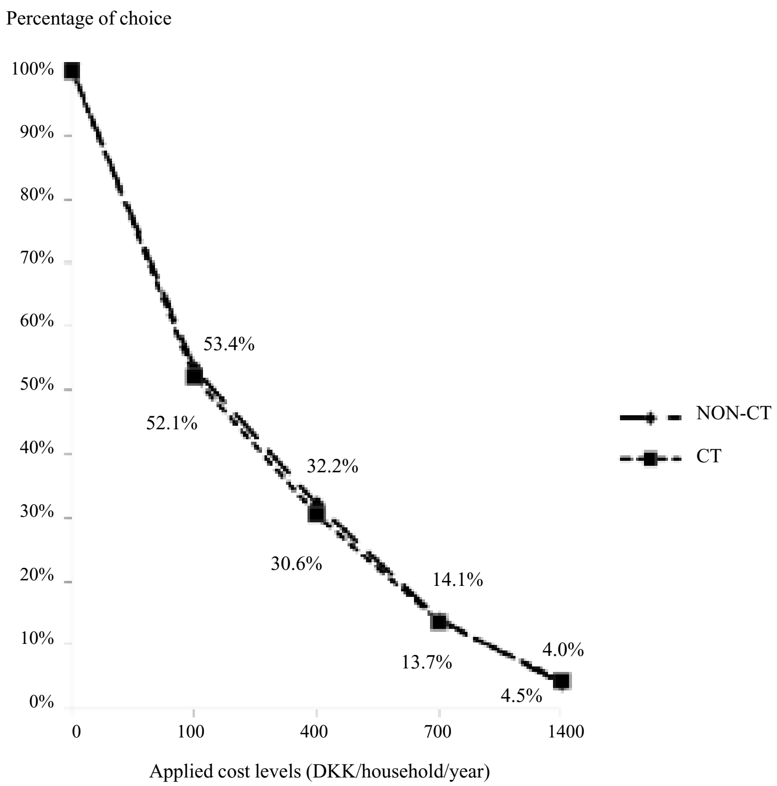

Figure 3. Cumulative probability function of choosing an alternative; male respondents.

5.3 Non-Parametric Analysis of the Effect of the Cheap Talk on Different Bid Levels

The above analysis indicated that when looking at the parametric effect of the CT on preferences, no statistically significant effects can be detected in terms of WTP and overall preferences. However, as suggested by the literature the effect of the CT might not be present for the entire price vector, even though the hypothetical bias is present at all price levels. Brown et al. (2003) and Murphy et al. (2005b) find that CT has an effect only on the respondents who are presented with bid levels in the higher end of the bid range in dichotomous choice and referendum CVM surveys. Inspired by these findings we carry out a test of whether the CT only influences preferences in the high end of the applied prices. In the present study, the choice sets entail price levels at 0, 100, 400, 700 and 1,400 DKK per household per year.

The relation between the costs of the alternative and the frequency of choice are explored in figures 2, 3 and 4, where Figure 2 shows all respondents, Figure 3 male

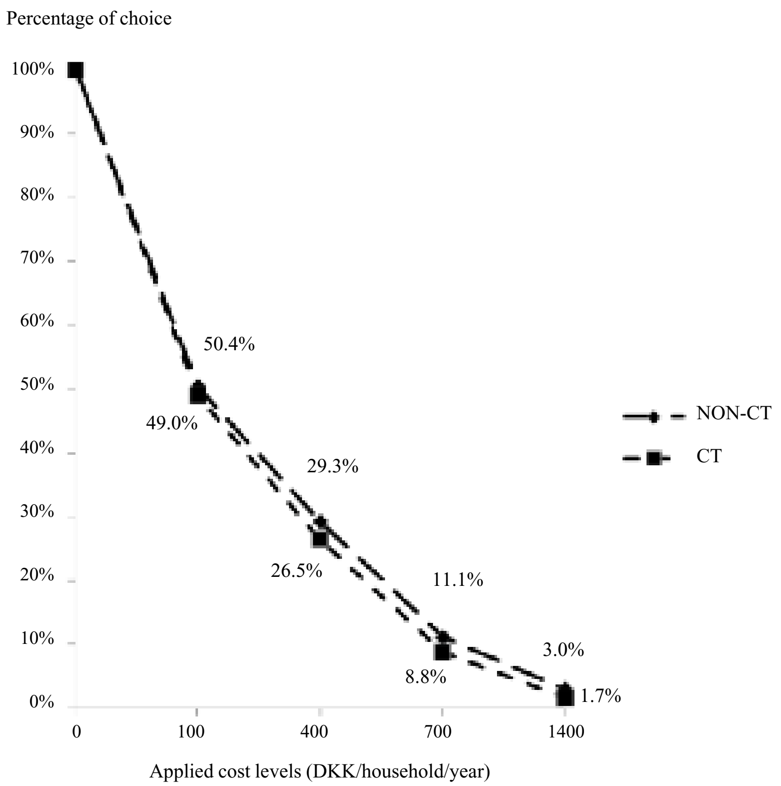

Figure 4. Cumulative probability function of choosing an alternative; female respondents.

respondents and Figure 4 female respondents. In the figures, the cumulative probability of choosing an alternative with the five applied price levels (0, 100, 400, 700 and 1400 DKK) are reported for the NON-CT and CT samples.

Figure 2 shows that the "demand curves" representing the NON-CT and CT samples seem to be overlapping and the reported levels of cumulative choice frequencies are relatively close for all cost levels. A Chi-square test for identical distribution for all price levels and for each individual price level are insignificant on a 95 percent level of confidence.

Looking at the comparison of choice and price frequencies for male respondents, the results from the analysis including all respondents are even stronger. The two "demand curves" are close to being identical. A χ^2-test confirms this. Accordingly, it cannot be rejected that the two choice distributions are based on the same set of preferences.

Interestingly, the results are quite different for female respondents. The cumulative demand curve is presented in Figure 4.

As the demand curves suggest, the female respondents, who were given a CT, have chosen alternatives with a price of 1,400 DKK less often when compared to the female respondents who did not get a CT. More specifically, the female respondents in the CT sample have chosen a 1,400 DKK alternative in 1.7 percent of the total number of choices compared to 3 percent in the NON-CT sample. In a χ^2-test this difference is significant on a 95 percent level of confidence. As the figure indicates, the choice frequencies also seem to be different with regards to prices at 400 and 700 DKK per household per year. Individually, they are not significant. However, when looking at 700 DKK and 1,400 DKK jointly the differences are significant on a 95 percent level of confidence. This suggests that it is at only at price levels of 700 and 1,400 DKK that the CT has an effect on the female respondents.

Accordingly, the CT does have an effect, but it is gender specific and only applies to the higher end of the price vector, i.e. 700 and 1,400 DKK. Accordingly, we reject hypothesis H3.

6. Discussion

The present study makes several contributions to the existing literature. First of all, it is the first study that establishes a link between the effectiveness of the CT and the specific cost levels in CE. The results thus support the lack of effectiveness of CT in the lower bid range in previous CVM studies, Brown et al. (2003); Murphy et al. (2005b). Secondly, the significant gender specific effect supports a growing literature with a specific focus on gender differences in information processing in stated preference surveys, Ladenburg and Olsen (2008); (2010b), Ladenburg (2010). In this relation, the present study, jointly with Barrage and Lee (2010), and Mahieu (2010), suggests that female respondents are more sensitive to hypothetical bias mitigation measures. Finally, despite the lack of overall significant effect on the preferences, the capability of the CT to reduce WTP to a lower level appears to be present.

6.1 Gender Specific Effects

As found in the analysis, female respondents seem to be sensitive to the CT information, whilst male respondents are not. In the following subsections arguments supporting this observed effect are discussed.

Information Processing Differences

In economically orientated fields, such as marketing research, the topic of gender differences has received considerable attention. Meyers-Levy (1989) establishes the "selective hypothesis" to explain observed gender differences in cognitive human expressions. The central point in the hypothesis is that male and female respondents process information differently. Males seem to base their judgement on a subset, schema or an overall message theme of the available information and are categorised as *selective information processors*. Females, on the other hand, make an effort to assimilate all of the available information before making a judgement, Meyers-Levy and Tybout (1989). In this sense, female respondents are *comprehensive information processors*.

In the light of the observed female sensitivity toward the CT, this suggests that males and females have processed the CT information differently. Consequently, they might put different emphasis on the content of the CT script and have related the content to the applied cost range. This is supported by Meyers-Levy and Sternthal (1991) who find that females have a lower threshold for elaborating on enclosed information compared to males. Accordingly, the threshold capacity of the information in the CT might only have triggered an information process response among female respondents.

The selective hypothesis is in line with the work of Gilligan (1982) who finds that females generally think about and act on moral dilemmas in a more inclusive manner when compared to males. Brown and Taylor (2000) argue that females are more likely to respond to the *market* context used in stated preference surveys, which relies heavily on the defined hypothetical market setup, i.e. information. In this sense, females might also respond better to the extra scenario information, which the CT in principle is. Following this line of arguments, the observed difference in gender specific effects could also be caused by male respondents, in the extreme case, simply not having read the CT script at all.

Conformity Effects

Another explanation for the observed gender differences could be the nature and wording of the CT script. Following Ladenburg and Olsen (2010b) the CT applied in the present study is different from the initially proposed CT by Cummings and Taylor (1999) in that their script is longer and gives explicit instructions on how the respondents (in their survey) themselves should choose. In the present study, the CT only gives information on how other respondents seem to overstate their hypothetical demand. As argued by Ladenburg and Olsen (2010b), the effectiveness of the CT applied in the present study thereby becomes conditional on the respondent perceiving the reported behaviour of others as inappropriate and, as a consequence, choosing to conform to the opposite behaviour, i.e. a kind of reversed conformity.

Though the type of conformity cannot be directly compared to the traditional test of herding behaviour, in which the individuals adapt/falsify their effective preferences to the consensus positions of their social groups, Anderson and Holt (1997), the information (signal) of what others do, have shown to subsequently influence preferences. In relation to only female respondents being affected by the CT script, Frey and Meyer (2004) find evidence that conforming behaviour is heterogeneous in their sample. Only respondents who are uncertain about their decision seem to be influenced by the proposed action of others. In the present survey the respondents were asked about how certain they were of their stated preference when choosing the preferred alternative in each of the six choice sets. An ordered logit analysis controlling for background characteristics and an ordering effect finds that male respondents are significantly more certain compared to female respondent and are thus in line with the findings of Frey and Meyer (2004). These results are available from the authors upon request.

Carlsson et al. (2008) carry out a test, to investigate whether the demand for coffee products is sensitive to the claimed level of green consumerism in society. Interestingly, they find that only female respondents conform to information on the proportion of other consumers that choose coffee made of 100 percent ecological beans.[10] In the context that the CT works via reversed conformity, the results from the present survey are in line with Carlsson et al. (2008).

6.2 Price Vector Sensitivity

The results from the analysis strongly suggest that the female respondents are only sensitive to the CT with regard to the two highest cost levels in the CE (i.e. 700 and 1,400 DKK per household per year). Though previously found in CVM studies, this is the first study to establish this relation in CE. These results thus suggest that female respondents only find it necessary to take the CT into account when faced with relatively high cost alternatives. When faced with lower cost alternatives, this is apparently not an issue. Accordingly, one interpretation of the results is that the female respondents only perceive hypothetical bias to be related to choosing a high cost alternative and not low cost alternatives. Consequently, they might disregard the CT information when faced with relatively low cost alternatives.

In a conformity framework, another interpretation could be that the female respondents on a less conscious level perceive the cost of conformity, i.e. self-denial cost, Klick and Parisi (2008), to be a decreasing function of the alternatives' cost levels. In that case, the benefits of conforming to the CT script would naturally be dependent on the costs. A change in conforming behaviour would then take place around the cost threshold at which the costs of conforming is equal to the benefits of conforming. In

10. Actually male respondents react negatively to the conformity information.

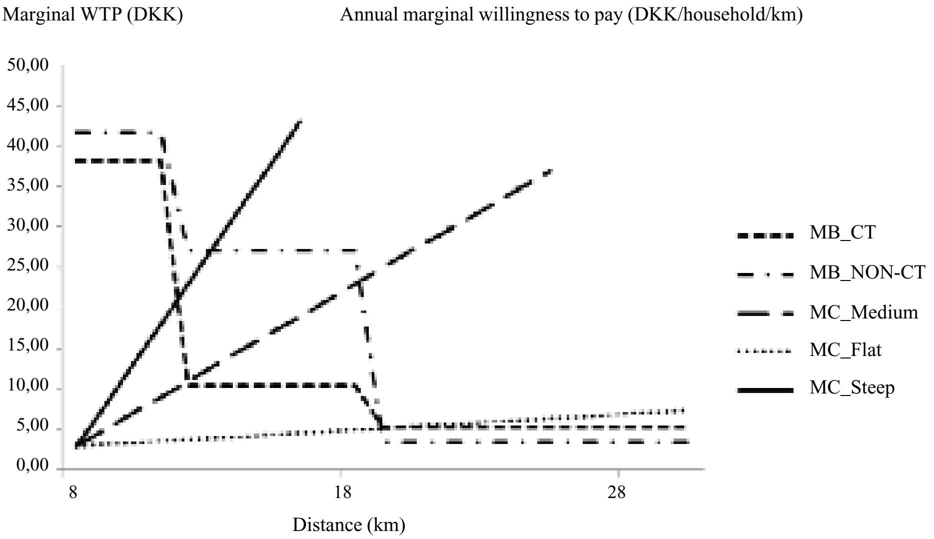

Figure 5. Comparison of the optimal distance using three marginal cost scenarios and marginal benefits with and without a CT.

the present analysis this threshold seems to be in the region of 400 to 700 DKK per household per year.[11]

6.3 Economic Implications of the Effect on Willingness to Pay

As found in Table 3, the CT seems to have lowered WTP for reducing the visual disamenities from offshore wind farms. Though these differences are not significant on a WTP level, they still deserve to be elaborated upon in an economic application context. Imagine a policy planner, such as the Danish Energy Authority trying to identify a set of offshore wind farm locations, which are optimal from a welfare economic point of view. One of the parameters that enter the economic welfare analysis is the external costs of visual disamenities.

In this case, cost optimality is obtained when the marginal benefits (MB) of reducing the visual impacts are equal to the marginal cost (MC) of doing so. To obtain an estimate of the benefits, a CE survey similar to the one given to the NON-CT sample in the present study might be carried out. Let us for simplicity assume that the elicited

11. In the same framework these results are supported by Shang and Croson (2007) and Alpizar et al. (2008). In two independent public good donation experiments they find that the signals of what other people have contributed needs to be of a certain magnitude in order to have an influence on the level of individual donation. Accordingly, assuming that the benefits of conforming is a function of the cues of other people's behaviour, the difference between self-denial costs and the benefits might be too little for small cue signals to influence behaviour significantly.

preferences would be representative of the Danish population. Based on the estimated level of WTP this would give the marginal benefit curve labelled NON-CT (MB_NON-CT) in Figure 5. As shown, the marginal benefits of moving an offshore wind farm an additional kilometre away from the coast drops from 41.75 DKK/km between 8 to 12 km, to 27.00 DKK/km between 12 and 18 km and to 3.53 DKK/km between 18 and 50 km. This indicates that when locating an offshore wind farm an additional kilometre from the coast (compared to a location at 8 km) the marginal benefits of locating offshore wind farms in the a distance interval from 8 to 18 km are close to being the same.

However, had the CE survey been carried out using a CT as in the CT sample, the marginal benefits are much more sensitive to the distance as illustrated by the benefit curve labelled MB_CT. In this case marginal benefits drop from 37.75 DKK/km between 8-12 km to 10.50 DKK/km between 12 and 18 km and to 5.31 DKK/km between 18 and 50 km.

As illustrated in Figure 5 the policy implications of including a CT or not in the CE survey, strongly depends on the location of the marginal cost functions. If the marginal cost function is relatively flat, the optimal distance (OD) appears to be less sensitive to the use of a CT, compared to the situation where marginal cost is steeper. More specifically, conditional on a flat marginal cost curve (MC_Flat), the optimal distance is around 18 km, independently of whether the marginal benefit curve is estimated using a CT or not. If MC is medium steep (MC_Medium), OD_{CT} =12 km and $OD_{NON\text{-}CT}$ =18 km. Finally, if MC is steep (MC_Steep), OD_{CT} =11 and $OD_{NON\text{-}CT}$ =13-14 km.

The examples and the conclusions put forward above are naturally conditional on the choice of marginal cost function and the relatively »rough« marginal benefit curves. However, this does not change the point being made, i.e. that if a CT had been applied, the optimal location might have been much closer to the shore compared to the case where an experiment without a CT had been applied. This seems particularly evident in the case of a medium steep marginal cost curve. So despite the CT not having a significant influence on the estimated levels of WTP for moving offshore wind farms, it might have a strong impact on the optimal level of visual disamenity abatement from offshore wind farms and therefore shift the optimal location towards the shore.

7. Conclusion

In an attempt to reduce and hopefully eliminate the gap between hypothetical and real demand, i.e. hypothetical bias in stated preference surveys, a script called a Cheap Talk (CT) script has previously been tested and found to be effective. In the present paper we test the effect of a much shorter CT script in a stated preference study focusing on the Willingness to Pay for reducing the visual impacts from offshore wind farms.

Applying a Random Parameter Error Component Logit model we find the CT script to have lowered Willingness to Pay, but not to affect preferences significantly. Controlling for potential gender effects does not change this finding. However, we do find significant effects of the CT when relating the effect of the CT to the cost levels of the alternatives. More specifically, we find that the CT seems to make female respondents choose alternatives with costs of 700 or 1,400 DKK less frequently when given the CT. We argue that this might be due to differences in information processing and conformity between male and female respondents.

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An Application of Fisheries Economics Theory – 100 years after Warming's paper: "Rent of Fishing Grounds"

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SUMMARY: This paper contributes to the state of the art within fisheries economics and management 100 years after Warming's inaugurating 1911 article. The developments are briefly described with reference to and following Warming and are illuminated by use of a complex multi-species multi-fleet dynamic discrete-time model. The neo-classical concept of resource rent is maximized by use of various physical measures, such as fishing effort restrictions and fishing quotas, and economic measures, such as property or user rights and taxes. Although theory ranks economic measures above physical measures, in practice the difference is not necessarily big in terms of generation of resource rent. The important step forward was the introduction of catch or effort limitations compared to open access. Warming was hardly aware that the cornerstones he put down in 1911 formed the basis for the cathedral we face today.

1. Introduction

The aim of this paper is, in a case study, to enlighten an application of fisheries economics theory in honour of the 100 years anniversary of Jens Warming's paper "Om grundrente af fiskegrunde" ("Rent of Fishing Grounds") published in the Nationaløkonomisk Tidsskrift in 1911, Warming (1911) and Andersen (1983). Further, there is reason to also honour the 80 years anniversary of Warming's paper "Ålegårdsretten"

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("Property Rights of Eel Weirs") published in the Nationaløkonomisk Tidsskrift in 1931, Warming (1931) and Eggert (2010). These two papers can in some sense be regarded as the mother and the father of fisheries economics theory with a view to management of a renewable natural resource. We acknowledge, however, that although known by these authors it were Gordon's (1954) and Scott's (1955) articles that inaugurated fisheries economics internationally.

Where Warming's approach is aimed at optimal equilibrium management of the fish resources, this paper describes important achievements within fisheries economics theory and management since Warming's contributions, and eventually shows what extensive fisheries economics disequilibrium models will say about the application of such management measures as limited entry, individual transferable quotas and taxes separately or combined.

The scope of our article is put light on the first wave of pure fisheries economics theory and management, which implies that a range of disciplines are omitted. Therefore, we put emphasize on the period from the nineteen fifties to the eighties. For recent developments in fisheries economics see Moto and Wilson (2006), Squires (2009), and Grafton et al. (2010).

It is important to distinguish between the development of fisheries economics theory and the development of fisheries management, where theory is an ordered set of general claims about the exploitation of the fish resources while management is actions taken to achieve a desired goal, which is not necessarily of economic nature. One could argue that, generally speaking, until the seventies most contributions within fisheries economics were based on management considerations founded in the general theory of welfare economics. From the seventies an independent comprehensive fisheries economics theory was developed with significant mathematical contributions by Clark and Munro (1975) and Clark (1976 and 1985). Copes (1970 and 1972) used welfare economics and the particular backward-bending characteristics of the supply curve in fisheries to demonstrate gains and losses. While all these people were situated in British Columbia, Canada, the Icelander Hannesson, living in Norway, also contributed to the work, Hannesson (1974) and (1978), and from the United States of America the contribution by Anderson (1977) needs attention and from the UK the contribution of Cunningham, Dunn and Whitmarsh (1985).

In Denmark, development of fisheries economics analyses and application was revived in the light of the development of the Common Fisheries Policy of the European Union, Andersen (1979), Frost and Løkkegaard (1981), Andersen (1981).

Fisheries economics management benefits from a consistent theory if it is to work properly. And the theoretical development of fisheries economics theory has strengthened the foundation for management. Nevertheless, management of fisheries has until today been dominated primarily by biology with respect to fish stock conservation and political science considerations about property rights and the distribution of the benefits from the sea.

There has been a tendency to favour individual transferable quotas among fisheries economists although taxes also play an important role as solutions to reach bioeconomic equilibrium, Grafton (1995). We will show, in a complex model, how these measures work in a dynamic setting that does not necessarily lead to equilibrium solutions. The model we use is a discrete-time model of which Clark says with respect to address the shortcomings of the theoretical mathematical models:

> In trying to model these and other complications, we face the danger that our mathematical models may become too complex to be analyzed and understood. One way to try to overcome this problem is to use the computer to simulate complex systems. .... it should be realized that from the scientific point of view the results of such exercises at best serve as illustrations of a general theoretical framework [Clark 2005 p. 197].

It is debatable whether the second part of Clark's statement is correct as the very complex models are impossible to solve mathematically, Flaaten (1988) and (1991). How do we then know whether the results from the simpler models are valid? Hence our purpose is to apply the theory in a model and by use of data from one of the best investigated fishing grounds, the Baltic Sea, to enlighten the theoretically advised management implications in a complex setting. We claim that the model is more than an illustration of the general theoretical framework.

The model we use, named Fishrent, is developed in a project commissioned by the EU Commission, Salz et al. (2010) and Salz et al. (2011). The model is composed by four modules: (1) a biological module that comprises fish stocks and fish stock recruitment, (2) a production module comprising fishing effort and changes in effort, catches and landings, (3) an economic performance module that translates landings and effort into economics by use of a set of prices, and (4) a management module that includes the restrictions (harvest control rules) put on the system by the managers and a mechanism that chooses the most restrictive option every time. The model is designed in such a way that various management measured can be tested in the same model in a dynamic setting where the fish stocks and the fishing fleets interact. As the various management measures can be inflicted on the physical output, the physical input or the economic components, it is required that the model can be reversed dependant on the measure which implies the strongest restrictions for the system. This is a unique causal feature of Fishrent that distinguishes it from other models, Prellezo et al. (2009).

This paper contributes to the question: What is the state of the art 100 years after Warming's inaugurate article. In particular we illuminate fisheries economics theory and management by use of a complex multi-species multi-fleet dynamic discrete-time model. There is no species interaction in the model, and no impact on the ecosystem from fishing. Further, it is assumed that fishermen are price takers on the factor and the product markets. The paper is organized in two main sections. The first section highlights important aspects of the development of the fisheries economics theory and management but is not exhaustive in that field, see Anderson (2002), while the second section is a brief exposition of Fishrent, applications and presentation of selected results. It should be noted that although the flexible structure of the model allows for it, we have left out explicit analyses of recent topics, such as uncertainty, compliance, high-grading, corporate management, asymmetric information and principal-agent issues both in the theoretical section and the modelling part, Andersen (1982), Andersen and Sutinen (1984), Sutinen and Andersen (1985), Anderson (1994), Arnason (1994), Ostrom (1999), and Jensen and Vestergaard (2002a) and (2002b).

2. Developments in fisheries economics theory and management

Warming himself was neither a fisheries economist nor a natural resource economist but was influenced by the neo-classical economic theory, Kærgård et al. (1998), Olesen (2003) and Topp (2008). However, Warming's paper from 1911 disclosed the central problem in natural resource and environmental economics that a common property resource subject to open access leads to an over-exploitation of, biologically, high-productive fishing grounds and an under-exploitation of, biologically, low-productive fishing grounds as the equilibrium will occur where the average revenue product of fish is equal to the marginal costs of fishing. This equilibrium is contrary to the conventional equilibrium condition where the marginal revenue product is equal to the marginal costs.

The 1931 paper pointed out that it would be a mistake to remove the property right, equivalent to a Pigouvian tax, to the fish resource and allow open access. By doing that the resource rent of the fishing ground (or the fish stocks) would dissipate, as too much fishing effort would be allocated to the fisheries sector. The analysis highlighted the measures required to manage the fishery properly. Warming's 1931 article as such addressed an institutional management problem caused by a Parliament proposal to remove the property right to fishing grounds. Both articles attracted some national attention, but no significant international interest, partly because they were published in Danish, Topp (2008) and Eggert (2010).

Thus Warming's contributions were characterized by a pioneering approach to (i) development and application of economic theory within fisheries and (ii) proposing economic management measures in order to solve fishery problems. Following these papers little happened for twenty years after 1931 within the area of fisheries economics. However, along these lines, the interest for fisheries management in an economic context developed by Warming was revived by Canadian economists with the contributions of Gordon (1954) and Scott (1955). Gordon's analysis explicitly included a biological yield function but showed, as Warming did, that the open access equilibrium was found when the price on fish was equal to the average costs of fishing. Scott extended that analysis to take into account the impact of changes in the fish stocks and the user costs of the fish stocks.

The development of fisheries economics theory and management is closely linked, Turvey U(1964). In particular much of the development of fisheries economics theory from the fifties to the seventies was with a few exceptions, Crutchfield and Zellner (1962) carried out by "institutionalists" , who observed problems in the exploitation of natural resources and not only the renewable, such as fish, but also the exhaustible, such and oil and minerals. Before that time it was a widespread opinion that fish could not be overexploited precisely because it was a renewable resource. So why bother. But the United Nation's conferences on the law of the sea (UNCLOS) in 1958 and 1960 in Geneva (and in 1972 in Caracas) stimulated the interest for fisheries economics during the sixties partly under the auspices of FAO. A symposium of the economics of fisheries management was held at the University of British Columbia, Vancouver, in 1969, at which the "institutionalists" including the Nobel Laureate R. H. Coase attended together with a new school of younger mathematically oriented economists, among those the later Nobel Laureate Vernon L. Smith, Quirk and Smith (1970). In a sense this conference represented a turning point in fisheries economics from "institutional" economics to mathematical economics, Munro (1992) and Wilen (2000). Inspired by this symposium significant contributions to the mathematical fisheries economics came from the mathematician Colin Clark and the economist Gordon Munro, for example Clark and Munro (1975), Clark (1976).

Particular interest for the kind of measures that could be applied to alleviate the failures of the exploitation of a common property resource is found in the Canadians Anthony Scott's (1979) and James Crutchfield's (1979) contribution to the Proceeding of the Symposium on Policies for Economic Rationalization of Commercial Fisheries held at Powel River, British Columbia in August 1978 and edited by Peter H. Pearse (1979), a third distinguished natural resource economist from British Columbia, Canada. The Powel River conference convened a number of experienced economists, who had discussed management problems with respect to fisheries since the early sixties. Canada introduced limited entry to important salmon fisheries in 1969 supplemented by buy-back schemes, Sinclair (1960) and (1978) and these were reviewed for example by Pease and Wilen (1979) and Fraser (1979). Scott (1979) concluded, based on a review of the management literature that the fisheries economics theory has not developed since Gordon (1954) and effectively since Warming, who is acknowledged in Scott's paper. Turning to management measures, Scott (1979) further discusses the advantages and disadvantages of limited entry and concludes that limited entry, at least the way it was applied to Canadian fisheries, was not entirely successful. He compared taxes and individual transferable quotas (ITQs) by use of a number of criteria and favoured ITQs in the end, partly because taxes might be impossible to introduce because of resistance by both the industry and the politicians and partly because of the difficulty in the determination of correct taxes that takes into account the characteristics of the different species with respect to value to the consumers, season, size of fish and differences in fishing technology. The American Francis Christy, (1973a) and (1973b) is often named the father of ITQ-management as he was first to describe detailed prerequisites for implementation of the system. Crutchfield (1979) and Copes (1986) were not so critical with respect to limited entry and argued that if ITQs were subject to assessment by the same criteria as limited entry it would fail as well. Careful studies of the work by Crutchfield, Pearse and Scott may reveal differences in their anticipation of input and output restrictions and taxation. However, they agreed that a limitation in one way or another was necessary to obtain resource rent and at least Crutchfield argues that each one of the measures cannot stand alone. Limited entry, ITQ and taxes are not alternatives but complementary instruments to achieve resource rent and secure sustainable exploitation. Empirical investigations, however, often rank limited entry less effective than ITQ and taxes, Sutinen (1999).

One can distinguish between two types of economic rent, Munro and Scott (1985). Type I is the rent gained from the fish stocks by preventing overfishing, while type II is the rent gained from cost minimization at a specific stock yield (quota).

Clark (1980) developed a mathematically consistent analysis of fisheries economics regulation with reference to the Powel River conference in which he participated. In general, Clark (1973, 1976) Clark and Munro (1975) and Clark, Clarke and Munro (1979) together with Smith (1968, 1969), Plourde (1970) and Quirk and Smith (1970) introduced mathematical analyses into the development and application of fisheries economics theory, and this has become the dominant school since then. It is questionable, however, to what extent this school has found its way into practical management, which to a large extent is still dominated by biological advice and conventions regarding the law of the sea. However, it is doubtful to what extent proper management would have been carried out, had it not been for the theoretical developments, Holden (1994), Deacon et al. (1998), and Wilen (2000), Frost (2010). Examples of optimal solutions based on the pure fisheries economics theory combined with discard and highgrading behaviour and regulation is found in Vestergaard (1996) and combined with regulation in Homans and Wilen (1997). The seventies are often characterized as the golden age of fisheries economics theory with significant contributions within dynamic optimization and optimal control theory. These analyses are purely analytical and highly mathematical. The analyses are based on single (homogeneous) species and single (homogeneous) fleet assumptions. Even under these assumptions, the analyses are complex and the problems related to fisheries management are difficult to solve. Contrary to this, the "institutionalists" from the sixties and the seventies addressed the issues in a broader perspective with respect to human behaviour and necessary management measures to alleviate the market failures, see also the work of the Nobel Laureate Ostrom (1999) and Bromley (2009). But what was gained in perspective was lost in less consistent analyses.

In his mathematical framework, Clark addresses the limited entry, transferable quotas and taxes and shows that with complete information there is no difference between these measures' ability to achieve optimal solutions Clark (1980). However, once assumptions are relaxed, and not addressed explicitly in the mathematical framework, the solutions differ, but still Clark cannot recommend one measure as superior to the other. Being strictly analytical, these recommendations were not viable in direct application due to their nature, i.e. no use of data and simplified assumptions. Clark points out these difficulties in attempts to apply the results in practice.

It is interesting to notice that although the majority of the development of fisheries economics is assigned to Canada (and the United States of America) none of these states have applied the recommendations from economists to any great extent, Munro et al. (2009). On the other hand, Iceland, Arnason (1993) and New Zealand, Lindner et al. (1992) introduced complete ITQ systems from the end of the eighties. Greenland introduced non transferable quotas for shrimp caught off shore in 1984 and extended it to an ITQ system in 1991, Christensen and Vestergaard (1993). It should be observed that the fishing industries of these countries were characterized by strong vertical integration and their Economic Exclusive Zones were to a large extent exploited by 3. countries. The Netherlands introduced ITQs from the mid-seventies for beam trawlers fishing for sole and plaice. It was not enforced, however, until the beginning of the nineties and the introduction could be viewed in the light of the enlargement of the EU in 1973 with Denmark and the United Kingdom. Denmark introduced non-transferable individual quotas in 1993 and these became transferable from 2003 for herring and from 2007 for the entire Danish fishery, Andersen et al. (2010). In general, the European Union has been on the forefront with respect to introducing fisheries management with reference to fisheries economics theory, Frost and Andersen (2006), and Frost (2010). On the other hand ITQ systems were strongly rejected by the Faroe

Islands, which instead introduced a limited entry system with individual transferable days at sea in 1997, Løkkegaard et al. (2007).

3. The model

3.1 The general framework

From the late eighties and until now fisheries economics analyses have benefitted from the development of computational power. This development has made it possible to extent the current theory based on single-species single-fleet assumption to multi-species multi-fleet (heterogeneous) analyses. Dynamics can be handled by discrete-time models, and stochastic recruitment to the fish stocks, spatial fishing, etc. can be addressed explicitly. A clear drawback of analyses based on such models is that the models become very complex, extremely data demanding and that the model components will appear as black boxes to persons outside the modelling teams. There is a tremendous task in understanding and explaining the results as some of the models do not comply, at least at first sight, with the conventional theory. It is difficult to derive "rules of thump" from these models because a very small change in an assumption could turn the results up-side down.

Following Arnason (2000), fisheries models may be classified in (1) analytical with no or little empirical content, (2) empirical with an empirical description of a fishery, and (3) numerical with numerical parameter values and generally solved by numerical methods using computers.

The strength of the numerical models (type 3 above) is that they make it possible to (1) project the development of the fishery into the future, (2) study the impacts of exogenous changes including management measures, (3) calculate biological, economic and social outcomes of the fishery under a variety of conditions, (4) calculate economically optimal adjustments paths for fishing fleets and fish stocks, and (5) demonstrate the potential gains of efficiency.

The drawbacks are that the models are (1) only sufficiently accurate if constructed on relatively large scale (disaggregated), (2) difficult to construct, demanding in time and resources, (3) sensitive to initial data input and requires continuous data collection and data validation, (4) difficult to manipulate and use and complex to operate and run, (5) computationally demanding as regard to optimization of the system, and (6) difficult to understand and to explain the outcomes (black-box syndrome). Quite a few of such models therefore ends up as dead models, Frost and Kjærsgaard (2003) or become very simplistic and aggregate in both the biological and the economic field, World Bank and FAO (2009), and Holt (2009).

The model, Fishrent, is featuring the above mentioned advantages, but also drawbacks. It is an empirical/numerical model in the sense that it needs numerical values for a large number of parameters but not all of these values are estimated due to lack of data. Some parameters are determined from theoretical considerations about the interval for possible values. Used as an endogenous optimization model, Fishrent: (a) generates a logically consistent response to any fisheries management measure, (b) can be used to test for loopholes in proposed management systems, (c) offers a natural way toward general equilibrium modelling of the fishery, and (d) can serve as a data generator, Arnason (2000).

In principle, it could be argued that the model should be constructed for each agent using various gear technology and exploiting different species and fishing grounds. This will inevitably increase the complexity and the demands regarding computational power. An operational alternative is to include a sufficient number of agents, species and fishing grounds to reflect the diversity of the fishery. This is how our approach is carried out.

Most conventional bio-economic fisheries models ignore fishermen's explicit dynamic behavior, Clark (2005), Anderson and Seijo (2010). Although profit maximizing behaviour implicitly forms the basis in these models, fishing effort (or its equivalents) is typically regarded as exogenous, to be decided upon by the model user or the fisheries manager. Two elements typically form the basis for the models: (a) an economic performance function, and (b) a biomass growth function.

Conventional fisheries models are, at least in principle, capable of identifying the optimal fisheries policy (in the sense of economic performance maximizing levels of fisheries inputs), calculating the corresponding route of the fishery over time as measured by the state variables, and calculating the maximized level of the performance indicator, i.e. the discounted profit aggregated over time. In stochastic versions of the models, these outcomes would receive a probabilistic representation. These optimal outcomes are often compared to the outcomes from the current or other, assumed, fisheries policies.

For simplicity of analytical derivations, the Cobb-Douglas production function is the preferred type with the exponents of the factor inputs set at unity, Anderson and Seijo (2010). This type of production function has caught particular interest since the seminal paper of Gordon (1954). Empirical work favours the translog type because of the fewer restrictions that are embodied in this type compared to the Cobb-Douglas type, Hoff (2004). In a recent exchange of views about the possible extinction of species, the impact of Cobb-Douglas exponents different from one has been discussed by Grafton et al. (2010) and Clark et al. (2010a) and (2010b).

Fishrent uses a Cobb-Douglas production function for harvest h as a function of effort e and fish stock biomass x with exponents $\alpha + \beta = 1$, and includes technical progress τ, Eide et al. (2003). The species are caught in fixed proportions by each fleet segment, Squires and Kirkley (1991). Furthermore, various forms of the biological growth (recruitment) model are estimated and applied in the model: Schaefer, Ricker, Beverton-Holt and stochastic. Fishrent includes a primal production function and an inverse production function making it possible to test both output and input controls, such as TACs and effort, by use of the same model, Hoff and Frost (2006) and (2008), Frost et al. (2009), Prellezo et al. (2009). The choice of model causality is made by the model user before each run. Thus the applied production function takes on the forms:

$$h = q \cdot e^{\alpha} \cdot x^{\beta} \cdot (1 + \tau) \tag{1}$$

and

$$e = \left(\frac{h}{q \cdot x^{\beta} \cdot (1 + \tau)}\right)^{\frac{1}{\alpha}} \tag{2}$$

Further, to take the fishermen's behavior into account Fishrent includes a neoclassical investment function and an entry/exit function translating investment into physical capital in terms of fishing vessels.

Vernon L. Smith introduced the investment function explicitly, Smith (1968) and (1969) where he, in a dynamic setting, investigates the importance of key parameters such as stock and crowding externalities represented by the shape of the cost function and the incentive to invest and disinvest. This approach plays a central role in our analyses, see also Kronbak (2005) for a dynamic model with an explicit in investment function included.

The investment function used in Fishrent is derived from the general neoclassical Cobb-Douglas investment function, Dornbush and Fisher (1994). The empirical evidence for investment behaviour in fisheries is sparse. Bjørndal and Conrad (1987) carried out a study for large Norwegian vessels fishing North Sea herring. A lagged model was used to take into account that adjustments take time. The results indicated that fleet adjustment in this fishery primarily depended on the current period's profit and that the opportunity cost may depend on returns in the alternative fishery. Inclusion of lagged variables to account for the construction time for new boats showed only a small improvement of the statistical fit. Moreover, the results did not support a hypothesis that entry in response to positive profits is more elastic than exit due to negative profits. These considerations comply with the Cobb-Douglas investment function:

$$I = K^* - K \; ; \; K^* = \lambda \cdot \frac{\pi}{r} \tag{3}$$

Where I is the investment, K^* is the optimal capital level, K is the current capital, π is profit, r is interest rate and λ is the partial adjustment coefficient (profit share invested).

The basis for all scenarios tested in Fishrent is formed by the following dynamic, discrete-time model (species, fleet and time indices on the variables are omitted). The main difference from static models is that an investment and an entry/exit function are included in the dynamic cases and play a significant role in relation to the results.

$$\Pi = \sum_{t=1}^{25} \pi_t \cdot (1+r)^{-t} \tag{4}$$

$$x_{t+1} = x_t + g(x)_t - h\,(e_t, x_t; z_t) \tag{5}$$

$$\pi_t(e_t, x_t; z_t) = p \cdot h(e_t, x_t; z_t) - c(e_t, x_t; z_t) \tag{6}$$

$$e_t = e_{t-1} + \Delta e_{t-1} \quad ; \quad \Delta e_{t-1}(\lambda, \hat{\pi}, r, \rho_{in}, \rho_{out}) = \begin{cases} \dfrac{\lambda \frac{\hat{\pi}}{r}}{\rho_{in}} & ; \ \hat{\pi} \geq 0 \\ \dfrac{\lambda \frac{\hat{\pi}}{r}}{\rho_{out}} & ; \ \hat{\pi} \leq 0 \end{cases} \tag{7}$$

The profit, π, is a function of fishing effort, biomasses of the targeted fish stocks, represented by the vectors e and x, and a set of management rules, represented by the vector z, all of which are functions of time. The net growth of a fish stock is a function of the growth of the stock biomass $g(x)$ and the harvest, h, where the latter is represented by a production function determined by stock, effort, and technical progress. The harvest and the costs of fishing, c, together with the fish price, p, determine the profit. If the profit is maximized over one or more of the control variables, e.g. fishing effort, the solution yields the optimal time paths of the control variables. This thus represents the optimal fisheries policy.

The change in effort is a function of a number of parameters, i.e. the partial adjustment coefficient, λ, the fisherman's interest rate, r, the opportunity cost for entry $\frac{\lambda}{\rho_{in}}$, and the opportunity cost for exit $\frac{\lambda}{\rho_{out}}$. Although the time horizon is infinite in the effort change function above, the model operates with a finite time horizon that is fixed at 25 years in the present application. The profit π is the average supranormal profit for the previous two years as the normal profit is included in the cost function.

3.2 Management regimes

The cases tested by Fishrent are carried out according to the conventional bioeconomic textbook theory, Clark (2005), Anderson and Seijo (2010). Although Fishrent can produce closed form management solutions, a major advantage of the model is that it also simulates disequilibrium, open form, solutions. This is an improvement compared to most conceptual models, which yield only equilibrium solutions. Although equilibrium solutions are valuable benchmarks for understanding the system or policy targets, such solutions are hardly to be found in practice.

Fishrent thus embodies and allows for test of the following management regimes: (1) Open access, (2) Individual non-transferable quotas, (3) Individual non-transferable quotas combined with restricted entry (ERIQ), (4) Effort (days at sea), (5) Individual transferable quotas, (6) Access fee, (7) Fee per day at sea, (8) Fee on landings value, and (9) Tax on profit.

The link to biological management rules, i.e. TAC and quotas, in the model is ascertained by inclusion of fishing mortality rates, which form basis for the determination of TACs and, thus, effort. In an output driven context, the fishing mortality rates are transformed into TACs that are then constraints in the model. This is called input based measurement in the economic literature.[1] Contrary to that, the fishing mortality rates may be linked to effort in terms of total days at sea so that future effort is determined by the current fishing mortality rate in proportion to a target fishing mortality rate, e.g. $F_{target} = F_{MSY}$.

The individual transferable quota management regime is handled by the model by use of dynamic optimization in which the net present value over 25 years is maximized by reallocation of fishing effort. In the non-transferable scenario, the exchange of quotas is restricted and effort is reallocated within each fleet, while in the transferable case the exchange of quotas, and thus effort, is fully flexible. The profit calculated for these cases is used as estimates for the tax revenue that could be collected, and how the path for such taxes could develop over the years.

All nine management regimes listed above are tested subject to a number of assumptions regarding: (a) fishing mortality rates, (b) gear selectivity, (c) over-quota discards, (d) below minimum size discard, (e) compliance, (f) partial fleet adjustment, (g) entry-exit constraints, and (h) technical progress.

Gear selectivity (on species) is represented by the parameters of the production function that ensure that the technology of fleet segments is different. In the European Union, discard of undersized fish (below a certain minimum size) and over-quota catches are compulsory. In other countries (e.g. Norway, Iceland Canada and United States), discard is prohibited. It is assumed in Fishrent that discarded fish die. Thus discard affects biomass growth negatively. In the model, two kinds of discard are considered; discard of undersized fish and over-quota discard. The amount of undersized fish is assumed to be a fraction of the catches, and it is assumed that all undersized fish

1. The literature output driven models, where output is fixed exogenousy, are often termed »input-based«, and input driven models where input fixed exogenously are termed »output-based«.

are discarded. Over-quota catches can either be completely discarded or they can be landed as illegal landings. This is controlled in the model by a compliance coefficient that is fixed by the model-manager and this is an approximation to the rule that compliance is determined by the penalty of the discarded fish times the probability of being detected, Sutinen and Andersen (1985); Jensen and Vestergaard (2002a).

Four more important features must be mentioned as central for the model. One is the partial adjustment rate of fleet capacity. It is assumed that the fleet does not adjust, through investments, completely and instantly to changes in current profit. In a Cobb-Douglas investment function it is assumed that the share of the profit used for capital adjustment is equal to the exponent of the capital variable. As the model's production function includes only capital and fish stocks there is no substitution between capital components, Squires (1987), Dupont (1990) and (1991).

Secondly, the model uses time lags. The default setting is that investments are based on the average of the two previous year's profit ahead of the decision year, and the investment is implemented the year after the decision year.

Thirdly, in practice there are a number of institutional restrictions on investments and, in particular, entry and exit of vessels. The model includes an option that takes these constraints into account. It is possible to limit the entry and exit with reference to the historical development of the fleet segments. It is not allowed to increase the number of vessels or the engine power for the EU member state fleets. Empirical evidence shows that the fleet capacity measured in number of vessels, engine power or gross tonnage has decreased at rates between 1-5% per year over the last 15 years. Finally, the model takes days at sea restrictions into account partly in such a way that a maximum number of days per vessel cannot be exceeded, and partly in such a way that investment in vessels only takes place if the current number of days at sea is higher than an arbitrarily fixed rate of the maximum number of day at sea per vessel. This model feature is optional and allows the model user to investigate the importance of behaviour where the participation restriction known from the principal-agent theory is taken into account, Jensen and Vestergaard (2002b).

Fourthly, the growth in harvest is a function of the fish stock, the capital and the technical progress. The model's production function includes technical progress (total factor productivity) which reduces the effort reduction impact of the decreased capacity.

The model simulates both static and dynamic scenarios. First, the following static scenarios are tested: Maximum Sustainable Yield and Maximum Economic Yield. Secondly, the "golden rule of capital accumulation" , Clark and Munro (1975) is approximated by the dynamic maximization of the net present value over a number of

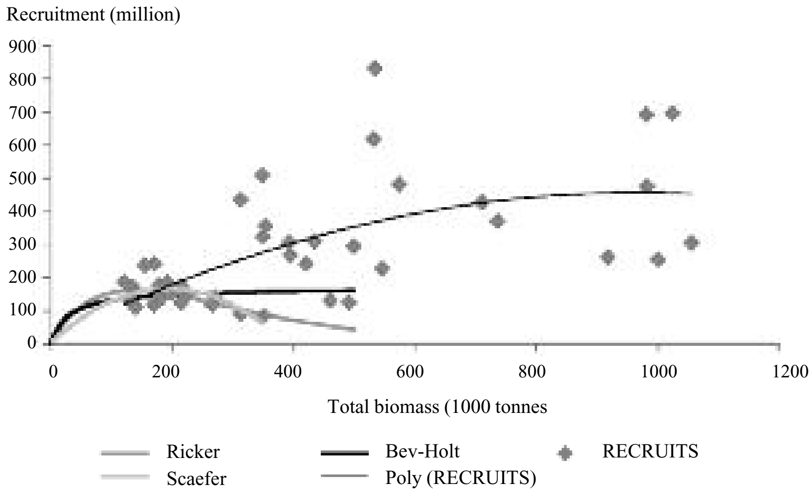

Figure 1. Recruitment at age 2 as a function of spawning stock biomass 1966-2008, and 1989-2008.

Note: 2 years lag.
Source: ICES (2008).

years subject to fish stock restrictions. It is 'approximated' as Clark's and Munro's solution is based on a continuous-time model, while our solution is based on a discrete-time model in a multi-species multi-fleet context. This solution is basically the same as the solutions obtained by taxes, ITQ or entry restrictions in a system with complete information, divisibility and no market power of the agents.

Thus we will test a number of dynamic scenarios based on management regimes 1, 2, 3, 4, and 5 presented above. Although open access (management regime no 1) has not been possible since 1977 for most developed countries, this scenario will serve as a benchmark. Interesting tested features are malleability of capital, Clark, Clarke and Munro (1979) and the risk of extinction, Clark, Munro and Sumaila (2010a and b), and Grafton, Kompas and Hilborn (2010).

3.3. Biological data

The development in the cod stock biomass of the Eastern Baltic Sea is shown in Figure 1. The catch in proportion to the total biomass is an estimate of the fishing mortality rate. The analysis is divided in two groups: (i) from 1989-2008, and (ii) from 1966-2008 in term of stock biomass. Investigations show, Diekmann and Möllmann et al. (2010), Lindegren et al. (2009), Lindegren et al. (2010), ICES (2010), that not only high stock biomasses but also the favourable environmental conditions in terms of salinity and oxygen contents in the Eastern Baltic Sea before 1989 formed basis for very high recruitments, which is outside the impact of the fishery. If this period is disregarded, an estimate of the relationship between total catchable stock biomass (1989-2008) and recruitment of age group 2 (1991-2010) has been carried out for three different but conventionally accepted recruitment functional forms: the Schaefer, the Ricker and the Beverton Holt, Thomson and Bell (1934), Ricker (1954), Schaefer (1954), and Beverton and Holt (1957). The recruitment as a function of the spawning stock biomass (app. age 3 and above) shows a very large variability, see Figure 1. The estimated trend line (2nd degree polynomial or Schaefer) shows for 1966-2008 a peak point for the total biomass at around one million tonnes equivalent to a spawning stock biomass of around 600 000 tonnes. For the period 1989-2008 the peak point for the total biomass is around 200 000 tonnes.

The recruitment is transformed into yield by use of a yield per recruit estimate at 0.4 kg. ICES estimates of yield per recruit vary as a function of fishing mortality rate (ICES 2010). As the fishing mortality rate decreases the yield per recruit increases. This relationship is disregarded here. The functional forms are shown in Figure 1.

The estimated functions do not show good statistical fit properties and may therefore be rejected completely from a statistical point of view. However, these functional forms are used in theoretical analyses and therefore accepted here. Estimated stock recruitment functions, where R is the number of recruits and x is catchable (total) biomass, are:

Schaefer	$R = -0.0000043 * x^2 + 1.6789 * x$
Ricker	$R = e^{1.34433} * x * e^{(-7.2*10^{-6}*x)}$
Beverton Holt	$R = 168097 * x/(31182 + x)$

The Schaefer function is implemented in Fishrent as this is the most frequently used in the analytical literature and because it includes a measure for the carrying fish stock capacity contrary to the Ricker and the Beverton-Holt functions. In the model, a target TAC for cod is based on a target fishing mortality rate at 0.3 (catches incl. discard in proportion to catchable biomass). The base year is 2005-07.

As discussed above, the discard function comprises two elements: (i) over-quota catches of fish above the minimum size may be discarded fully or partially if the fishermen do not comply with the regulation, and (ii) discard of fish below the minimum size. Discarded fish do not count in the gross revenue but reduces the stock size in future years. Fish prices are kept constant although the model includes a price elasticity option. It implies that consumer surplus is disregarded.

The cost function includes (i) crew share that is a function of the gross revenue, (ii) fuel cost that is a function of the number of days at sea, (iii) other variable cost as a function of gross revenue, (iv) semi-fixed cost as a function of vessel capital, and (v) capital cost as a function of vessels capital.

The entry/exit restriction (embodied in eq. 7) assures that investments in new vessels cannot take place at unacceptable high rates due to management restrictions. Empirically based, only a 10% increase in number of vessels and a decrease of 20% as a maximum is allowed per year and, further, entry will only take place if the number of days at sea per vessel is above a certain limit (70%) of the maximum possible number.

3.4. Economic data

All the countries surrounding the Baltic Sea fish for cod in that area and, except for Russia (Kaliningrad), all are members of the EU and subject to the fisheries policies of the EU. All countries use the two types of technology trawl and gill net, primarily, but the underlying cost and catch structures are different. Cod is found in the southern part of the Baltic Sea, and the dominant countries in the area east of the island Bornholm are Sweden, Poland, Denmark and Germany accounting for around 65% of the total landings. The landings of cod dropped from around 89 000 tonnes in 2000 to 48 000 tonnes in 2009.

Although cod is the target species a number of other species constitutes the catch composition of the fleets and hence the costs and earnings and the effort are not associated with cod alone. This problem can be avoided only by use of a general equilibrium model, Andersen et al. (2010) while delineation of stocks and effort causes a number of problems in a multi-species multi-fleet fishery. One method is to compute the cost share for cod (marginal cost approach) but that would make it impossible to use the effort as a control in a multi-species fishery. The method used in our case is to extract all the vessels with recorded cod landings above a certain level from the Baltic Sea and account for all landings, revenue and costs of the identified fleets. This allows for using the number of vessels as a control variable. But further data elaboration is required as explained below in relation to Table 1.

To initialise Fishrent for the base year (or period), data is required with respect to number of vessels, number of days at sea per vessel, production technology, fishing costs and fish prices. For simplicity and greater transparency only two different dominant types of fishing technology common for all countries are specified in this case study, namely trawl and gill net. The two types of technology possess different advantages and disadvantages as regard to the impact on the ecosystem. The two types also represent distributional aspects as the small gill netters fish from many different small fishing ports while trawlers are bigger and concentrated in larger ports.

Table 1. Number of vessels for which cod is important. Average 2005-2007.

	Days at sea Number	No. of vessels	Days at sea per vessel	Danish sample Landings (1000 tonnes)	Danish sample No. of vessels	Danish sample Total days at sea (1000)
Total 0-12 m, gill net	2784	178	64	3.6	642	9.590
Total 12-24 m, trawl	620	76	123	2.5	70	26.322
Grand total	3404	254	75			

Source: Anderson and Guillen 2009, and the Danish Directorate of Fisheries.

While the fleet statistics from the Fleet Register of the EU in terms of number of vessels, capacity and engine power is good the fishing effort statistics in terms of days at sea is still relatively poor. One measure of fishing effort is the number of vessels multiplied with the number of days at sea per vessel. Days at sea are recorded for fleet segments but often not allocated on fishing waters and species.

In spite of the data richness, the operational fishing effort applied for cod in the Baltic Sea is difficult to estimate as it is obtained based on general statistics for the countries fishing in the Baltic Sea. The average size of all vessels at around 30 GT in size and 100 kW in engine power is relatively small and taking into account that a large part of the Danish, German and Swedish vessels fish outside the Baltic Sea, the average size of Baltic Sea vessels is even smaller.

Based on statistics, collated by EU's Joint Research Centre (JRC) to the Annual Economic Report, Anderson and Guillen (2009), fleet segments for which cod is considered the target species have been selected and the results are shown in Table 3. Only vessels for Denmark, Germany, Poland and Sweden are important in this context. The number of vessels and the fishing effort used for cod in the Eastern Baltic Sea are overestimated as some of the vessels are fishing in other waters as well. On the other hand, the vessels listed in Table 1 account for around half of the total cod landings. The rest is landed by vessels belonging to other length groups.

The fishery is dominated by trawlers 12-24 m and gill netters 0-12 m. While most of the trawlers are active with around 120 days at sea on average, a large number of the gill netters are inactive but registered for fishing in the vessels register of the EU. The recorded number of days at sea per vessel for gill netters were on average over the period 2005-2007 32 days for Germany, 42 days for Denmark, 73 days for Sweden, and 95 days for Poland, Anderson and Guillen (2009).

Table 2. Start values of Fishrent for Baltic Sea cod fishery.

	Trawlers 12-24 m	Gill netters 0-12 m
Initial no. of vessels	1176	1427
Initial days at sea per vessel	140	120
Maximum days at sea per vessel	140	120
Cod price	2.39 €	2.39 €
Gross revenue all species base years	305 000 €	125 000 €
Value of other species compared to cod value	200%	121%
Fuel cost share of gross revenue	20%	5%
Crew cost share of gross revenue	50% (2.5 crew)	50% (1 crew)
Fixed cost share of vessel value	18%	25%
Capital cost share of vessel value	10%	10%
Discount rate (socio-economic)([1])	3.5%	3.5%
Discard of undersized cod	10%	10%
Catch-effort elasticity (α)	0.6	0.4
Catch-stock elasticity (β)	0.4	0.6
Technical progress per year (τ)	1%	1%
Interest rate (r) 1)	3.5%	3.5%
$\rho_{in} = \rho_{out}$ (1000 ¤) 234 32		
Partial adjustment factor (λ)	0.12	0.12

([1]) HM Treasury, 2003.

Costs and earnings information collated according to the Data Collection Framework of the EU by JRC is in general not particularly good yet, especially not for the gill netters 0-12 m. A complete and detailed data set is only available for Denmark. Therefore, Fishrent is initialized (calibrated) with starting values based on the Danish fleet segments trawler 12-24 m and gill netters 0-12 m. It is assumed that the Danish, Swedish and German cost structure is similar. Poland may face lower production costs but also lower catch per unit of effort.

The TAC for cod at 66 000 tonnes is allocated to the trawler and the gill net fleets, respectively, according to their landings shares for Danish vessels, which is 64% for trawlers and 36% for gill netters. Danish data for catch, vessels and days at sea, displayed in Table 1, are then used to scale the number of days at sea to catch the total TAC for trawlers and gill netters, respectively. The current number of average days at sea per vessel is used to estimate the initial number of vessels in each fleet segment. The initial number of days at sea for the trawler fleet is 164 640, which at an average number of days at sea at 120, entails 1176 vessels. For the gill netters the total number of days at sea is estimated at 171 200, which at an average number of days at sea at 40, entails 4280 vessels. However, it is known that a large number of the gill netters are inactive although entitled for fishing rights. This aspect is taken into account by assuming that the active gill netters fish 120 days per vessels per year implying 1427 vessels. The number of days at sea for each segment and the catchable biomass at 150 489 tonnes are then used to calculate the catchability coefficient of the production function.

Therefore, for trawlers 12-24 m 1176 vessels with 140 days at sea per vessel, and for gill netters 1427 vessels and 120 day at sea per vessels is used as the initial values in Fishrent. The model calculations show that this number is high compared to what is optimal, and it underlines the view that it is important to monitor the fleets in terms of number of active and inactive vessels and days at sea to get valid data.

Based on (incomplete) data for all countries it is found that the Danish and the Swedish costs per day at sea are higher than for Poland and Germany, but at the same time the catch rates are higher, which means that costs per tons of fish landed are more equal among the countries' segments. The cost estimates used in the model is shown in Table 2.

Change in catch caused by changes in effort and stock is determined by the catch-effort elasticity α and the catch-stock elasticity β. Empirical investigations show that for trawl the catch-effort elasticity is higher than the catch-stock elasticity and for gill net the opposite is the case; the sum of α and β is estimated at 0.9-1.6, Garza-Gill et al. (2003), Eide et al. (2003) and Kronbak (2005). Technical progress is included with 1% per year, Dornbush and Fisher (1994), and Eide et al. (2003).

3.5. Results

The model is used in a number of static scenarios and a number of dynamic scenarios. The difference is that the static scenarios are point estimates in time for which it is assumed that the fishery has fully adapted to an optimal solution as a consequence of the applied management measures. What is happening in between the optimal situation and the present situation is not taken into consideration. This adaptation path is, on the other hand, taken into consideration in the dynamic scenarios.

The static scenarios deal firstly with Maximum Sustainable Yield (MSY) which is the maximum production surplus a stock can yield. In this case, the objective is to maximize the profit and at the same time secure that catch is equal to the yield at MSY. Basically, MSY is not an economic measure but a biological measure linked to an effort irrespective of the costs. In a multi-fleet fishery it yields multiple combinations of vessels in the different fleet segments. Secondly, Maximum Economic Yield (MEY) is considered, and this scenario computes the combination of fish stock biomass and fishing fleet effort that maximizes the total profit for all fleets. In Figure 2, the revenue from the target species: cod, the non-target species, and the cost of catching the yield of the stocks are shown as a function of the size of the catchable biomass of cod.

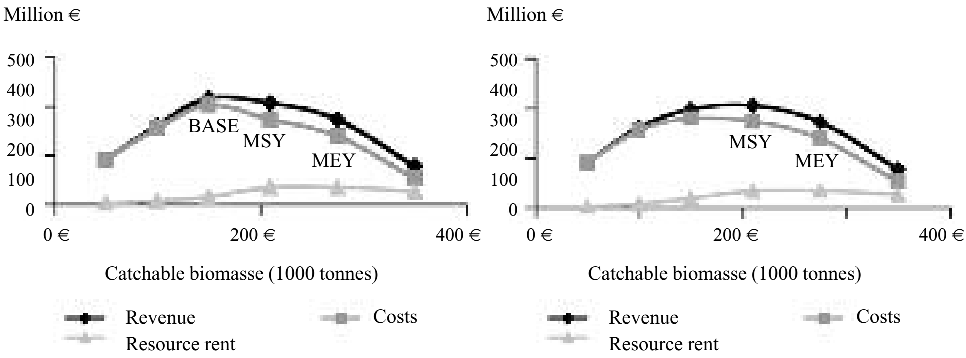

Figure 2. Maximum sustainable and maximum economic yield from the Eastern Baltic Sea cod stock.

Note: The revenue at the base position is above the sustainable level.

In Figure 2, the MSY and MEY cases are compared to the current situation that shows the highest catch. The reason why the current situation yields the highest catch is that this particular case is not sustainable. The catches are higher (66 000 tonnes, €430 million) than the sustainable yield of the stock (62 000 tonnes, €404 million) and the stock will decrease in the long run.

In order to broaden the perspective, two other estimates for stock sizes at 100 000 tonnes and 50 000 tonnes are included in Figure 2. At these two positions the fishery is still viable and it is sustainable but obviously the fishery can perform better at the MSY and MEY positions. It is noted that costs as a function of the stock increases as the stock size goes down until a certain level beyond which the costs go down as well.

The resource rent is higher at MEY compared to MSY, but the catches and, in particular, the costs are lower. The reason for this is that the high stock abundance increases the catch per unit effort and hence lowers the costs. Absolute numbers are presented in Table 3. As cod constitutes only a share of the total landings value, the resource rent is divided into cod and other species in proportion to the landing values. A substantial increase in resource rent is observed while moving from the current situation (2005-2007) to MSY and further to MEY.

The catches of other species are assumed to develop in the same way as cod. This assumption implies that other species are assumed to be overexploited in the same way as cod. Therefore, two other assumptions have been investigated: catches of other species are constant and catches of other species are dependent on the number of days at sea. The first assumption about constant implies that a reduction in effort increases the catch per unit effort of these species indefinitely and it will pay not to fish. The consequence of the second assumption is that the fishery may turn out unprofitable at

Table 3. Solutions for different management targets.

	Base year (avg. 2005-2007)	Maximum sustainable yield (MSY)	Maximum economic yield (MEY)
Gross revenue all species (million €)	430	410	343
Gross revenue cod (million €)	158	156	123
Resource rent total (million €)	29	63	80
Resource rent cod (million €)	11	25	31
Yield from the cod stock (1000 t)	62	65	55
Catchable biomass of cod (1000 t)	150	210	275
Catch of cod (1000 t)	66	65	55
12-24 m trawl (no. of vessels)	1176	667	350
12-24 m trawl (1000 days at sea)	165	93	49
0-12 m gill net (no. of vessels)	1427	1627	904
0-12 m gill net (1000 days at sea)	171	195	109

MEY for cod as the required strong reduction in effort leads to significant lower landing value of other fish that, because of the catch composition, is larger than the increase in cod landings value. Therefore, the higher resource rent that is calculated for all species of the two fleets and the share allocated to cod according to the value share of cod in proportion to the total value are much higher in the MEY case compared to the MSY case.

None of the static solutions presented above are stable. If the resource rent is not extracted by the government, at least part of the rent is invested in fleet capacity leading to increased effort and new equilibria. This problem is addressed in the dynamic analyses.

The dynamic model computes results for a period of 25 years and returns the net present value (NPV) for each scenario. Results for each year are also computed and results for selected indicators are shown in Table 4 and diagrammes 4 and 5.

The open access case (scenario 1) is not restricted at all. Entry and exit is determined by the average profit of the two years before the decision year. As the profit is positive in the base year, but the fishery is unsustainable, the increase in effort leads to increased unsustainability, and as the fleets become unprofitable the decrease in effort is not fast and strong enough to secure sufficient growth in the stock. Capital is fully malleable and if capital is non-malleable the fishery will collapse even faster. It is only by accident that the open access fishery will arrive at an equilibrium solution.

The introduction of a TAC (scenario 2) assures that the catches do not exceed the yield of the stock and hence assures that the stock does not collapse. The profit is restricted compared to open access in the beginning of the period but the effort is higher because no entry and exit restrictions are imposed, leading to dissipation of the resource rent.

Table 4. Results in terms of net present value over 25 years.

Scenario Schaefer recruitment 1991-2010	Net present value (billion €)	Discounted value in year 25 (billion €)
1. Open access	-0.2	Collapses after 10y
2. Individual non-transferable quotas	0.1	0.000
3. Individual non-transferable quotas with entry/exit limitations	0.9	0.035
4. Effort limitation	1.0	0.033
5. ITQ	1.2	0.042

If effort is restricted (scenario 3) in terms of vessel entry and exit on top of the TAC, the picture changes significantly with respect to NPV which increases substantially. Irrespective of the profit the number of vessels is allowed to increase 10% or less and decrease 20% or less compared to the previous year. These limits are arbitrary but higher than the recorded annually entry and exit over the last decade.

If the TAC restriction is removed and the effort restriction is maintained (scenario 4), the NPV is slightly higher than for scenario 3. The reason for this is that over-quota catches are not discarded but contributes to the profit, which on the other hand is not transformed into higher investments in the fleets.

Finally, an ITQ system is introduced (scenario 4). The solution is found by use of dynamic non-linear programming in which the NPV is maximized. This solution can be compared to the golden rule of capital accumulation, but in a discrete-time setting. Scenario 5 compares to scenario 3 as the same restrictions on entry and exit of vessels are used. Further, in the final year the biomass must not be lower than the MEY biomass calculated in the static case. This is to avoid that the model will propose to fish the stock down in the end year.

The development of the fishery over time is shown in Figure 3 and 4 for the open access case and for the ITQ case, which are the two extremes of the analysis. In Figure 3, it is noticed that the profit in the beginning of the simulation period leads to investments and entry of vessels, especially gill net, which subsequently leads to extinction of the cod stock as the fleets do not adjust quickly enough downwards.

One could argue that the calculation shows large deficit in the fleet profits around year seven and that the fishery would then stop and allow the stock to recover. The large deficits are partly due to the delayed reaction built in the model. On the other hand and based on rational expectations, when profit decreases the fishermen would tend to believe that other fishermen would leave and, that the situation could only improve. Therefore, they would continue even with negative profit. Only an instant stop would

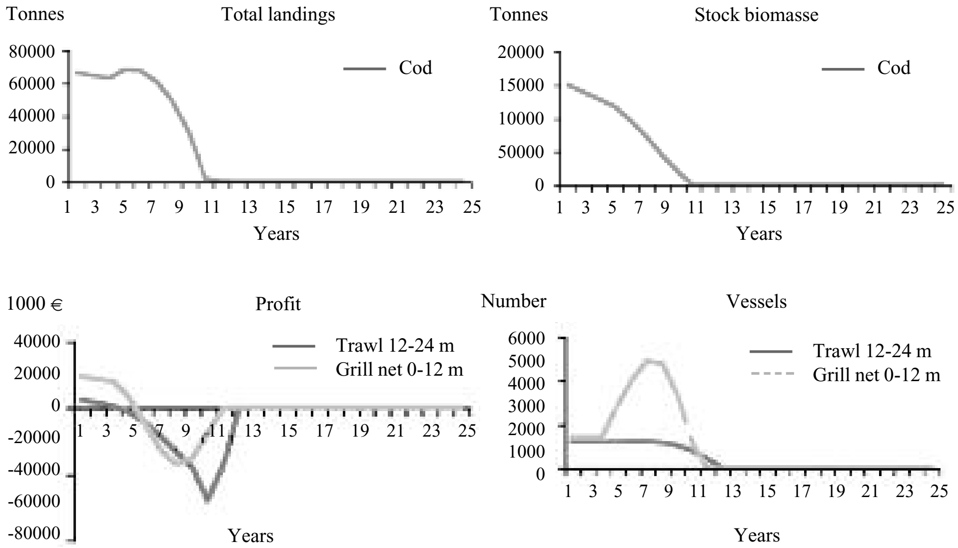

Figure 3. Adjustment path in an open access fishery.

rescue the stock and it will take almost ten years for the stock to recover to a size that would allow the fishery to be resumed on a small scale.

In the ITQ-management system (Figure 4) with completely malleable capital a reduction in number of vessels and hence effort in terms of total sea days occurs continuously during the first ~6 years after the system is implemented, which is hardly realistic in practice because of transaction boundaries and lack of information. However, the reduction in vessels is constrained in the model by the restriction that the fleet can be reduced by 20% or less per year. If the fleet is allowed to adjust instantly, the NPV will increase at around 7% compared to the figure for ITQ, in Table 4, at €1.2 billion.

Note also that the stock biomass is constrained in the model in such a way that it is not allowed to fall below 250 000 tonnes in the year 25. Without this restriction the NPV would have been higher as the model would then propose to fish out the stock in the end years.

The ITQ result simulates the result from the golden rule of capital accumulation, Clark and Munro (1975), but the result is overestimated because in practice there are lack of information, lack of divisibility, transactions costs, time lacks and non-malleable capital.

In line with the theory, further simulations with the model show that as long as we assume identical functions, assumption and restrictions, the optimal effort manage-

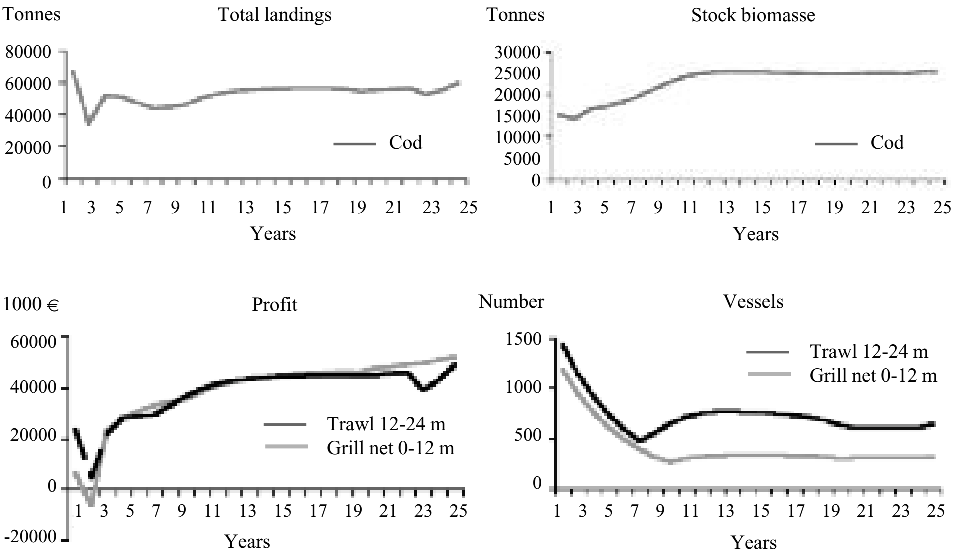

Figure 4. Adjustment path under ITQ management.

ment and the ITQ management will show the same results. However, in practice transaction costs, substitution between inputs and species, etc. in these two cases are different. And as soon as either of them is changed, the model will produce a different result, which would show that in some cases effort limitation is to prefer, in other cases ITQ is to prefer.

4. Discussion and the way forward

The scope of this paper is highlights of the development of the fisheries economics theory and management since 1911 supplemented by a complex discrete-time bioeconomic model. In fisheries, theory and management are closely linked although they have developed as two separate areas. The development of the theory is often dependent on the management issues that were subject to debate through time. Basically, management, aiming at achieving a goal, does not need to be based on theory. The theory, verbally or mathematically, is a development of thoughts, which consistently describes the research area leading to a comprehensive insight into the exploitation of renewable resources, no matter whether the fish resources needs to be managed or not and it could be argued that for example the implementation of property rights in fisheries is not based on theory but simply on the wish to exclude certain groups from access to the fish resources. The law of the sea conferences of the United Nations (UNCLOS) leading to the introduction of exclusive economic zones is an example of this. From this point of view it could be argued that the development of the fisheries economics theory has played little or no role in the management of the fish resources as another example is that often the aim is to ascertain that fish stocks do not fall below a certain level and in that respect the biological science has played a more important role than fisheries economics.

On the other hand, we believe that proper management cannot be carried out independent of economic theory as fishery, basically, is an economic activity. To combine theory and management this paper also presents a comprehensive empirical/numerical bioeconomic management assessment model based on biological as well as economic theory. The model illustrates that it is possible to apply the, in many respects, relatively simple economic theory in a complex management setting. But when the model, for illustrative purposes, is applied to the case of cod fishery in the central Baltic Sea there is no significant difference in the various measures' capability of generating resource rent. The significant step forward is rather the introduction of catch or effort restrictions into an open access fishery.

The case shows that the results do not contradict the theory. But the differences between the resource rent in terms of net present value of various management measures are not very big in the present case study, and it is therefore possible, by designing the management systems properly, to achieve almost the same NPV by use of effort restrictions in terms of days at sea or entry/exit of fishing vessels and output restriction in terms of ITQ. The chosen management measures often end up as equally effective leading to 'second best' situations, in the sense that the choice not only depends on the management measure, but also on the actual characteristics of the various fisheries. In Fishrent we have included elements from the theory which we have not given much attention in our description of the development of the theory, namely discount rates, discards, high-grading, compliance, imperfect information and principal agent theory. There is made space in the model for application and analyses of these topics, which have been given some attention in the fisheries economics theory during the last twenty years. Although the theory clearly shows the direction in which the solution moves if these elements are introduced into the models, nothing or little is said about the magnitude of the impacts. This can be shown using numerical models, such as the one presented in this paper, which could also be used as a laboratory which generates data for further analyses that could be used to compare causes and effects of various measures more extensively.

Finally, there is no doubt that the way forward in fisheries economics theory is to expand the theory and model developments to include ecosystem services defined as the underlying production factors to the fish stocks, MEA 2005 and Holland et al. (2010). In fisheries economics theory, the fish stocks already play a role in the production function and the stock-recruitment function and disregarding that, remuneration of the fish stocks leads to market failures. An ecosystem approach would, however, complicate the theoretical models and make them difficult or even impossible to solve analytically. In this sense, investigation of the economics of the marine environment could benefit from the progress within the numerical models of fisheries economics theory. Warming was hardly aware that the cornerstones he put down in 1911 formed the basis for the cathedral we face today.

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Is there an upward long term trend in Danish real house prices?

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SUMMARY: *In Denmark, like in other countries, there is no agreement on the fundamental long term path of real house prices and the sustainability of the present price level. The paper presents Danish house price indices and discusses the question of quality correction of the indices. Subsequently, factors behind the long term trend in real house prices and its sustainability are discussed. The paper finds an annual real growth trend around 1.5 per cent for Danish single family house prices likely for the coming ten years.*

1. Introduction

It is the everyday business of brokers on financial markets to give advice on the position of stock prices relative to a perceived or estimated fundamental price. The advice is typically termed buy, hold or sell, indicating that actual share prices are below, equal to, or above what is believed to be their fundamental price. However, financial rating and management companies do not always agree on the advice, and their estimated fundamental prices for the shares differ. A similar disagreement can be found around the natural rate of unemployment, leading to a disagreement about the correct fiscal and monetary policies. Economists also disagree on whether house prices are above or below their fundamental level, and on the prospects for future price developments. In the first half of the year 2010, the disagreement concerned whether the downturn since the recent price peak had come to an end or whether it was going to continue in the years to come. Statistics show that Danish house prices have bottomed out, but are we really at the bottom or is a double dip to be expected?

The Danish economist Jacob Brøchner Madsen estimated as early as August 2003 that house prices were unrealistically high and were to fall over the next three to five years. At that time, house prices had doubled since the bottom year 1993 and continued to increase until a peak was finally reached in 2007. A public debate between the Danish Economic Councils and the two economists Jens Lunde and Henrik Chri-

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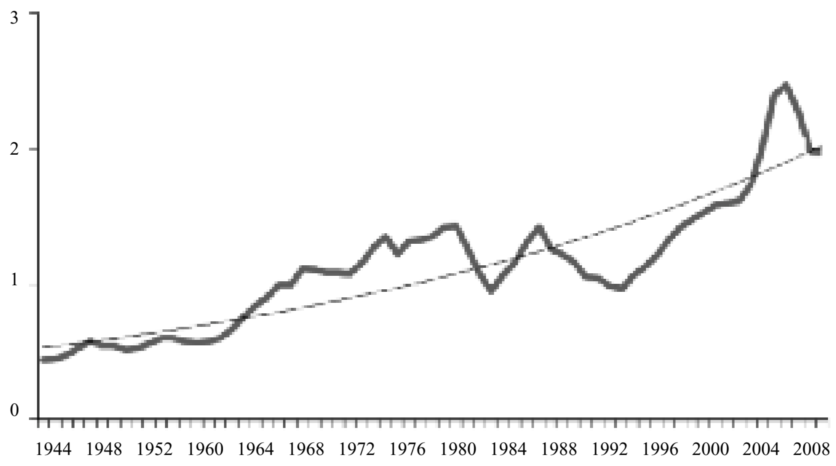

Figure 1. Real single family house prices in Denmark 1944-2010, 1965 = 1.

Note: The real house price index shown is based on mean trading prices for single family houses in major provincial cities until 1965 after which an index for single family house cash prices is used. From 1992, the single family house price index described in section 2 takes over. The deflator is the consumer price index. An exponential trend line has been added.
Source: Statistics Denmark.

stoffersen over the long term sustainable house price development evolved in 2009. The Economic Councils (2009) maintained that real house prices, i.e. house prices deflated by the consumer price index, had an upward long term trend, whereas the two economists took the position that real house prices could hardly rise in the long run. Jens Lunde (2009) argued that over-profitability of housing investments would be dampened by increasing supply, and that a real house price increase must be less than the real growth rate of GDP to make a difference for the gradual improvement in the quality of houses. Henrik Christoffersen (2009) criticised the Economic Councils for being unrealistic about the price effect of limitations on land available for construction. Jacob Brøchner Madsen (2010) stated in the summer of 2010 that house prices were far above their fundamental level and could be expected to drop by a further 20 per cent over the coming three years. A number of papers and reports on Danish house prices has been published since then. Skaarup and Bødker (2010) state that house prices by mid-2010 are close to their equilibrium value. The Economic Councils (2010) have house prices at 10 to 20 per cent above their long term trend value in their main scenario, and prophesise a correction of this difference over the coming ten years. Laursen et al. (2010) and Jørgensen (2010) argue that real house prices can at best show a very modest increase in the long term (0.2 per cent per year is mentioned on

p. 36). Dam et al. (2011) find no overvaluation of house prices by the end of 2010 and see largely unchanged real house prices over the next five years as their main scenario.

In the US, Robert Shiller (2009a,b) has been a proponent of the view that house prices cannot deviate much from the inflation rate in the long run. The growth of real house prices and their volatility has been a debated theme in the UK for many years; see Meen (2008). Scrolling down websites, one can find radical positions like the one taken by Frisby (2010) who argues in MoneyWeek that house prices are constant in the long term when measured in ounces of gold.

This paper tries to identify the underlying factors behind the long term trend of real house prices in Denmark as measured by Statistics Denmark's house price index deflated by the consumer price index. A discussion of this index in comparison with other types of price indices for the housing market will follow below.

Econometric models used to detect the fundamental house price in a medium term setting typically incorporate demand side elements like real incomes, real interest rates, taxation, capital market regulation and demographic developments. Girouard et al. (2006) give an overview of empirical studies of this kind, and a number of the abovementioned Danish studies present econometric models of this type. With no long term trend in real interest rates, taxation and capital market regulation, demand depends on the development of real income and demography, and price increases stemming from the supply side will pass through as long as they are sustained by demand.

The evidence presented in the following sections supports the view that there is a long term upward trend in real house prices defined by Statistics Denmark's house price index for single family houses deflated by the consumer price index. One of the factors underpinning this is an increasing trend in real construction costs and land prices, where rising land prices in cities lift the prices of existing houses above the production costs of new houses at the periphery of cities. Continued migration from the countryside to cities tends to lift the house price index.

The paper is structured as follows: Section two describes available Danish house price indices, and section three goes deeper into conceptual and methodological considerations. Section four looks at quality changes of the housing stock and the ability of the indices to capture these changes. After this, section five explains the factors behind an upward long term trend in real house prices. Section six shows the time variance of the price trend and discusses the question of sustainability. Finally, section seven contains the conclusions.

2. Danish house price indices

This section gives a brief description of the most frequently used Danish house price indices. For a deeper insight into different house price indices, see Bourassa et al.

(2006), Diewert (2007), de Vries et al. (2009), Shi et al. (2009), Dorsey et al. (2010) and Laursen et al. (2010).

2.1 Statistics Denmark

Statistics Denmark publishes a quarterly index of the development of real estate prices. The index is based on cash values of all "normal" real estate sales during a quarter. The concept "normal" excludes trading where the seller and buyer are from the same family and where a gift element is involved in the trade. Other excluded "non-normal" transferences are foreclosure auctions.

The sample of traded houses (the words "house" and "unit" are used in this section to represent both land and structure) will normally change from one quarter to the next with the consequence that both the type and the location of the houses sold in the two consecutive quarters will change. To correct for this, the price index is of the value weighted Sales Price Appraisal Ratio (SPAR) type, which compares price developments relative to the most recent public real estate appraisal of each house. The index formula for quarter t is calculated as

$$I_t = \frac{\dfrac{\sum_{n=1}^{N} p_t^n}{\sum_{n=1}^{N} e_b^n}}{\dfrac{\sum_{m=1}^{M} p_{t\text{-}1}^m}{\sum_{m=1}^{M} e_b^m}} I_{t\text{-}1}.$$

Here, a traded unit out of a total number of N traded units in quarter t has obtained the price p_t^n. The most recent public real estate appraisal year is b, where the unit obtained the appraised price e_b^n. The relation between the selling price and the appraisal value is the SPAR.[1] In the previous quarter t-1, M units were sold and the SPAR for this quarter is calculated in the same way. When the relation between the two SPARs is above one, unchanged or below one, the SPAR price index I increases, remains unchanged or falls from quarter t-1 to quarter t.

The calculation secures that if, in quarter t, very valuable houses are sold compared to the ones sold in quarter t-1, this is neutralised by the division of the selling prices in both quarters with the public real estate appraised values for the sold units. However, the index may be influenced by shifts in geographical patterns of transferences. If, e.g., trade in one quarter predominantly takes place in a region with very modest price increases and in the next quarter trade predominantly occurs in a region with high price increases, the index will show price acceleration between the two quarters when there

1. In Danish: afstandsprocenten.

is no price acceleration in either of the two regions. Statistics Denmark does not find that the development of the index is being twisted by this effect.

When a new real estate appraisal takes over, the index is chained by using the new appraised values for the calculated changes of the index. Indices for 22 different kinds of real estates, including two for non-agricultural land lots, are published, but no overall index is calculated. The indices are published quarterly three to four months after the end of a quarter. The present paper will focus on the index for prices of single family houses, which has been made using this technique since 1963.

Statistics Denmark also publishes a sales price index for single family houses calculated as the arithmetic mean for the units sold during a quarter:

$$P_t = \frac{\sum_{n=1}^{N} p_t^n}{N} .$$

Here, no correction for changing distribution of house size and quality is made. The index is published for regions and for the whole country without correction for changes in the regional composition of sales. The ratio between two years for the mean price index is

$$\frac{P_t}{P_{t\text{-}1}} = \frac{\sum_{n=1}^{N} p_t^n}{\sum_{m=1}^{M} p_{t\text{-}1}^m} \frac{M}{N} .$$

And the ratio between two years for the SPAR price index is

$$\frac{I_t}{I_{t\text{-}1}} = \frac{\sum_{n=1}^{N} p_t^n}{\sum_{m=1}^{M} p_{t\text{-}1}^m} \frac{\sum_{m=1}^{M} e_b^m}{\sum_{n=1}^{N} e_b^n} .$$

The two indices will show the same change if identical houses are sold in two quarters. But if this is not the case, we have

$$\frac{I_t}{I_{t\text{-}1}} \lesseqgtr \frac{P_t}{P_{t\text{-}1}} \Leftrightarrow \frac{\sum_{m=1}^{M} e_b^m}{\sum_{n=1}^{N} e_b^n} \lesseqgtr \frac{M}{N} \Leftrightarrow \bar{e}_b^m \lesseqgtr \bar{e}_b^n ,$$

where $\bar{e}_b^n = \sum_{n=1}^{N} e_b^n / N$ is the mean of appraisals of houses sold in quarter t.

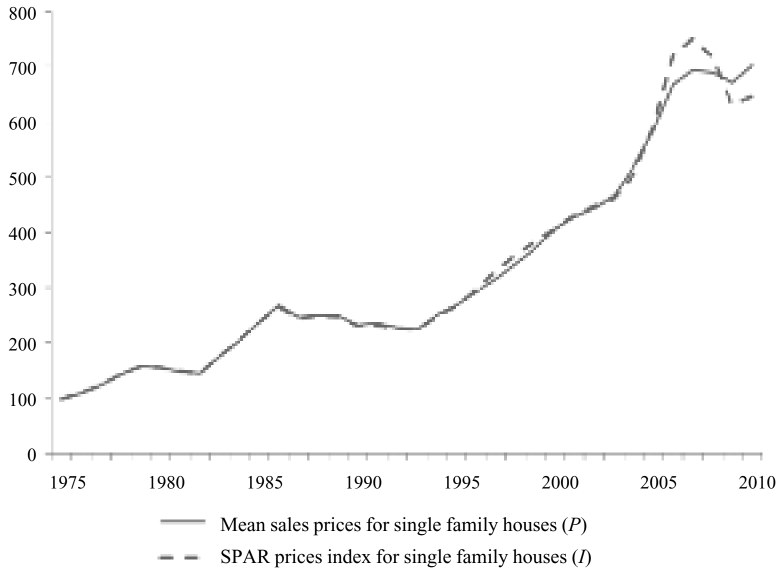

Figure 2. Price index and mean price of single family houses sold. 1975 = 100.

Figure 2 compares the development of the SPAR house price index with the mean index for the sales prices of single family houses. The two indices follow each other rather closely although a gradual improvement of the quality of traded houses over time should imply that

$$\bar{e}_b^n => \bar{e}_b^m \Rightarrow \frac{P_t}{P_{t\text{-}1}} > \frac{I_t}{I_{t\text{-}1}} \ .$$

However, the SPAR price index *I* shows a steeper increase than the mean house price index *P* for the recent bubble upturn with the opposite being the case for the downturn. The explanation must be that less valuable houses are sold more frequently in a booming house market and are pushed out of the market during the subsequent price fall. And this effect dominates a tendency for luxury goods (luxury houses) to be more in demand and sold pro cyclical. The pattern is parallel to the labour market where more marginalised workers get employment in a booming economy and are pushed into unemployment during recessions.

2.2 Danish tax authorities

Danish tax authorities publish public appraisals and sales prices for traded real estate

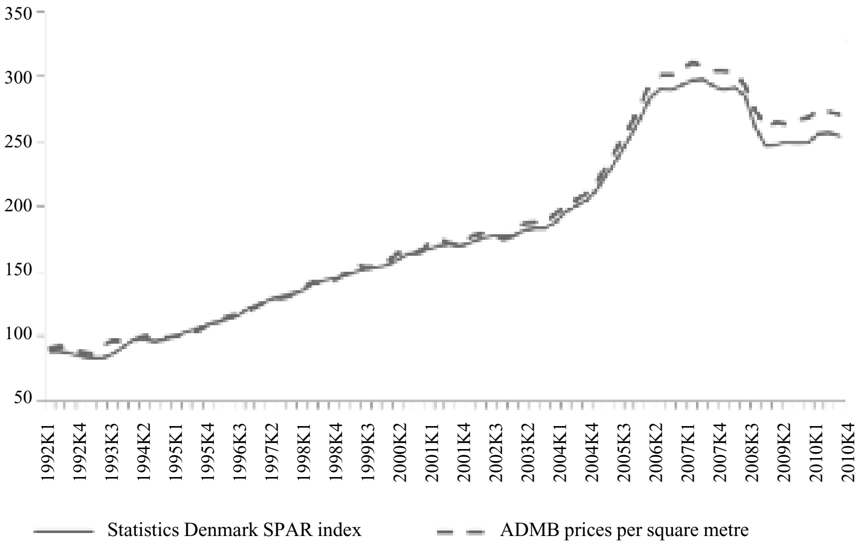

Figure 3. Price indices for single family houses. Quarterly data.

Note: First quarter 1995 = 100.
Source: Statistics Denmark and ADMB.

together with sales prices per square metre and equal weighted SPAR house price indices.

2.3 The Association of Danish Mortgage Banks

The Association of Danish Mortgage Banks (ADMB) calculates and publishes house prices per square metre on a quarterly basis.[2] A weighted number of housing square metres is used for the calculation, where e.g. 100 per cent of ordinary living areas are included along with 90 per cent of roof areas and 50 per cent of insulated sunrooms. The index is calculated for single family houses, condominiums and summer cottages respectively. An index is calculated for each municipality, and also at regional and country levels with the average price per square metre in each municipality being weighted in proportion to the municipality's share of houses.

New data are released approximately two and a half months after the end of a quarter. Figure 3 shows a comparison between the ADMB index for prices per square metre and Statistics Denmark's SPAR index for single family houses.

3. Conceptual and methodological considerations

The ongoing discussion about the long term trend for real house prices implicitly

2. The new Boligmarkedsstatistikken is described.

assumes that it is necessary to "clean" mean house price developments for changes in house quality. Crude house prices are seen as representing the house value, which is the product of the quantity of housing[3] multiplied by the price of a housing unit. Newly built houses typically carry a higher price than older houses because they are bigger and better equipped and so contain more housing units. Thus, the growth in the amount of quality must be subtracted from the increase in the value in order to get a correct index for the price of housing. However simple this may sound, there is no universally accepted method to best separate the development in value into a volume and a price development.

3.1 The purpose of a house price index

The need for quality correction depends on the purpose of the price index. The ADMB does not state an explicit purpose of their price indices, but Statistics Denmark states that their indices aim to illustrate the development of the trading volume and the prices of real estate. The indices shed light on the business cycle and are used by realtors and others who follow the development of sales and prices of real estate at a regional level.[4] Besides this, they enter into the public debate as the best evidence on house price developments in the country and are used by the media.

If price indices are produced with the aim of informing realtors and their customers about house prices, it is not evident that a correction for quality change is needed. Realtors may be most interested in actual sales prices for houses of their present standard in the various regions of the country. Economists, on the other hand, typically prefer to see a house as an input to the production of housing, and in that sense more housing units are produced if the house grows in terms of square metres and rooms, in equipment and insulation etc. A crude index for mean sales prices is perceived as a volume index that can be divided into a quantity index and a (quality corrected) price index. Location can also be very important for the price of a house besides its physical appearance. A nice view as well as a short distance to a metro station, a commercial centre and to cultural amenities will all influence the price and may be said to add to the number of housing units produced by a house. A hedonic price equation typically incorporates all these quality elements that are embedded in the house and its location, the only limitation being lack of data. It is important to include the location of traded houses in the data set because in one quarter they are a (random) pick among all houses, and in the next quarter they are a different pick with another spatial distribution. A specific location, which over time adds the same to the production of housing, e.g. because the

3. There is no established Danish translation of the word housing, but boligservice may be the best translation.

4. Stated on Statistics Denmark's website.

distance to the city centre is constant, may carry a gradually increasing price when the city grows. Such price increases should have a full impact on a quality corrected price index.

3.2 The lacking quality correction of the repeat sales and the SPAR indices

A number of papers on house price indices have appeared recently, see Gelfand et al. (2004), Bourassa et al. (2006), de Vries et al. (2009), Shi et al. (2009), Widlak and Tomczyk (2010) and Dorsey et al. (2010). The purpose has been to compare various methods for calculation of price indices embedded in the three main methods, i.e. the repeat sales, the SPAR and the hedonic price estimation method. All three methods aim to produce a quality corrected price index, and Bourassa et al. (2006) classify all as producing constant quality indices.[5] However, while the hedonic method may potentially correct for quality improvements of all houses in the stock, the repeat sales method does not correct for much of the quality improvements of the existing housing. It excludes sales of newly built houses because of the lack of an earlier sale, and implicitly assumes that the quality of existing houses is constant between two sales. In addition it is often refined by excluding observations where a major quality change can be detected. Standard and Poor (2009) report an elimination of 0 to 15 per cent of the observations from the calculations of the Case Shiller index as a result of substantial physical changes to the properties. The SPAR method counts the appraisal as the "first sale" and thus includes newly built and appraised houses. This gives a richer data set than for the repeat sales method, and it corrects for the quality improvements that follow from the higher quality of newly built houses because the appraisals reflect the (higher) market value. The SPAR method also corrects for quality improvements of the existing housing stock provided that appraisals simultaneously follow the value of each house. Bourassa et al. (2006), who compare the New Zealand SPAR indices with other index types, write that "the SPAR method is less subject *[than the repeat sales method]* to bias due to changes in the properties' characteristics provided that appraisals are carried out relatively frequently and adjusted when improvements are made". Denmark has a system where hedonic estimated coefficients to physical characteristics of the estate are used to guide the appraisers, who aim to follow the market values. While quality changes that involve the consent of public authorities are known to the appraisers, most quality changes made inside single family houses are not known and this gives incomplete information for the appraisers. Faulty appraisals may result in wrong short term development of the SPAR index, but such errors will disappear with subsequent more correct appraisals. However, with new appraisals every second year,

5. In Bourassa et al. (2006), table 2, the »all repeats« method is the only one not classified as a constant quality method.

there will be no correction of the Danish SPAR index for single family houses for quality changes made over the last eight quarters before a sale. This lack of correction will unfortunately be accumulated over time.

4. The impact of quality change on the house price index

The above deliberations on the ability of the various methods to produce the best quality corrected house price index become rather academic if the impact from quality change is negligible. What is the annual growth of house quality? Does the existing housing stock depreciate or is it continuously upgraded towards new standards? How much quality improvement of the housing stock comes from the higher quality of newly built houses compared to the modernization of older houses? This section tries to provide answers to these questions for Danish single family houses.

As a starting point, the quality improvements of the stock of houses as a result of newly built houses versus the modernisation of older houses can be put into an equation. Let the number of houses in the stock be S, each containing Q_s quality (or housing) units, and let the annual increase of houses be of the number N, each containing Q_n quality units. Furthermore, let the depreciation rate for the quality of the existing stock be δ, which leads to an annual loss of $\delta S Q_s$ quality units. With this, the annual increase in the number of quality units is $NQ_n - \delta S Q_s$ and the percentage growth rate for quality units in the stock will be

$$\frac{dQ_s}{SQ_s} = \frac{NQ_n - \delta SQ_s}{SQ_s} = \frac{N}{S}\frac{Q_n}{Q_s}\ \delta.$$

As an example, put the following numbers[6] into the right-hand side of the equation:

$$\frac{dQ_s}{SQ_s} = 1.5 \times 1.4 - 0.5 = 1.6.$$

The number of houses grows by 1.5 per cent each year in this example and new houses contain 40 per cent more quality than the average for existing houses. Finally, the quality of existing houses depreciates by 0.5 per cent each year. This leads to an annual increase of 1.6 per cent for the average quality of the stock of houses. This is also the average quality of traded houses under the assumption that they are picked evenly from the stock. The example shows that the forty per cent higher quality level

6. The numbers are borrowed from DiPasquale and Wheaton (1996, p. 238).

of new houses raises the average quality level by 0.6 per cent (1.5 × 0.4) each year. But depreciation of the stock pulls 0.5 per cent out of the quality, leaving only 0.1 per cent annual improvement. Hence, quality correction will in this example only pull 0.1 percentage points out of the annual growth of a mean house price index.

The numbers in the equation are important for the discussion of quality correction of house price indices and they of course vary between countries. In Denmark, the ability to change one's home in accordance with one's own preferences is a main motive for ownership, see Andersen (2010), and much maintenance, repair work and modernisation of existing houses is carried out by owners of single family houses. An important element of modernisation is the improvement of sanitary facilities. The installation of central heating, water closets and baths/showers in older houses leads to an upgrading of the quality. However, when all houses have this equipment, the annual growth of quality units will come from newly built houses alone. Nevertheless, approximately half of all installations of these facilities were carried out in existing (detached single family) houses during the early 1990s. Since then the share has fallen to zero.[7]

Another indicator of house quality is the number of rooms.[8] The average age of Danish single family houses was 50 years in 2010, and the annual percentage growth of the number of rooms from 1960 to 2010 was 1.95 with a growth rate of 1.63 for the number of houses. The number of rooms per house in the stock is today 4.40 while the number is 4.59 in newly built houses.[9] This gives a rate for Q_n/Q_s equal to 1.04. Using this, the growth of the average stock quality can be calculated as

$$\frac{dQ_s}{SQ_s} = 1.63 \times 1.04 - 0.25 = 1.95.$$

It follows that the annual quality improvement of the stock measured by the number of rooms is 1.95 – 1.63 = 0.32 per cent out of which 78 per cent comes from the extensions to existing houses.

Denmark has a unique central register for buildings, which contains information on all single family houses in Denmark. Both municipal authorities and owners of real estate must report changes, but adding or removing partitions in houses only requires a building permit from the municipalities if it involves essential parts of the construc_

7. Calculations based on data from Statistics Denmark. In more recent years, demolition of houses with central heating, water closets and baths/showers pulls the quality addition from the existing housing stock down below zero in some years.
8. Rooms are living rooms, exclusive of kitchens, bathrooms, corridors, rooms for storage and the like. The numbers and calculations here are for occupied single family houses.
9. The average for houses built in 2008 and 2009.

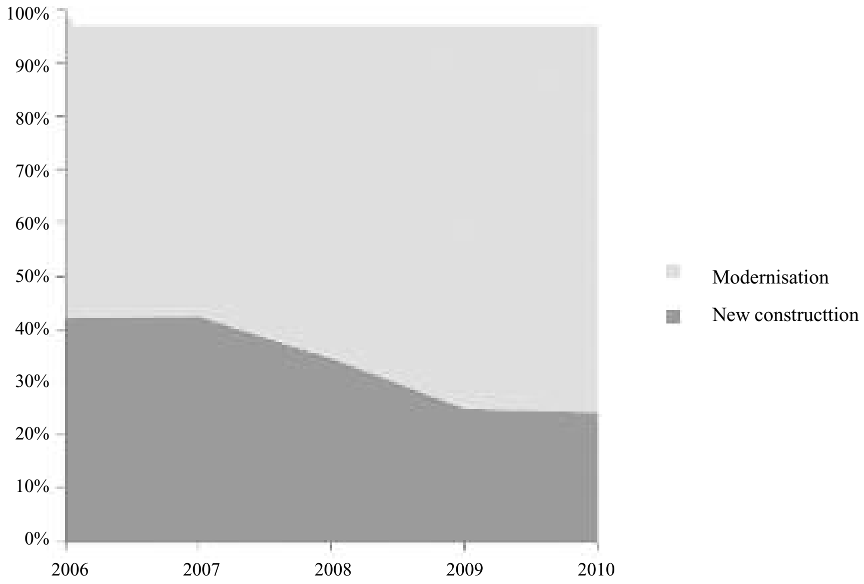

Figure 4. Revenue shares of kitchen and bathroom furniture sold.

Note: Modernisation covers sales for existing dwellings.
Source: Confidential information from a major supplier to the Danish market.

tion, and this leads to bad reporting. It is not known how the lacking reporting of changes in the number of rooms influences the data for the existing stock of houses, but an investigation in 2007, see Erhvervs- og Byggestyrelsen (2007), showed an average underreporting of the size of buildings measured in square metres close to 5 per cent. If this source of error is disregarded, the data shows an annual improvement of the average house size of 0.1 per cent since 1981. An important type of renovation and modernisation of Danish single family houses is the installation of new kitchens and bathroom furniture.[10] Many households who buy an older house renovate it and bring the kitchen and bathroom up to present-day standards. Also, surveys conducted by the ADMB show that more than half of new loans raised by existing home owners are spent on investments in the houses. Figure 4 gives an indication of the share of kitchen and bathroom quality improvements that come from newly built houses versus the modernisation of the existing stock.

The share of sales for new construction of houses is strongly influenced by the building activity, which peaked in 2007. The average over the five years in the figure

10. Also, better insulating windows, cavity wall insulation, heat pumps and solar cells are common renovations that upgrade the quality of older houses.

shows that approximately two thirds of the quality improvements come from the existing stock of houses, i.e. two times the contribution from new construction of houses.

While the above figures indicate that the average quality of the housing stock may improve each year with a minor part coming from higher quality of newly built houses, hedonic price estimations show that older houses – everything else being equal – are less valuable and apparently of lower quality than new houses. The estimations done by Bourassa et al. (2006) and Dorsey et al. (2010) do not show the percentage effect of increasing age on house prices, but a significantly negative coefficient for age appears. This means that the quality of houses without renovation and modernisation depreciates each year. Statistics show an annual increase in the average age for Danish single family houses of 0.55 years between 1981 and 2010,[11] which leads to a decrease in the average house quality from depreciation connected to the age of houses. When this effect is subtracted from the improvements resulting from the addition of rooms and square metres, better insulation and modernisation of the interior, it becomes clear that the average house quality does not necessarily change over the years. In fact, figure 2 showed no deviation in the long term trends[12] between the SPAR index and the means price index for Danish single family houses. Widlak and Tomczyk (2010) present figures for the Warsaw housing market for the (unfortunately short) period from 2006 to 2009, displaying no long term trend deviation between the mean house price index and their estimated hedonic house price indices. However, Hosios and Pesando (1991, table I), who compare mean sales prices with a permit adjusted repeat sales index for the city of Toronto from 1974 to 1989, report an annual increase of house quality close to 0.3 per cent when calculated from the difference in the development between the two indices over the 15 years.

It was shown in section 2 that when the SPAR index and the mean price index coincide, it implies that $\bar{e}_b^n = \bar{e}_b^m$, i.e. the appraisals for newer houses (n) do not change over time compared to appraisals for older houses (m). Danish tax authorities declare that the appraisals aim to reflect the market value of the houses, and there is reason to believe that the public appraisals deviate systematically from market prices in the long term. The empirical evidence for the Danish single family housing market thus indicates that the average quality of the housing stock does not change over time. Improvements in quality brought about by newly built houses and the modernisation of older houses are neutralised by the depreciation of houses due to ageing.

11. The calculation is made based on data from Statistics Denmark and includes farm houses because a number of these are reclassified as single family houses each year.

12. Exponential trend lines indicate an annual growth rate of 5.2 per cent for both indices.

5. Factors explaining the long term trend in house prices

While quality correction is important for short term changes in price indices for single family houses, this may be less so for changes over the longer term where all houses in the stock are traded. The annual growth in the average house quality contains a quality increase of less than one per cent per year from new construction and modernisation of older houses, but this improvement may be neutralised by the increasing age of houses over time. In the following discussion, the SPAR index for single family houses from Statistics Denmark deflated by the consumer price index is used as an indicator of real house prices, and it is explained why there may be an upward long term trend in this index.

The explanations for a long term trend (up or downward) in real house prices must be based on economic variables which exhibit a positive or negative long term trend. Changes of interest rates, unemployment rates and borrowing conditions do not show long term trends and must be excluded although they often appear as explanatory variables in equations for price developments over the short to medium term. Better candidates are the growth of real income, changing demographics, changing location of the population, persistent productivity differences between sectors and limitations of building sites. It is obvious to use Tobin's *q*-theory as a base model to explain trends in house prices in a world with growing demand. This compares to the traditional growth model approach where supply side factors alone determine the development. The following two subsections look at explanations on the supply side of the house market, while the availability of demand is treated in section 6 to enlighten the question of sustainability of demand under an upward long term trend in real house prices.

5.1 Replacement price effects

Tobin (1969) defines q as the ratio of the market price of capital goods to the price of currently produced capital goods. Applied to the housing market, q measures the ratio of current selling prices to current production costs, where production costs encompass both construction costs and the costs of land lots for new construction of houses. If growing demand leads to higher prices and a q ratio above one, supply will increase until q is restored equal to one. This implies that house prices will follow the long term trend of production costs. However, q defined in this way will show a long term increasing trend when the average price of land lots for existing houses increases more than the price of land used for new production or house construction. In many city cores it may be literally impossible to build new houses comparable to the existing ones as there is no free land for construction, and it is equally difficult to get proper data for land prices if free land for construction is not or very seldom traded. The term replace-

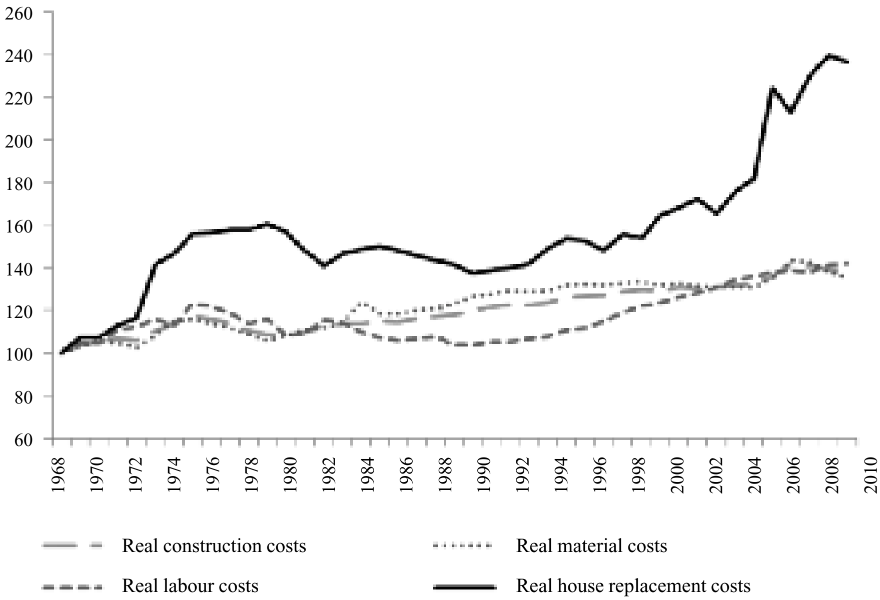

Figure 5. Development of real construction and replacement costs for single family houses 1968-2009. 1968 = 100.

Note: Real costs are deflated by the consumer price index.
Source: Statistics Denmark.

ment costs will be used to cover the price of construction and the price of the required land for new as well as older houses.

Construction costs may be split into material costs and labour costs. Figure 5 shows the development of real construction costs for Danish single family houses. The indices for material and labour costs are based on approximately 200 price indices for goods and 20 wage indices for labour input, all merged into a representative single family house. Both the index for real material costs and the index for real labour costs show an increasing trend over time. Some materials used for construction are modestly traded internationally and thus less exposed to international competition compared to consumer goods, and this results in an upward impact on the trend for real material prices. Furthermore, low productivity increases in the construction industry relative to other industries also cause higher real production costs. Calculations by Statistics Denmark show a modest development of the labour productivity in the construction industry compared to the whole market economy since the 1960s. The total factor productivity of the industry performs better, but both the labour and the total factor productivity have shown a falling trend after the end of the 1980s.

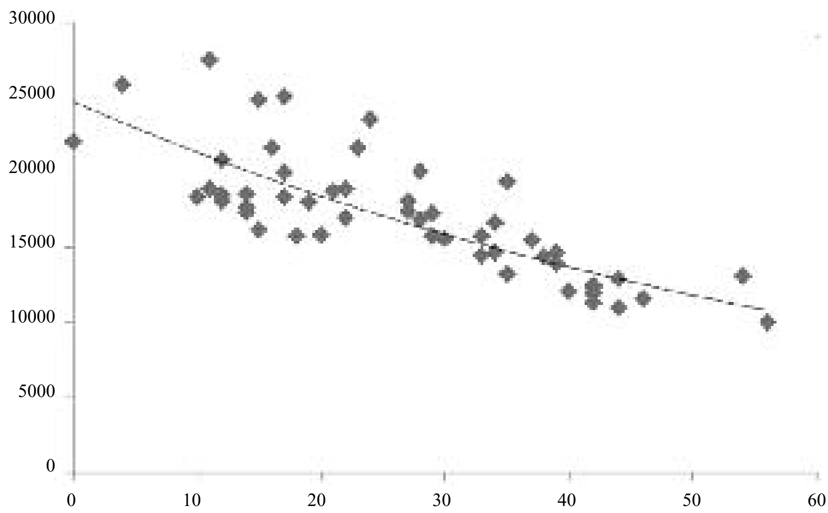

Figure 6. Single family house prices and travel distance to central Copenhagen.

Note: The figure shows single family house prices from 2005 in DKK per square metre in municipalities in the Copenhagen area and private car travelling distances to the centre measured in minutes. The use of travel distances in km or Euclidean distances reveals a similar picture, but gives a slightly poorer fit for the exponential trend line.
Source: Statistics Denmark and route findings on the web.

The steady increase in Danish real construction costs shown in figure 5 can be contrary to the development in other countries. Thus, Shiller (2009a,b) presents data for the USA, which show falling real construction costs since 1978. One reason for this may be that high rise construction with comparatively low production costs per dwelling takes a gradually bigger share of construction in the USA. Another reason may be that immigrant workers exert more downward pressure on US wages in the construction industry than they do in Denmark, where trade unions are comparatively strong. The high number of small building companies in Denmark may also hamper productivity increases. The U.S. Census Bureau statistics for real construction costs and real production costs for single family houses reveal a flat long term trend since the end of the 1970s.

Besides construction costs, land prices are important for the total production costs of bringing new houses to the market. It is well known from urban economics that land prices tend to increase the closer the land is to the city centre. Figure 6 illustrates how this affects house prices in the Copenhagen area.

With new houses mainly being built at the periphery, trading prices for land correctly reflect the impact of land prices on the total production costs of new houses. But they may be very far from replacement costs and trading prices for houses closer to the city centre. The closer a house is to the city centre, the bigger land's share of the total house price will be. It is also a fact that the average price of houses in a city will increase when the city expands, while construction and production costs may remain unchanged at the periphery. This gives an increase of q over time, when production costs are calculated for new construction of houses only.

It is difficult to pinpoint exactly the influence of land prices on the price of houses inside city borders when the land price index is dominated by land traded at the periphery. The price development for the few traded land lots used as building sites in city districts should be given (high) index weights in accordance with the share of houses in each district, while the price development for the many traded land lots at city borders should be given (low) index weights in accordance with the share of houses along borders. Data for Danish municipalities reported in Mandag Morgen (2008) give an indication of the increasing impact of land value on house prices. The increase of appraised real estate values was 133 per cent from 1993 to 2006, and the contemporary increase of appraised land values was 148 per cent.

Figure 5 has another graph showing the development of an index for house replacement costs. This index is calculated as 0.8 times the index for real construction costs plus 0.2 times the index for the mean land price per square metre[13] for the year 1992. With land prices exhibiting the highest increase over the years, the weight of land prices in relation to total production costs goes from 27 per cent in 1968 over 20 per cent in 1992 to 47 per cent in 2010. This is a high share for land costs for newly built Danish single family houses in the city outskirts but more acceptable for the supply side impact on prices for all houses. Oikarinen (2010) estimates the share of the land value component in house prices in the Helsinki metropolitan area to be almost 50 per cent. Davis and Palumbo's (2008) data for 46 US metropolitan areas show an increase in the land share of house prices from 32 to 50 per cent between 1984 and 2004. This development contrasts with Shiller's writings. He argues (2009a, p. 22) that "land values long ago accounted for only a tiny fraction of a home's value, and so land prices could appreciate at a relatively high rate in successful cities without making home prices climb rapidly." An exponential trend line for the index for real replacement costs in figure 5 shows a 1.23 per cent annual increase.

5.2 Zoning policies and location effects

Restrictive zoning policies may add to the upward trend in single family house prices by preventing a city from growing and limit land available for residential use. In-

13. The average land price seems to better capture the increasing impact of land value on house prices than the SPAR price index for land. Madsen (2009) employs a geometric average of construction costs and agricultural land prices as an index for the production costs of houses to be used as denominator in the q ratio.

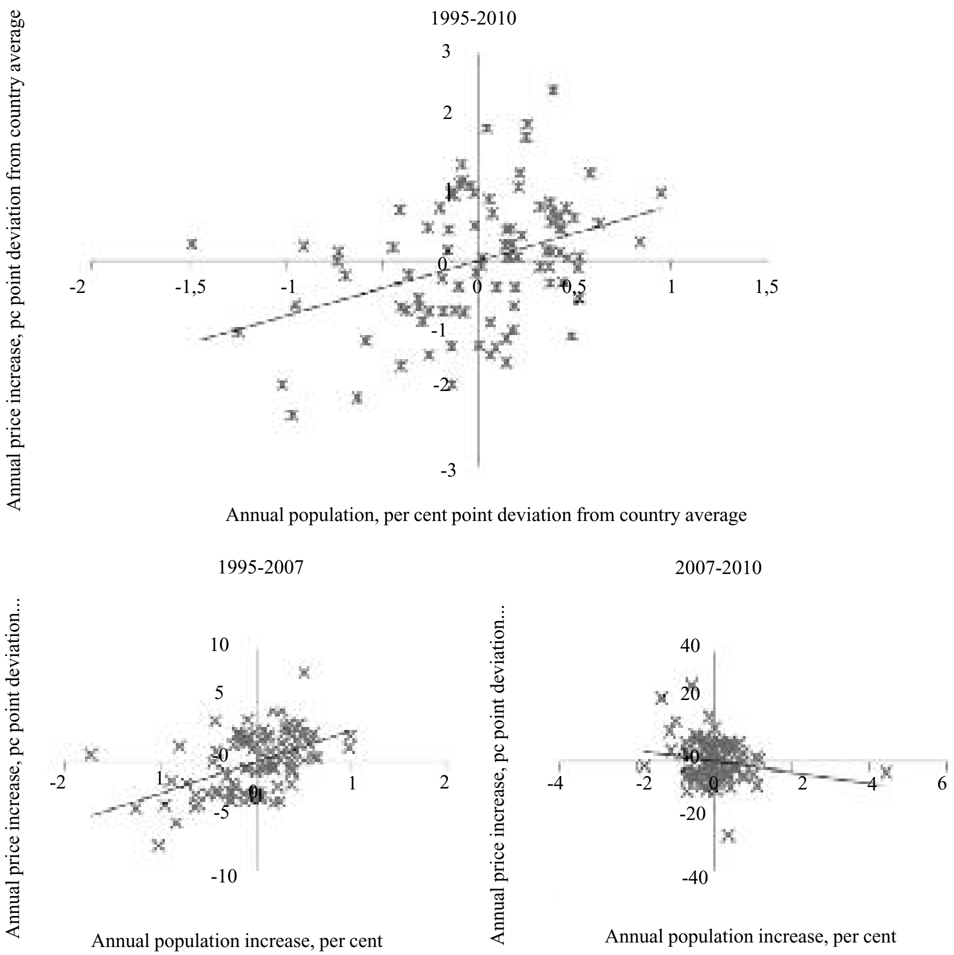

Figure 7. Population and single family house price changes in Danish municipalities.

Note: The periods shown in the panels are 1995 1.*q* – 2007 2.*q* (price peak quarter) – 2010 1.*q*.
Source: Statistics Denmark.

creasing demand must in this case be satisfied inside the borders and this raises the average land price and leads to taller buildings, which may eventually squeeze some single family houses out of the market. It is not difficult to find cases where land for construction has been restricted by municipalities (see Mandag Morgen 2008), but there is no thorough study of the impact of zoning policies on Danish house prices. Besides zoning, many other factors will influence house price developments at regional and municipal levels. For a recent study that incorporates national as well as regional explanatory variables for house prices in smaller sub markets, see Bramley, Leishman and

Watkins (2008). Restrictive zoning policies will, however, have a limited impact on house prices in open cities, where companies and citizens will migrate to other cities with lower land prices. Shiller (2009a, p. 24) argues that migration and competition between open cities keep house prices down. But urban external economies of scale may work in the opposite direction and make it more attractive for companies and households to move towards urban areas with high densities and land prices.

Figure 7 illustrates the relation between the population growth and single family house price developments in Danish municipalities. The figure is split into three panels with the big one showing the development over a time span covering both an upturn and the subsequent downturn of house prices, and two smaller panels showing the development over the price upturn and downturn, respectively. The graphs show how the long term positive relation between population growth and house prices is concentrated in years with rising prices and ceases under falling prices. The inserted regression line in the first panel reveals a coefficient equal to 0.8 for price deviations from the country mean, implying that municipalities with a one percentage point higher population increase than the average will have a 0.8 percentage point higher price increase than the mean for the country.

Data from Statistics Denmark show a tendency for people to move towards more densely populated areas. The percentage living in urbanised areas has increased from 82.6 in 1976 to 87.0 in 2010. This movement may further result in a more technical upward push to the house price index because extremely high and low observed house prices are eliminated from the calculation of the index. A number of houses in country villages are left unsold for years and are eventually declared unfit for housing and demolished. The prices of these houses will be extremely low and thus eliminated from the index calculation with the implication that it becomes upward biased. Land price increases in city cores may also push some single family houses out of the statistics when single family houses are demolished and the land is used for high rise buildings. However, the number of eliminations in the higher end is more limited.

6. The magnitude of the long term trend and its sustainability

The preceding section pointed towards an upward long term trend in real house prices. The factors behind this trend were an increase in real construction costs enhanced by the upward trend in real land prices, the latter in some areas probably being caused by restrictive zoning policies. Moreover, demolished houses in remote areas tend to give a technical upward bias of the index.

It now remains to give an indication of the magnitude of the trend. Figure 1 depicts the development since 1944. The exponential trend line fit to the data shows an annual increase of 2 per cent. This “estimate” may be overly influenced by the recent boom

Table 1. Growth trends in real single family house prices during sub periods.

Time period	Annual growth trend
1944-1960	1.81
1961-1970	3.75
1971-1980	1.29
1981-1990	1.41
1991-2000	5.42
2001-2010	4.07
1944-2010	2.03
1965-2010	1.24

Source: Calculations on data from figure 1.

period although the total period is fairly long. Table 1 has growth trend estimates for a number of sub periods and demonstrates the insecurity of the trend when applied to shorter periods[14] where short term changes of demand more strongly affect the price development. But the trend is above 1.2 per cent for all the shown periods, and one could take this as an indication of a lower growth limit for real house prices close to the 1.23 per cent annual trend increase of the real replacement costs as shown in figure 5. How much the long term growth rate may surpass this bottom in the future depends very much on the locational distribution of new single family houses. More urbanisation can be expected to pull the periphery of the major Danish urban areas further out from the centre, and this tends to lift land prices for existing houses. Demand trends will also be more important for house price developments when houses are located in areas with no or limited land for new construction.

The upper limit for the price increase – or its sustainability – depends on the development of households' purchasing power. Statistics Denmark does not publish consistent long term series of real disposable income per household, but the annual growth trend of the real disposable income per family reached 2.3 per cent between 1991 and 2008. However, national accounting series for real private consumption outlays per capita from 1966 to 2010 show a more modest real growth rate of 1.5 percent per year.[15] Housing outlays have taken a growing share of private consumption since 1966, but the share has remained fairly constant, slightly above 20 percent since the beginning of the 1990s. A crude long term indicator of the upper limit for house price increases, which can be followed far back in time, is the GDP per capita.[16] Table 2 shows growth trends for

14. The Economic Councils (2010) also present estimates for various sub periods.
15. The growth trend is 1.55 per year for the period 1991 to 2008.

Table 2. Growth trends in GDP per capita and single family house prices.

Index and time period	Annual growth trend
Real GDP/cap 1818-1943	1.27
Real GDP/cap 1944-1980	3.08
Real GDP/cap 1981-2010	1.42
Real GDP/cap 1944-2010	2.18
Nominal GDP/cap 1944-1980	8.63
Nominal house prices 1944-1980	8.53
Nominal GDP/cap 1981-2010	4.18
Nominal house prices 1981-2010	5.29

Note: From 1818 to 1966 calculations on GDP at factor prices, from 1966 to 2010 calculations on GDP at market prices.
Source: Calculations on data from Statistics Denmark and Gammelgård (1985).

GDP per capita and single family house prices and reveals the jump in trends between the years before and the years after the Second World War. Based on the whole post-war period, an annual growth trend of 2 per cent seems sustainable. But this 2 per cent growth rate stems from a prosperous period with more than 3 per cent annual growth of GDP per capita up until 1980 when industrialisation and trade liberalisation among industrialised countries spurred growth; and only a 1.42 growth rate of GDP per capita after the energy shortages in the 1970s had an impact on the economy. The sustainability of the growth of house prices is, however, best judged by comparing nominal growth rates. This comparison shows slightly lower house price increases than GDP per capita increases for the period 1944 to 1980, but clearly unsustainable house price increases for the subsequent period. Figure 8 illustrates the development of the nominal indices after the Second World War. One interpretation of the figure could be that single family house prices seem to be at a sustainable level in year 2010. But the future development depends on the growth prospects for the economy and it is beyond the scope of this article to discuss the future growth of the Danish economy. The interested reader may consult The Economic Councils (2010) on this matter. However, there is widespread concern about the ability of the Danish economy to maintain a satisfactory growth rate when outsourcing of traditional industries is daily business. Taking this into account, the outlook for long term growth in real single family house prices may not be much higher than a 1.5 per cent annual increase.

16. Household income follows GDP/cap proportionally when the household size is constant, and disposable income follows GDP proportionally if net taxation is a constant share of GDP. National accounting shows an increasing share of housing consumption in relation to GDP between 1966 and 1980 after which the share has remained stable around 10 per cent of GDP. The low volatility of rents used in Statistics Denmark's calculations explains part of this stability.

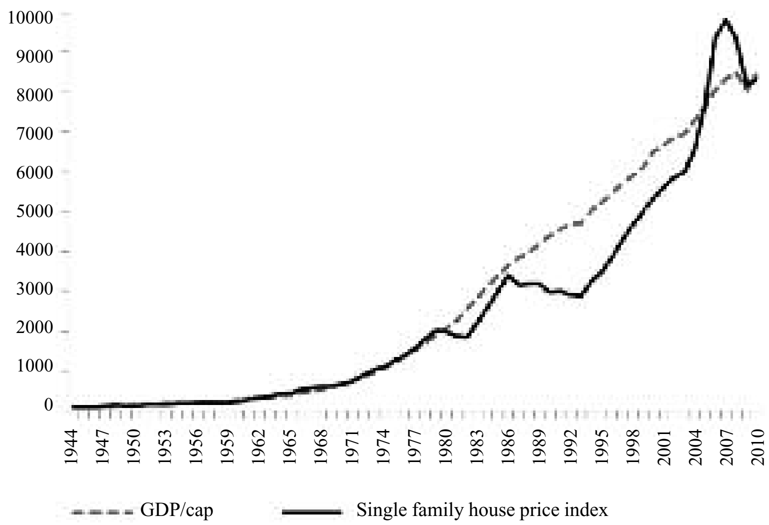

Figure 8. Single family house prices and GDP per capita. Index 1944 = 100.

Note: The figure shows the development of nominal indices.
Source: Calculations on data from Statistics Denmark and Gammelgård (1985).

7. Conclusion

It is important for the efficiency of an economy that agents are as well informed as possible. Future house prices have crucial importance for the welfare of households acting on the house market and there is a continuous quest for information about the likely future price trends. Professional economists and private counsellors have different points of view on this based on their evaluation of how current prices match the fundamental level, combined with their forecasts of future housing demand. The fundamental price can be perceived as the long term trend for real house prices, which is the object of this paper. After a presentation of Danish house price indices, the question of quality correction is treated. Statistics Denmark's SPAR price index for single family houses corrects for quality improvements, but only for improvements that are completed more than eight quarters before a house is sold. However, the SPAR index shows the same long term trend as the mean price index, and this indicates that the average quality of the Danish single family housing stock remains constant over time.

The annual long term growth trend for single family house real prices has been above 2 per cent since the Second World War. But this encompasses a higher growth trend up to 1980 after which the trend has slowed down to slightly less than 1.5 per cent. Factors behind the upward long term trend are increasing real construction costs and land prices, with increasing land prices in cities that raise the prices of existing houses above the production costs of new houses at the periphery. Also, continued migration from the countryside to cities tends to lift the house price index. These factors point to a lower limit for the annual increase of real house prices around 1.25 per cent. The upper limit is dictated by demand and depends on the real growth prospects for the Danish economy. Based on growth estimates made by various Danish economic forecasting institutions, the sustainable growth level for single family real house prices may not be much higher than 1.5 per cent for the next ten years.

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Debat og kommentarer

Husholdningsstrukturen i Danmark under forvandling: Betyder det noget for de offentlige udgifter?

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SUMMARY: *This paper considers the magnitudes of changes in household structures in Denmark over the period 1981-2007. It is found that most transition probabilities display trends, thus indicating that population projections based on an assumption of constant transition probabilities could be seriously flawed. The paper also offers a tentative assessment of what the observed changes in household structures have implied for welfare expenditures over the past 25 years. Focusing on components of welfare services with noticeable differences in unit costs between individuals living as singles and couples, respectively, it is found that the gross fiscal effects of changing household structures may be substantial. However, the net effects are minor yet non-negligible.*

1. Indledning

Overalt i den vestlige verden sker der i disse år store demografiske ændringer. Det er velkendt, at der som følge af faldende fødselshyppighed og voksende levetid bliver flere ældre og færre i de erhvervsaktive aldersgrupper. Endvidere sætter stigende omfang af migration præg på befolkningens sammensætning. Et mindre påagtet fænomen består i fremkomsten af nye familiemønstre, herunder en stigende andel af fraskilte, flere alenemødre, flere alenefædre og flere eneboende ældre. I tillæg til, at flere bor alene, vælger et voksende antal især højtuddannede kvinder at udskyde deres første fødsel.

Vi er taknemlige for kommentarer til en tidligere version af denne artikel fra deltagere i, »Ageing Households and the Nordic Welfare Model«, som blev afholdt på Økonomisk Institut på Oslo Universitetet d. 13.-14. oktober, 2011.

Formålet med denne artikel er dels at belyse omfanget af sådanne ændringer i husholdningsstrukturen i Danmark og dels at vurdere deres samfundsøkonomiske betydning.

At demografiske ændringer potentielt har store samfundsøkonomiske effekter, er der næppe tvivl om. Således har effekterne af befolkningsaldring på arbejdsudbud og de offentlige finanser været genstand for et stort antal analyser i de senere år, se f.eks. Velfærdskommissionen (2004). Der knytter sig imidlertid en høj grad af usikkerhed til forudsigelser af ændringer i aldersstrukturen, hvilket dermed også gælder for de samfundsøkonomiske konsekvenser heraf, se f.eks. Alho m.fl. (2008). Hvis man udover at tage højde for ændringer i den aldersmæssige sammensætning også inddrager ændringer i husholdningsstrukturen, vil der komme yderligere et element af usikkerhed til beregninger af de økonomiske konsekvenser.

Set fra et dansk – og nordisk – perspektiv er de observerede ændringer i husholdningsstrukturen af stor interesse. I hvert fald er de centrale egenskaber ved skatte- og transfereringssystemet i den nordiske velfærdsmodel nært knyttet til husholdningerne. Der sker således store indkomstoverførsler til børn, unge og ældre i form af børnecheck, studiestøtte, pensioner m.v. Ligeledes afholdes store offentligt finansierede udgifter til servicering af husholdninger i form af børnepasning, undervisning, fritidsordninger, sundhedspleje, ældrepleje m.v. Også provenuet fra visse skatter kan være følsomt over for ændringer i familiestrukturen, f.eks. indkomst-, bil- og boligskatter.

Dertil kommer, at en ændret familiestruktur kan påvirke arbejdsudbuddet. Den nordiske velfærdsmodel er således karakteriseret ved, at kvinder i stort mål er en del af arbejdsstyrken. Dette vurderes at være en vigtig forudsætning for at opretholde finansieringsgrundlaget bag velfærdssamfundet. Beslutninger om deltagelse på arbejdsmarkedet må i betydeligt omfang forventes at afhænge af den samlede familiesituation, og ændringer i denne vil derfor kunne føre til ændringer i arbejdsudbuddet og dermed f.eks. i finanspolitikkens holdbarhed.[1]

I denne artikel forsøger vi først at kvantificere de ændringer i husholdningsstrukturen, der har fundet sted i Danmark i perioden 1982-2007, og dernæst at beregne, hvad disse ændringer har betydet for (vigtige dele af) velfærdsudgifterne. Vi vælger her at fokusere på de komponenter af velfærdsudgifterne, hvor der er en væsentlig forskel i enhedsudgifterne forbundet med forsørgelse af personer, der lever henholdsvis som single og i parforhold. Til grund for vore beregninger konstruerer vi et kontrafaktisk forløb, hvor vi viser, hvordan forskellige kategorier af velfærdsudgifterne ville have forløbet, hvis husholdningsstrukturen ikke havde ændret sig i forhold til 1982.

1. Også på boligområdet kan der være konsekvenser af en ændret sammensætning. Det burde være en ukontroversiel antagelse, at antallet af personer i en husholdning er en kritisk determinant for den fremtidige boligefterspørgsel.

Lad os tage et eksempel i form af ældrepleje. Det er muligt at beregne enhedsomkostningerne forbundet med ældrepleje, enten samlet eller for udvalgte underkategorier. Vi ved, at udgifterne forbundet med at forsørge to ældre mennesker, der lever som par, er mindre end udgifterne forbundet med at forsørge to mennesker, der lever alene.[2] Med viden om, hvad de samlede udgifter til ældrepleje er i 2007, kan vi beregne, hvad de samlede omkostninger ville have været, hvis andelen, der levede som par i 1982, var den samme i 2007. Forskellen mellem det faktiske beløb i 2007 og det således beregnede beløb giver os et bud på, hvor store effekterne af en ændring i husholdningsstrukturen er på det konkrete område.

Artiklen placerer sig i en lille, men voksende litteratur på området. Quintano og D'Agostino (2006) ser på skift i indkomstfordelingen som følge af ændrede husholdningsstrukturer i fire europæiske lande. De finder, at den voksende andel af enlige, særligt for kvinder, vil være forbundet med en større risiko for at blive fattig. I et britisk studie finder Palmer (2006) tilsvarende resultater for England og Wales, idet den større andel af enlige findes i stort set alle socioøkonomiske grupper. Det påpeges, at det således ikke i sig selv er et problem, at flere lever som enlige, idet der ofte er tale om et bevidst valg, men det kan betyde, at mange personer bliver udsat for fattigdom. Hatland (2001) ser på, hvordan de nordiske velfærdsstater har reageret på de skiftende husholdningsstrukturer. Det interessante i denne sammenhæng er, i hvor høj grad landenes velfærdssystemer har ændret sig i takt med ændringerne i familiemønstrene. Særlig vigtigt er det, i hvor høj grad man f.eks. har ret til pension mv. efter samme rettigheder som samboende som for et ægtepar. Ved sammenligning imellem de nordiske lande viser det sig, at især Danmark i høj grad har ændret systemet til et individualiseret system, hvor udbetalinger kun i lille grad afhænger af husholdningstype i forhold til de øvrige nordiske lande.

Herefter er artiklen struktureret på følgende måde. I afsnit 2 viser vi, hvordan forskellige husholdningssandsynlighedstyper kan klassificeres, nogle foreløbige resultater i form af såkaldte transitionssandsynligheder samt en illustration af, om der er tegn på kohorteeffekter i relation til forskellige husholdningskarakteristika. Afsnit 3 er et forsøg på at kvantificere betydningen af en ændret husholdningsstruktur for forskellige kategorier af velfærdsudgifter og visse offentlige indtægter. Afsnit 4 sammenfatter og giver nogle perspektiver på det videre arbejde.

2. Ændringer i husholdningsstrukturen i Danmark 1982-2007

I det følgende anvendes et datasæt med registeroplysninger indeholdende hele den

2. I modsætning til arbejdsløshedsdagpenge og efterløn, som ikke afhænger af, hvilken husholdningskategori den enkelte modtager af disse velfærdsydelser er medlem af.

danske befolkning fra 1982 til 2007. For alle personer gælder, at deres karakteristika (alder, civilstatus mv.) er kendt den 1. januar hvert år.

2.1. Klassifikation

For hvert enkelt år er samtlige personer i Danmark herefter indplaceret i en og kun en af nedenstående syv husholdningstyper, se f.eks. Alho og Keilman (2010):

A1: Ægtepar med eller uden børn.
A2: Samlevende eller samboende med eller uden børn.
A3: Enlige forældre.
A4: Børn (til og med 25 år). Dette inkluderer kun hjemmeboende børn.
A5: Enlige.
A6: Andre i private husholdninger. Dette inkluderer voksne, der lever med andre voksne, men som ikke er et par, f.eks. to venner og lignende. Personer, der fortsat bor hjemme hos forældrene efter det fyldte 25 år, indplaceres også i denne gruppe.
A7: Beboere i institutioner. Primært inkluderer denne husholdningstype ældre, der lever på plejehjem og personer, der pga. fysiske eller psykiske problemer er nødt til at modtage hjælp hele døgnet.

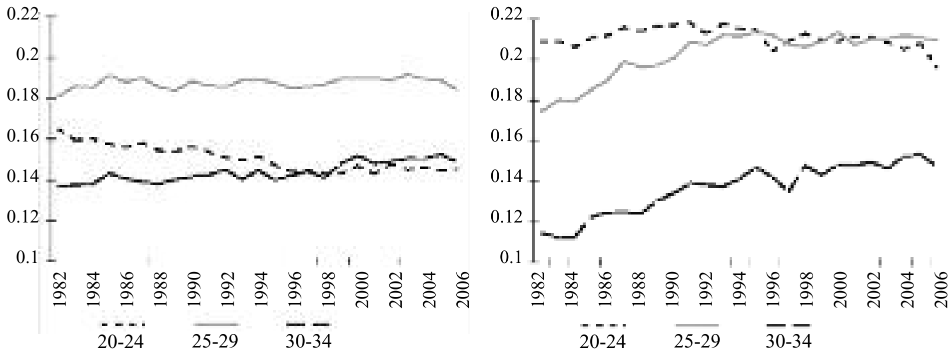
Udover at være tilskrevet en af ovenstående syv husholdningstyper er befolkningen inddelt i køn og 5-årsgrupper.

Vi kan nu udlede de empiriske transitionssandsynligheder på baggrund af køn, aldersgruppe og husholdningstype. For hvert køn og aldersgruppe er sandsynlighederne givet ved antallet af personer i status s til tidspunkt $t+1$ divideret med antallet af personer i pågældende køn- og aldersgruppe til tidspunkt t:

$$Pr(s, r, t) = \frac{N(s, r, t+1)}{\Sigma_p N(r, p, t)}$$

hvor $N(s, r, t)$ angiver antallet af personer i husholdningstype s til tidspunkt t, og som befandt sig i husholdningstype r til tidspunkt t-1. Derved angiver nævneren antallet af personer i husholdningstype r til tidspunkt t, og den samlede transitionssandsynlighed angiver andelen af personer i husholdningstype r til tidspunkt t, der til tidspunkt t +1 er i husholdningstype s.

For et givet år, køn og aldersgruppe kan man herefter opstille en 7x7 transitionsmatrix, der samler overgangssandsynlighederne fra og til alle de 7 husholdningstyper.



Figur 1. Transitionssandsynligheden fra enlig til gift eller samlevende/samboende for mænd (venstre) og kvinder (højre).

Man vil her forvente, at diagonalindgangene i denne matrix, altså den empiriske sandsynlighed for at forblive i den samme husholdningstype som året før, er klart de største. Og tilsvarende, at hvis hypotesen om markante ændringer i husholdningsstrukturen er korrekt, så vil det vise sig ved, at adskillige af de øvrige transitionssandsynligheder afviger betydeligt fra nul. Dette vil blive præsenteret nærmere nedenfor.

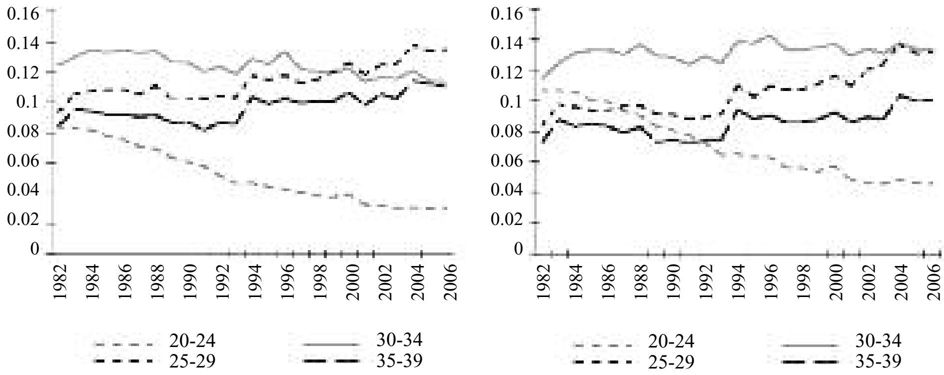
Det bemærkes, at transitionssandsynlighederne i den specifikation, vi anvender her, ikke vil summe til én, idet overgangen til død og emigreret er udeladt i analysen. Det er selvsagt vigtigt at tage højde for alle mulige tilstande, når man udregner befolkningsfremskrivninger. Formålet med denne analyse er imidlertid at fastlægge ændringer i familiestrukturen over tid, og derfor er det ikke nødvendigt at inkludere disse tilstande.

I det følgende gives en grafisk præsentation af ændringerne i familiestrukturen over tid.

2.2. Empiriske transitionssandsynligheder i Danmark

I dette afsnit præsenteres udvalgte empiriske overgangssandsynligheder mellem nogle af de syv husholdningstyper fra den ovenstående liste. Transitionssandsynlighederne for hver aldersgruppe er hvert år udledt på baggrund af populationen den 1. januar det pågældende år. Det betyder, at kurverne i figurerne ikke illustrerer en analyse af en enkelt kohorte, men af forskellige kohorter hvert år.

Figur 1 viser de empiriske transitionssandsynligheder for at gå fra enlig til at være gift eller samlevende/samboende for aldersgrupperne 20-24 år, 25-29 år og 30-34 år. For mænd ses en svag tendens til at danne par senere, da transitionssandsynligheden for aldersgruppen 20-24 er aftagende over tid, imens den tilsvarende sandsynlighed for aldersgruppen 30-34 år er stigende over tid.



Figur 2. Transitionssandsynligheden fra samlevende/samboende til gift for mænd (venstre) og kvinder (højre).

For kvinder i aldersgruppen 30-34 år ses der ligeledes en stigende tendens til at danne par over tid. Mere end 20 procent af de enlige kvinder i aldersgruppen 20-29 år danner par hvert år, hvor de tilsvarende tal for mænd ligger på mellem 15 og 20 procent.

En anden interessant observation i figur 1 er niveauet på kurverne i de to figurer. Det ses, at det er mere sandsynligt for kvinder i aldersgruppen 20-29 år at danne par end for mænd i samme aldersgruppe, men for aldersgruppen 30-34 år vender billedet. Dette viser, at mænd, der indgår i et parforhold, i gennemsnit er ældre end deres kvindelige partnere.

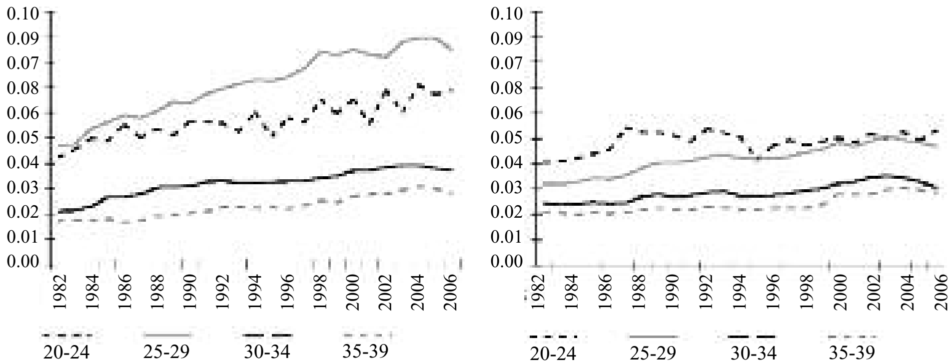
Herefter kigger vi på næste skridt i pardannelsen, nemlig at blive gift. Transitionerne fra at være samlevende/samboende til at være gift er vist i figur 2 for henholdsvis mænd og kvinder.

Figuren viser en tydelig tendens for både mænd og kvinder til at indgå ægteskab i en ældre alder end tidligere. De empiriske transitionssandsynligheder fra at være samlevende/samboende til at være gift er faldet markant for aldersgruppen 20-24 år. Et fald fra 8 til 3 procent om året for mænd og 11 til 4 procent om året for kvinder.

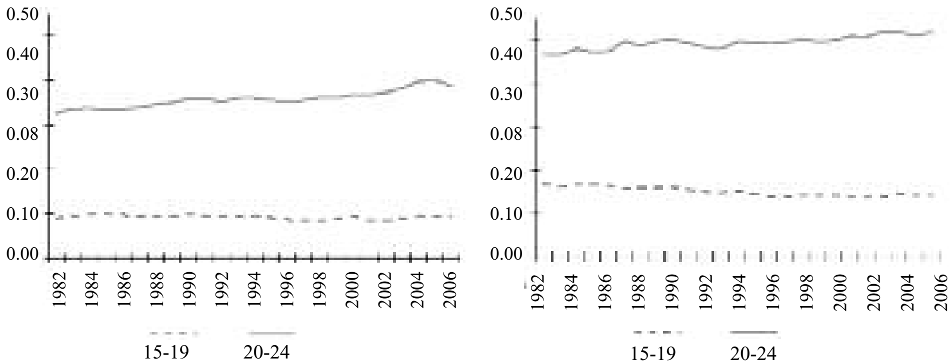
Transitionssandsynligheden for aldersgruppen 25-29 år ses approksimativt at være konstant, mens den for de ældre grupper er steget. Dette er især gældende for aldersgruppen 30-34 år. Denne tendens ses også tydeligt i gennemsnitsalderen på en person, som indgår ægteskab, da denne i den betragtede periode er steget fra 28,2 år til 34,2 år for mænd og fra 25,4 år til 31,4 år for kvinder.

Ligesom gennemsnitalderen for at indgå første ægteskab er steget, så er sandsynligheden for at blive skilt også steget. Figur 3 viser transitionssandsynligheden fra at være gift til at enten være enlig, samlevende/samboende eller enlig med børn.

Sandsynligheden for at forlade et ægteskab til en af de tre andre husholdningstyper er



Figur 3. Transitionssandsynligheden for at gå fra gift til enten enlig, samlevende/-samboende eller enlig med barn/børn for mænd (venstre) og kvinder (højre).

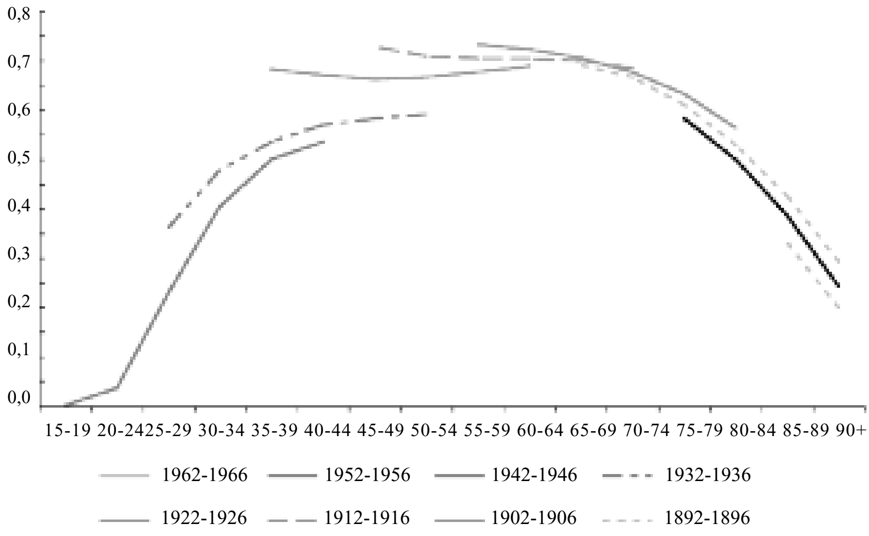


Figur 4. Transitionssandsynligheden for at gå fra barn til ikke-barn for mænd (venstre) og kvinder (højre).

stigende for begge køn for alle aldersgrupper. Den mest markante stigning findes for mænd i aldersgruppen 25-29 år, hvor de empiriske sandsynligheder for at forlade ægteskabet er steget fra 5 procent om året i 1982 til 9 procent om året i 2006. For alle andre aldersgrupper er stigningerne mindre, men der ses den samme trend med opadgående kurver igennem hele den analyserede tidsperiode.

Figuren viser endvidere, at inden for de samme aldersgrupper er mænd mere udsatte end kvinder for at blive skilt. Dette skyldes igen det faktum, at mænd er ældre end deres kvindelige partnere i det gennemsnitlige ægteskab.

Det ses i figur 4, at transitionen fra barn til udeboende (dvs. sandsynligheden for at flytte hjemmefra) er steget for aldersgruppen 20-24 år og forbliver nogenlunde konstant for aldersgruppen 15-19 år. De empiriske transitionssandsynligheder ses at være større



Figur 5. Andelen af gifte mænd.

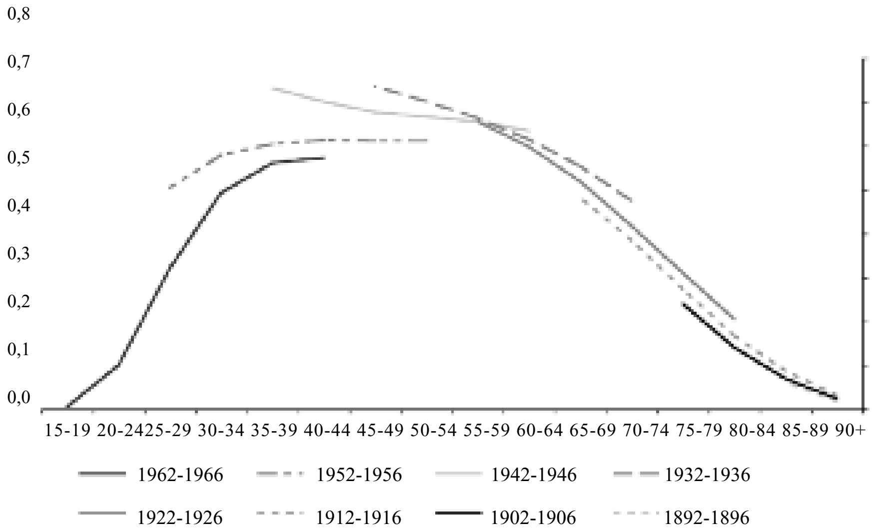
for kvinder end for mænd, så kvinder i gennemsnit flytter hjemmefra i en tidligere alder end mænd. Tallene viser ikke nogen tendens til, at alderen, hvor kvinder og mænd flytter hjemmefra, udligner sig i den nærmeste fremtid.

Opsummerende viser denne analyse af udvalgte transitionssandsynligheder imellem forskellige husholdningstyper i Danmark, at størstedelen af disse sandsynligheder angiver en trend. Dette er især gældende for de sandsynligheder, der kan forventes at have økonomiske effekter, f.eks. at man bliver gift senere og har større sandsynlighed for at blive skilt. Resultatet bekræfter også, at analyser af befolkningsfremskrivninger baseret på antagelser om konstante transitionssandsynligheder kan være misvisende.

2.3. Kohorteeffekter

I dette afsnit præsenteres figurer, der illustrerer andelene af gifte, enlige og samlevende/samboende mænd og kvinder over tid og inddelt i aldersgrupper.

Figur 5 viser andelen af gifte mænd over tid. Det ses, at andelen af gifte 30-34-årige mænd er faldet over tid. Dette ses f.eks. ved, at for mænd født mellem 1962 og 1966 var 40 procent gifte, da de var 30-34 år, hvorimod 48 procent af mænd født mellem 1952 og 1956, var gifte da de var 30-34 år. For 65-69-årige er andelen af gifte mænd stort set konstant over fødselsårgange. Det betyder, at selvom færre 30-34-årige var gifte over tid, er den samme andel gift ved en alder af 65-69 år, hvilket ligesom ovenfor viser, at mænd bliver gift i en senere alder end tidligere. Samtidig ses det, at andelen af gifte, ældre mænd er steget over tid, hvilket betyder, at ægtepar lever sammen længere end tidligere.



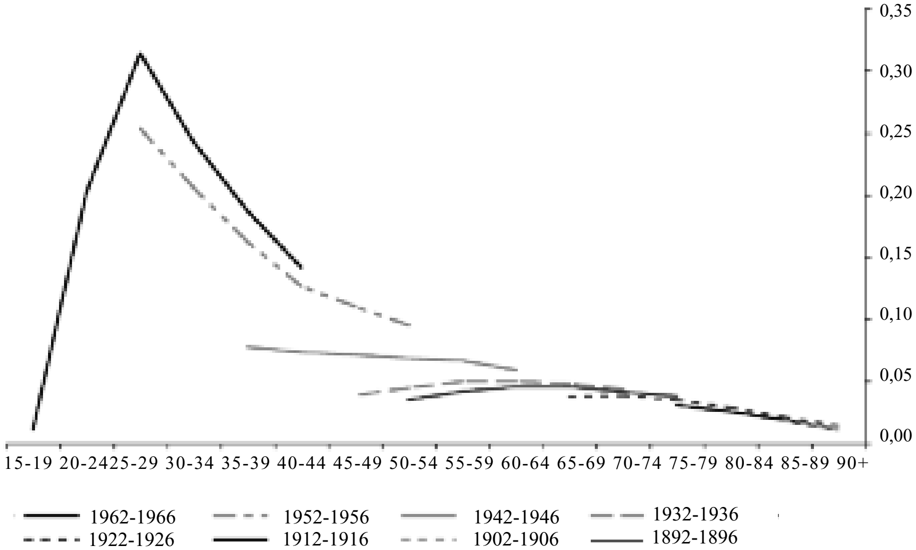
Figur 6. Andelen af gifte kvinder.

Figur 6 viser andelen af gifte kvinder over tid og kohorter. Her ses en lignende tendens, nemlig at kvinder født i 1960erne bliver gift i en højere alder end kvinder født tidligere. For 40-44-årige er der således stor forskel i andelen af gifte kvinder, mens andelen af 55-59-årige gifte kvinder stort set er konstant over tid. Såvel for mænd som for kvinder er der en tendens til, at ægtepar lever sammen længere, idet andelen af gifte er større for de yngre kohorter.

I figur 7 ses andelen af samboende/samlevende mænd. Først og fremmest illustrerer figuren en stor andel af samlevende/samboende yngre mænd med et maksimum for de 25-29-årige. Det ses yderligere, at andelen af samlevende/samboende af f.eks. 40-44-årige mænd er meget højere for kohorten født mellem 1962-1966 end for den født mellem 1942-1946. Sammenholdt med figur 5, der viste, at mænd blev gift i en højere alder end tidligere, betyder det, at selvom folk bliver gift senere, er det ikke ensbetydende med, at de ikke lever i par. Efter ca. 65-års alderen lever mindre end 5 procent af den mandlige befolkning som samlevende/samboende.

Et tilsvarende billede observeres for samlevende/samboende kvinder, se figur 8. Som for mænd, ses det, at der er en stor andel 25-29-årige kvinder i denne husholdningstype. Efter denne alder er der et stort fald i andelen af samlevende/samboende kvinder.

Figur 9 viser, at andelen af mænd, der lever alene, kun er større end 20 procent for aldersgruppen 25-29-årige født mellem 1962-1966 og igen for de ældre kohorter. Den store stigning i andelen af enlige mænd fra 15-19-årige til 20-24-årige skal ses som et resultat af, at mænd primært flytter hjemmefra i denne alder. Herudover er det tydeligt



Figur 7. Andelen af samlevende/samboende mænd.

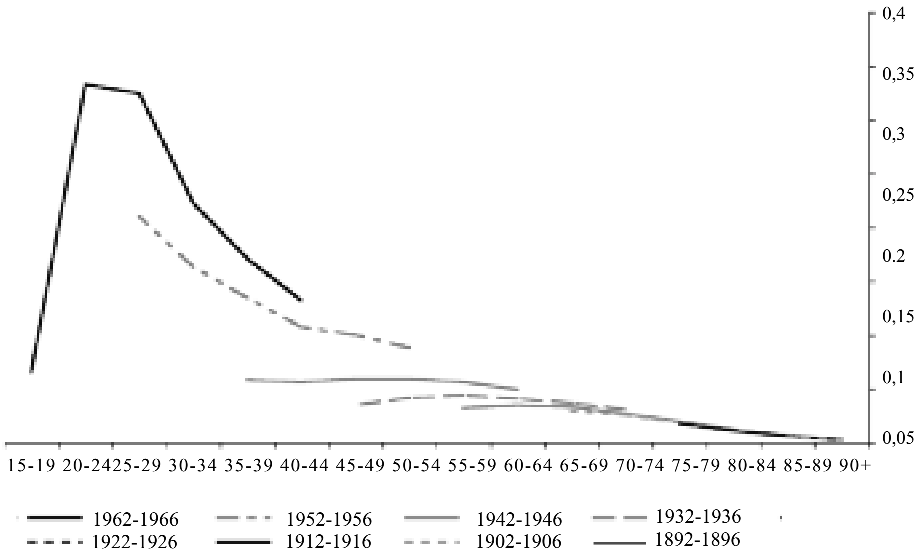
fra figuren, at der for alle aldersgrupper er tale om en stigende tendens til at være enlige over tid. F.eks. er andelen af enlige mænd i aldersklassen 50-54 år steget fra 10,2 pct. blandt de, der var født 1932-36 til knap 20 pct. blandt de, som er født 1952-56.

Som opsamling på ovenstående gennemgang vil vi betragte den samlede danske befolkning fordelt på de syv forskellige husholdningstyper i henholdsvis 1982 og 2007, se tabel 1.

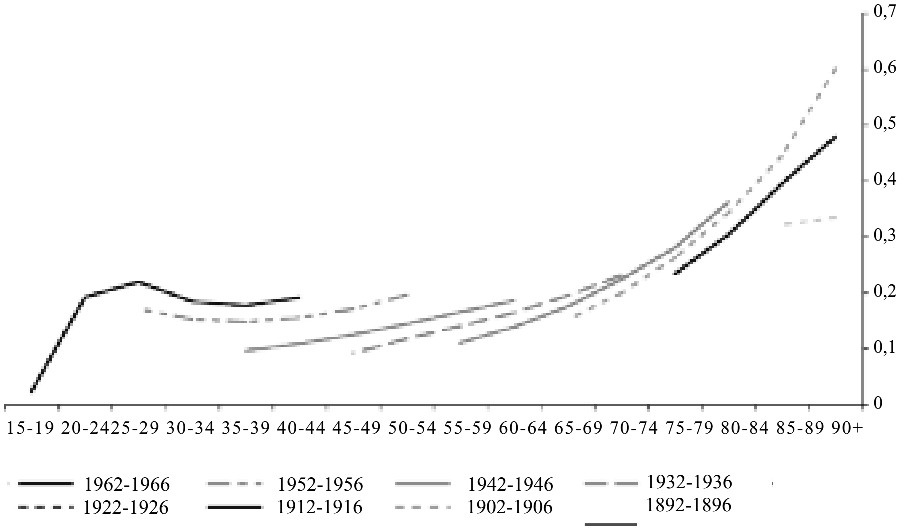
Det fremgår, at der er sket betydelige ændringer over den betragtede 25-årige periode. Især er der over perioden sket et skift imellem at være gift og være samboende, selvom den samlede andel af gifte og samboende har været tilnærmelsesvis konstant over de 25 år. I antal personer er der på de 25 år blevet 220.000 flere samboende og ca. 70.000 færre gifte.

Ligeledes markant er skiftet i andelen af enlige. Denne er for mænd steget fra hver tiende til hver sjette, og også hos kvinder har der været en stigning fra 14 til 19 procent. I antal betyder det, at der i 2007 var 350.000 flere enlige end i 1982, se også Gram-Hansen m.fl. (2009).

Et sidste område, der bør nævnes, er enlige forældre, hvor andelen også er vokset, selvom de stadigvæk udgør en mindre del af befolkningen. Dog er det for kvinder næsten hver tyvende, der lever som enlig forælder. I perioden fra 1982 til 2007 er antallet af enlige forældre vokset med 63.000 personer, hvilket måske ikke lyder af så meget, men det repræsenterer en stigning på mere end 60 pct., da det samlede antal enlige forældre i 1982 kun var på 99.000 personer.



Figur 8. Andelen af samlevende/samboende kvinder.



Figur 9. Andelen af enlige mænd.

3. Økonomiske og velfærdsmæssige effekter

Vi har i de foregående afsnit vist, at husholdningsstrukturen i Danmark er blevet ændret i perioden 1982-2007. På den baggrund forsøger vi herefter at vurdere, i hvilket

Tabel 1. Fordelingen af den danske befolkning på husholdningstyper, 1982 og 2007.

	Mænd		Kvinder	
	1982	2007	1982	2007
Gift	40,8%	36,9%	39,4%	35,8%
Samboende/samlevende	6,8%	10,5%	6,7%	10,3%
Enlig forælder	0,7%	1,4%	3,5%	4,9%
Børn	31,6%	26,9%	26,8%	24,0%
Enlig	9,8%	16,7%	14,3%	18,8%
Andre	9,3%	7,2%	7,8%	5,7%
Institution	0,9%	0,4%	1,4%	0,4%

omfang dette har haft betydning for de offentlige finanser. Der er i det danske velfærdssystem en række regler for service, indkomstoverførsler og skat, der indebærer, at de offentlige udgifter og indtægter er følsomme over for, om folk lever som par eller enlige. I det følgende ser vi først på tre områder af det offentlige budgets udgiftsside, nemlig ældrepleje, kontanthjælp og folkepension. Til sidst vurderes, om en ændret husholdningsstruktur har haft betydning for skatteprovenuet.

3.1. Ældrepleje

Omkostningen forbundet med ældrepleje kan være afhængig af ændringer i husholdningsstrukturen på to måder, der begge betyder lavere omkostning til ældrepleje. For det første: når befolkningen i gennemsnit lever længere, betyder det, at flere par lever sammen længere. Det blev understøttet af figur 5 og 6, der viste andelen af hhv. gifte mænd og kvinder. Hvis således kun en i husholdningen behøver pleje, så kan ægtefællen i nogle tilfælde hjælpe til, hvor en enlig plejekrævende ville have haft brug for pleje fra den offentlige sektor. Denne effekt implicerer alt andet lige, at par kan leve uden offentlig hjælp længere end enlige.

For det andet: omkostninger til par, der behøver pleje, vil i mange tilfælde være lavere pr. person end omkostninger til pleje til en enlig. F.eks. har par ikke brug for dobbelt så meget plads i en ældrebolig som en enlig. Hertil kommer, at man kan forestille sig, at nogle direkte omkostninger vil være lavere pr. person for par end for enlige.

På baggrund af omkostningerne til ældrepleje i Danmark i 2007 har vi forsøgt at beregne effekterne af ændringer i husholdningsstrukturen på omkostningerne til ældrepleje. Der eksisterer desværre ikke nogle kendte indikatorer for forskellen i enhedsomkostningerne til ældrepleje mellem ægtepar og enlige. Derfor har vi været nødsaget til at gøre en antagelse herom, og denne består i, at enhedsomkostningerne til ældrepleje for ægtepar er 0,8 gange omkostningen for en enlig.

De samlede omkostninger til ældrepleje i Danmark er svære at opgøre alene ud fra kommunernes regnskabssystem, idet de relevante udgifter skal stykkes sammen af flere forskellige konti.[3] Samtidig skal en del af udgifterne på disse konti fratrækkes, da de vedhører handicappede og andre plejekrævende, der ikke er ældre. På den baggrund anvender vi de samlede udgifter til ældrepleje som opgjort på Socialministeriets hjemmeside.[4]

Dette giver en samlet udgift til ældrepleje på 32,5 mia. kr. i 2007. Denne udgift er herefter fordelt ud på antal personer i alderen fra 70 og ældre i 2007 fra vores befolkningsopdeling.[5] Endvidere er der anvendt en vægtning af udgifterne, der svarer til de observerede enhedsudgifter for Finland, som opgjort af Lassila m.fl. (2011). Denne vægtning betyder, at de meget ældre har en større enhedsomkostning end de yngre. F.eks. viser den finske opgørelse, at omkostningerne pr. capita for personer over 90 år er mere end 100 gange større end for personer i 70-74-års alderen. Denne effekt er en kombination af, at flere af de meget gamle har brug for ældrepleje, og at de meget gamle typisk også har brug for en dyrere pleje.

Som nævnt ovenfor antages det herefter, at personer, der lever i par, kun har en enhedsomkostning, der er 0,8 gange den for personer, der er enlige. Ud fra denne antagelse kan man beregne nye enhedsomkostninger pr. person i par og pr. enlig. Disse enhedsomkostninger anvendes herefter til at belyse betydningen af flere ældre, der lever i par.

Tabel 2 viser resultatet af denne analyse.

Tabellen viser den overordnede demografiske ændrings effekt på ældreplejeomkostningerne. Der ses en stigning i ældreplejeomkostninger på omkring 11,6 mia. kr. gennem analyseperioden på baggrund af en aldrende befolkning. Yderligere ses det, at effekten af den ændrede husholdningsstruktur har været et fald i omkostningerne til ældrepleje på 230 mio. kr. Effekten er altså ikke stor sammenlignet med den overordnede demografiske effekt.

3.2. Kontanthjælp

Personer på kontanthjælp i Danmark oplever oftest, at det udbetalte beløbs størrelse afhænger af deres husholdningsstatus. Da ægtefæller har en lovpligtig ret til at forsørge

3. Det drejer sig om konto 5.32 (pleje) og 5.34 (bolig).

4. *http://www.sm.dk/noegletal/sociale-omraader/aldreomsorg/Sider/Start.aspx*. Tallene på ministeriets hjemmeside er opgjort i 2010-priser, hvorfor den opgjorte udgift på 35,8 mia. kr. er deflateret til 2007-niveau.

5. I princippet kunne man tage udgangspunkt i gruppen A7, der angiver antallet af personer på institutioner, men denne gruppe er ikke særligt godt opgjort for Danmark, idet der i den betragtede periode er sket en skift på området, så personer på plejehjem, i ældreboliger mv. i stedet betragtes som lejere på almindelige lejevilkår.

Tabel 2. Demografiske effekter på omkostninger til ældrepleje, 1982-2007, mio. kr.

	Beløb
Totale omkostninger 1982 (med 2007-enhedsomkostninger)	21.092,4
Omkostninger 2007 hvis husholdningsstruktur som i 1982	32.717,2
Faktiske omkostninger 2007	32.487,8

hinanden økonomisk, så oplever gifte personer på indkomstoverførsler ofte en mindre økonomisk hjælp end ugifte personer, da deres ægtefæller menes at kunne forsørge dem. Ligeledes kan personer med børn opnå yderligere økonomisk støtte til at forsørge deres børn.

Det betyder, at en gennemsnitlig indkomstoverførsel for personer, der er enlige forældre eller samlevende/samboende, vil være omkring 10.000 højere per person end for personer i ægteskab.

I Danmarks Statistikbank er det muligt at finde oplysninger om udbetalte ydelser til forsørgelse (kontanthjælp) fordelt på alder og husholdningstyper.[6] Disse husholdningstyper stemmer ikke helt overens med dem, der anvendes i denne artikel, hvorfor det har været nødvendigt at sammenlægge nogle af grupperne. Danmarks Statistikbank leverer også antal modtagere fordelt på samme grupper, hvorfor det er muligt at udregne det gennemsnitlige beløb pr. modtager. Når disse udregnes, fremgår det, at grupperne enlige kvinder med børn og enlige mænd med børn i gennemsnit modtager stort set samme beløb, ca. 145.000 kr. i 2007.[7] På samme måde modtager gifte ca. samme beløb som enlige uden børn i gennemsnit, ca. 135.000 kr. i 2007. Derfor er der i udregningerne taget udgangspunkt i to husholdningstyper: enlige med børn inkl. samboende med børn og andre.

På samme måde som ovenfor er enhedsomkostningerne herefter fordelt ud på de to husholdningstyper i 1982 og 2007, og det er opgjort, hvad den ændrede husholdningssammensætning har betydet for den offentlige udgift på dette område. Tabel 3 viser resultatet heraf.

Den primære grund til, at udgifterne til kontanthjælp til forsørgelse er steget i perioden, er en lidt større befolkning i 2007. Denne effekt står for godt 900 mio. kr. i ekstra omkostninger i perioden. Ændringer i husholdningsstatus har derimod bidraget med 550 mio. kr. i øgede omkostninger sammenlignet med et tilfælde uden ændringer i husholdningssammensætningen. Hovedårsagen til disse øgede omkostninger findes i den stigende andel af enlige forældre og samlevende/samboende par som påpeget ovenfor.

6. Disse findes under Sociale forhold, Sundhed og Retsvæsen => Kontanthjælp mv.
7. Denne gruppe indeholder også papirløse par, altså samboende og samlevende.

Tabel 3. Demografiske effekter på udgifterne til kontanthjælp til forsørgelse, 1982-2007, mio.kr.

Element	Beløb
Totale omkostninger 1982 (med 2007-enhedsomkostninger)	14.727,9
Omkostninger 2007 hvis husholdningsstruktur som i 1982	15.630,8
Faktiske omkostninger 2007	16.188,4

3.3. Folkepension

Det danske folkepensionssystem giver alle pensionister et basisbeløb, hvorefter de ældre, på baggrund af lav formue, høje boligudgifter osv., kan søge forskellige supplerende beløb. Den gennemsnitlige overførsel til par er pr. person typisk lavere end den til enlige, hvilket skyldes, at pars udgifter oftest ikke er det dobbelte af enliges.

Herudover gælder der for pensionister, der er gifte med ikke-pensionister, at de kan få et nedslag i deres pension på grund af specielle modregningsregler. Dette forstærker effekten af, at de gennemsnitlige overførsler til par oftest er relativt lavere.

Danmarks Statistikbank oplyser de samlede udgifter samt antal modtagere fordelt på fire forskellige grupper: gift med pensionist, gift med ikke-pensionist, samlevende og enlig.[8] Givet den gennemsnitlige overførsel til pensionister i de forskellige grupper er det muligt at beregne bidraget af den ændrede husholdningsstruktur til stigningen i de offentliges omkostninger til pensioner fra 1982 til 2007 ved at tildele den gennemsnitlige udbetaling pr. person til befolkningen i 1982. Resultatet heraf ses i tabel 4.

Den tydeligste demografiske effekt på omkostningerne til folkepension kommer fra ændringen i befolkningssammensætningen, hvor andelen af personer over 65 er steget, hvilket betyder øgede omkostninger på 9,4 mia. kr. i 2007 i forhold til 1982. Derimod har ændringer i husholdningsstrukturen bidraget med et fald i omkostningerne på 1,4 mia. kr., da andelen af gifte par er steget og andelen af enlige er faldet for aldersgrupper over 65 år.

3.4. Beskatning

Det danske skattesystem tillader gifte par at overføre ubrugte personlige skattefradrag til ægtefællen. Det samme er ikke tilladt for sammenlevende/samboende par. Denne regel er i særdeleshed vigtig for ægtepar, hvor den ene part har en medium-til-høj lønindkomst, mens den anden har en lav indkomst. For eksempel kunne et sådant par være en student og en fuldtidsansat med medium-til-høj løn. For sådanne par er forskellen i skattebetaling mellem, om de er samlevende/samboende eller gifte, omkring 10.000 under reglerne, der var gældende i 2007.

8. Disse findes under Sociale forhold, Sundhed og Retsvæsen => Folke- og førtidspension.

Tabel 4. Demografiske effekter i udgifterne til folkepension, 1982-2007, mio. kr.

Element	Beløb
Totale omkostninger 1982 (med 2007-enhedsomkostninger)	69.784,1
Omkostninger 2007 hvis husholdningsstruktur som i 1982	79.401,4
Faktiske omkostninger 2007	77.808,7

Fra registerdatasættet har det været muligt at identificere antallet af par af typen nævnt ovenfor. Dermed bliver det muligt at vise effekterne af ændringen i husholdningsstrukturen.

Tabel 5 illustrerer, at den offentlige sektor har modtaget ekstra skattebetalinger fra de yngre aldersgrupper. Det skyldes, at gennemsnitsalderen, når folk bliver gift, er steget betydeligt fra 1982 til 2007, og derfor er der ikke mange par tilbage, der kan gøre gavn af denne skattefordel. For de lidt ældre aldersgrupper ses det, at de offentlige skatteindtægter er faldet, idet der er flere par i disse aldersgrupper i 2007 end i 1982.

Alt i alt er nettoeffekten for den offentlige sektor lille, hvilket skyldes de to modsatrettede effekter.

4. Sammenfatning

Denne artikel har undersøgt karakteren og omfanget af ændringerne i husholdningsstrukturen i Danmark i perioden 1982-2007. Blandt resultaterne er der grund til at fremhæve, at der er sket:

- et fald i andelen af gifte på ca. 10%;
- en stigning i andelen af samboende/samlevende på ca. 55%;
- en fordobling i andelen af enlige, mandlige forældre og en stigning på ca. 40% i andelen af enlige, kvindelige forældre;
- et fald i andelen af børn på ca.15%;
- en stigning i andelen af enlige mænd på ca. 70% og en stigning i andelen af enlige kvinder på ca. 25%.

Det virker fair at fortolke disse bevægelser som markante, og der kan peges på flere interessante implikationer:

For det første viser disse ændringer i husholdningsstrukturen observeret over en periode på 25 år, at det potentielt kan være forbundet med betydelige fejl, hvis befolkningsfremskrivninger foretages under den antagelse, at transitionssandsynlighederne er konstante. Dette er en vigtig indsigt, som kan bruges til at guide arbejdet med fremskrivninger af befolkningsudviklingen.

Tabel 5. Demografiske effekter i »tabte« skatteindtægter, 1982-2007, millioner DKK.

Aldersgruppe	Omkostning i 2007	Omkostning i 2007,1982 andele	Off. nettogevinst
20-24	4,15	21,39	17,22
25-29	32,67	59,12	26,45
30-34	71,61	63,59	-8,02
35-39	82,61	63,49	-19,12
Total	191,04	207,57	16,53

For det andet er det givet, at de betragtede ændringer i husholdningsstrukturen også har samfundsøkonomisk betydning. I den forbindelse har artiklen vist, at det er muligt at dekomponere væksten i den offentlige sektors udgifter på en række kerneområder i bidraget fra ændringen i befolkningens størrelse og bidraget fra den ændrede husholdningssammensætning. Beregningerne viser, at bidraget fra den ændrede husholdningssammensætning er begrænset, men dog ikke ubetydeligt.

Her skal nævnes, at der til trods for beskedne nettoeffekter godt kan være tale om relativt store bruttoeffekter, hvor de enkelte effekter til dels ophæver hinanden. F. eks. er omkostningerne til kontanthjælp steget som følge af flere enlige forsørgere og flere papirløse par, mens udgifterne til ældrepleje og folkepension er faldet som følge af, at flere ældre lever sammen i par.

I fremtidigt arbejde vil vi se nærmere på betydningen af igangværende og forventede ændringer i husholdningsstrukturen for befolkningsfremskrivninger, vurderinger af finanspolitisk holdbarhed, boligmarkedet, arbejdsudbuddet m.v.

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Udviklingen i matematik målt i de danske PISA rapporter

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Siden den første PISA rapport udkom i december 2001 har PISA undersøgelserne sat deres meget stærke præg på folkeskoledebatten. PISA rapporternes oprindelige intension var at måle, hvor godt unge mennesker er forberedt til at møde udfordringer i et globaliseret samfund. Siden 2001 er der udkommet mindst 8 PISA rapporter, og disse PISA rapporter har fået stor opmærksomhed ikke mindst i pressen. Men PISA rapporterne sætter også deres spor i lovgivningen og rapporterne bruges i dag også til at evaluere mange centrale størrelser i folkeskolen. I den sidste nationale PISA rapport fremkom det meget overraskende resultat, at matematik-niveauet var faldet signifikant i forhold til de tre tidligere undersøgelser, dette på trods af at man med den seneste store ændring af folkeskoleloven har ønsket at styrke faget matematik. I denne artikel sættes spørgsmålstegn ved, om dette signifikante fald er udtryk for at eleverne er blevet dårligere til at løse matematik opgaver, eller om det skyldes en ændring i PISA undersøgelsernes stikprøvedesign.

I foråret 2000 blev der gennemført en undersøgelse blandt 4.212 skolebørn fra 223 skoler. Eleverne var alle født i 1984, og de blev testet i læsning, matematik og naturvidenskab samt blev bedt om at udfylde et baggrundsskema. I december 2001 udkom rapporten: »Forventninger og færdigheder – danske unge i en international sammenligning«. Dette var den første danske PISA rapport. Siden da har der været afholdt tilsvarende nationale test i 2003, 2006 og 2009. De efterfølgende danske PISA rapporter har alle fået stor opmærksomhed blandt forskere og i den offentlige debat, men PISA rapporterne har også haft kraftigt indflydelse på lovgivningen inden for folkeskoleområdet.

Ved den sidste store revision af læreruddannelsen (ofte kaldet den nye læreruddannelse) i 2007, blev der netop fokuseret på fagligheden inden for dansk, matematik og naturfag. Ydermere skal de lærerstuderende nu vælge mellem begynder- og sluttrin på linjefagene henholdsvis dansk og matematik. Netop opdelingen i begynder- og sluttrin vil mange opfatte som værende kraftigt inspireret af Finland. Finland har absolut klaret sig godt i disse internationale PISA undersøgelser. De er som regel blandt de tre første på ranglisterne og må klart siges at være det bedste europæiske land. Og når man har forsøgt at forklare Finlands høje placering, så har man ofte fokuseret på, at Finland har særligt uddannede lærere til at varetage undervisningen efter 7. klasse.

Det er samarbejdsorganisationen OECD, der har nedsat et internationalt PISA konsortium, som har det overordnede ansvar for PISA testene. Det internationale PISA konsortium står for udvælgelse af testspørgsmålene samt konstruktionen af det baggrundsskema, som eleverne også skal udfylde. De deltagende lande skal sørge for oversættelse af testspørgsmål samt baggrundsskema. Tilsvarende skal de deltagende lande stå for den praktiske gennemførelse af testene. Et vigtigt karakteristikum – og til tider kraftigt diskuteret – ved PISA testene er, at det er de samme spørgsmål, der stilles i alle de deltagende lande. I og med at det er identiske spørgsmål, der stilles i alle lande, er det teknisk muligt at udarbejde en rangliste over, hvor godt de enkelte lande præsterer. Ranglisten og ikke mindst forudsætningen for at kunne udarbejde en valid rangliste har været voldsomt diskuteret, Kreiner (2011). I denne artikel vil der ikke blive fokuseret på Danmarks placering på denne rangliste, derimod vil udviklingen over tid inden for domænet matematik blive analyseret.

Også internationalt har PISA fået stor opmærksomhed. Ved den sidste PISA test i foråret 2009 deltog 65 lande, ved den første PISA test var der 32 lande, der deltog. En stigning som absolut kan fortolkes som en stor succes.

Nationalt har der også været stor fokus på PISA. Københavns kommune har således afholdt tre tilsvarende PISA test i 2004, 2007 og 2010. Disse PISA-K, som de ofte omtales, er en gentagelse af tidligere PISA test. På nationalt plan er PISA en stikprøve, mens PISA-K omfatter alle 9. klasser i alle Københavns folkeskoler samt de private skoler i København, som måtte ønske at deltage. I nedenstående tabel er vist en oversigt over afholdte PISA test i Danmark.

Man kan se af tabellen, at der har været 4 nationale PISA test og 3 københavnske PISA test. De nationale test er stikprøveundersøgelser, og designet er relativt kompliceret. Grundideen i et PISA design er at inddele skoler i et mindre antal strata. Efterfølgende foretages en stikprøveudvælgelse af skoler, ofte efter skolestørrelse. Endelig udtrækkes tilfældige elever på skolen (uanset hvilken klasse de går i) dog maksimalt 28 elever pr. skoler. En passende betegnelse for designet er en tilnærmet stratificeret to-trins klyngeudvælgelse. Det komplicerede design har medført, at PISA datasættene er udstyret med vægtvariable, der skal anvendes når datasættene analyseres.

I den 4. nationale PISA test er designet ændret væsentligt for at få flere af anden etnisk herkomst med i undersøgelsen.

Når man skal følge en udvikling over tid baseret på stikprøver, er det meget væsentligt at sikre sig, at det ikke er ændringerne i stikprøvedesignet, der bevirker ændringer i interessevariablen. Interessevariablen skal helst måles på samme gentagne måde.

I dette tilfælde er det scoren i matematik, der er interessevariablen. Score i PISA undersøgelserne er konstrueret så gennemsnittet af OECD landene er på 500 (og den tilsvarende spredning er 100). I ovenstående fig. 1 er optegnet PISA scoren for de 7 afholdte PISA test i Danmark.

Tabel 1. Oversigt over PISA test i Danmark siden år 2000.

År	Test	Antal elever	Antal skoler	Rapport	Stikprøve Design	Deltagelse Elever	Deltagelse Skoler	Matematik Score
2000	1. PISA	4.212	223	Dec. 2001	Skoler inddelt i tre strata efter størrelse. Derefter klyngeudvælgelse. Elever skal være 15 år den 1. januar. Max 28 elever	92 %	95 %	514
2003	2. PISA	4.218	206	Dec. 2004	Som i 1. PISA	88,6 %	97,6 %	514
2004	1. PISA-K	2.352	59 folkeskoler 27 frie skoler		Alle 9. klasser, alle i klassen, alle folkeskoler. Samt de private der måtte ønske at deltage	86%	Alle folke-skoler; 27 ud af 44 frie	478
2006	3. PISA	4.532	209	Dec. 2007	Som i 1. PISA	89,1 %	95,9 %	513
2007	2. PISA-K	2.598	57 folkeskoler 28 frie skoler		Som i 1. PISA-K	82%	Alle folke-skoler; 28 ud af 45 frie	475
2007	2. PISA-K	2.598						
2009	4. PISA	5.924	285		Her sker en oversampling af skoler med elever af anden etnisk herkomst. Denne ekstra »skævhed« i design kompenseres ved at udarbejde nye vægte i datasættet	89,29 (vægtet)	90,75 (vægtet)	503
2010	3. PISA-K	3.196	28 frie skoler 55 folkeskoler	Dec. 2010	Som i 1. PISA-K	86%	Alle folke-skoler; 28 private ud af 45	482

Kilde: PISA rapporterne. I oversigten er PISA etnisk fra 2005 udeladt.

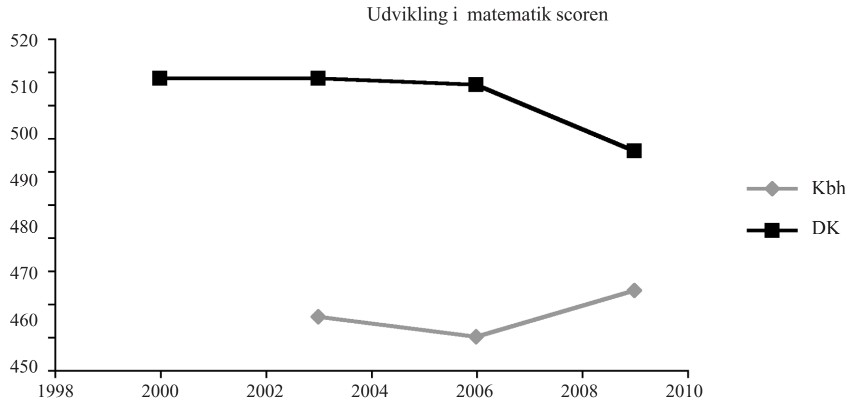


Fig. 1. Udvikling i matematikscoren i de nationale og københavnske PISA test, (rent visuelt er PISA-K skubbet et år tilbage).

Kilde: Diverse PISA rapporter.

Det fremgår af figuren, at de nationale PISA test er stabilt over de københavnske PISA test. Den helt afgørende årsag hertil er befolkningssammensætningen i København kontra resten af landet. Elever af anden etnisk herkomst scorer lavere end etniske danskere (et resultat som kan overføres til næsten alle OECD lande). Da København har relativt flere elever af anden etnisk herkomst er det helt forventeligt, at PISA København er mærkbart under de nationale test.

Det, der derimod er meget overraskende i figuren, er det dramatiske fald fra 2006 til 2009 i de nationale test (jvf. Bay 2011). Faldet er signifikant, som det konstateres i rapporten: »Der er tale om en signifikant tilbagegang i de danske elevers præstationer fra 2006 til 2009 på 11 point« (PISA2009 s. 88). Imens er udviklingen i de tilsvarende Københavnske test stabil. Det fremhæves i rapporten vedrørende matematik, at »For alle deltagende elever under ét er der ikke tale om signifikante ændringer fra 2007 til 2010 – ej heller når der deles op på køn eller skoletype.« (PISA-K(2010) s. 35).

Når der sker store ændringer i udviklinger, der er målt med stikprøver, kan dette skyldes at stikprøvedesignet er ændret. Og netop designet i PISA 2009 er kraftigt ændret i forhold til de tre første PISA runder. Stratifikationen af skoler er nu baseret på etnicitet frem for skolestørrelse, og stikprøven er øget for at få tilstrækkeligt mange elever med anden etnisk herkomst.

Kønsfordeling:

I første omgang skal det vurderes, hvor repræsentativt stikprøven er for 2009 undersøgelsen mht. fordelingen af drenge og piger. I tabel 2 er vist fordelingen af piger og drenge for den opnåede stikprøve.

Tabel 2. Fordeling på køn samt PISA score i matematik.

PISA 2009	køn	%	Fordeling af 15 årige pr. 1. januar 2009 (udtræk fra Statistikbanken, Danmarks Statistik)	PISA score i matematik (egne beregninger på PISA datasættet)
Piger	3038	51,3	48,7	495,3
Drenge	2886	48,7	51,3	511,4
I alt	5924	100,0	100,0	503,3

I den opnåede stikprøve for 2009 er der flere piger end drenge, der har deltaget i testen. Dette på trods af at der er flere drenge end piger i denne årgang. Udvælgelsen af elever er sket ved, at de skal være født i år 1990. Der er udført en test for, om fordelingen i stikprøven er lig fordelingen i hele landet. Testet bliver stærkt signifikant med en signifikanssandsynlighed, der er mindre end 0,0001. At den danske stikprøve er skæv mht. kønsfordelingen har ikke den store indflydelse på de nationale resultater. Men det er interessant, at stikprøven er blevet skæv, når designet er baseret på udtræk af skoler og efterfølgende tilfældigt udtræk af elever. Når det er vigtigt at undersøge, om stikprøven er repræsentativ på køn, så skyldes det, at det har vist sig at drenge klarer sig bedre end i piger i matematik. Dette gælder ikke alene i Danmark, men i stort set alle lande, der deltager i PISA undersøgelserne. Den umiddelbare konklusion vedr. stikprøvens repræsentativitet er, at drenge i højere grad end piger undgår at deltage. Deltagelsesprocenten for eleverne har siden den første undersøgelse i 2000 været under 90%. Her bør de danske PISA-aktører overveje, om ikke et nationalt krav på mindst 95% elevdeltagelse bør indføres. En opnåelse på 95% bør sikre, at stikprøven bliver repræsentativ mht. kønsfordeling. Trods alt er stikprøven baseret på elever, der går i skole, og prøven bliver gentaget senere for de elever, der har været syge på prøvedagen. En større opnåelse vil altid sikre en større repræsentativitet.

Det må dog også noteres, at kønsfordelingen altid har været lidt skæv, som det fremgår af tabel 3.

Det ses af tabellen, at man normalt i Danmark får flere piger end drenge til at deltage i PISA testene. Dette på trods af at der fødes flere drenge end piger. Den foreløbige konklusion er, at kønsfordelingen har været skæv i de sidste tre nationale PISA test, i den forstand, at flere piger end drenge deltager. Dette må så igen betyde, at den skæve kønsfordeling kun i begrænset omfang kan være årsag til den signifikante nedgang i matematik for 2009.

Tabel 3. Kønsfordeling for de sidste tre nationale PISA test i Danmark.

Antal elever	2003	2006	2009
Piger	2136	2331	3038
Drenge	2082	2201	2886
	4218	4532	5924

Kilde: Egne beregninger på PISA datasæt. Det har ikke muligt at se kønsfordelingen i datasættet fra 2000.

Socioøkonomisk baggrund

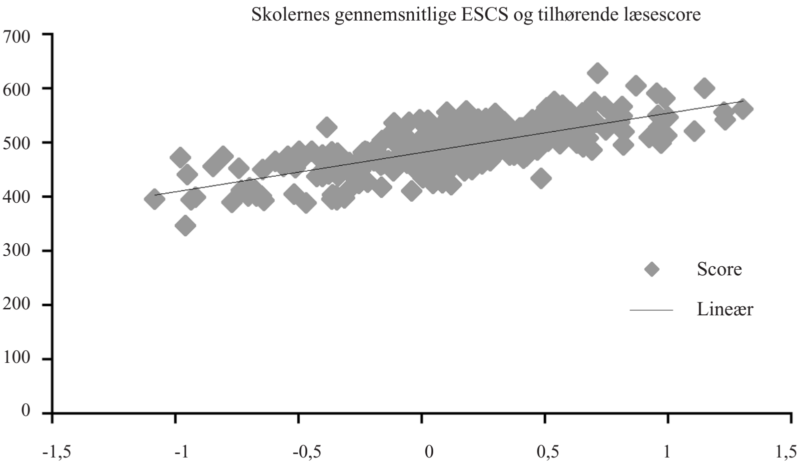
I forbindelse med PISA rapporter har det internationale PISA konsortium udarbejdet et indeks som er benævnt ESCS (economic, social and cultural status). »Dette indeks afspejler en række aspekter ved den enkelte elevs familie- og hjemmebaggrund, som kombinerer information om forældrenes uddannelsesniveau, erhvervsmæssige stilling og forskellige typer af besiddelser i hjemmet« (PISA 2009 s. 130). Det er meget bemærkelsesværdigt, at indekset alene er udarbejdet ved at bruge elevernes egne svar på forældrenes uddannelse, stilling samt diverse besiddelser i hjemmet. Man skal altså ikke bruge registre til at beregne indekset men blot stille eleverne et antal spørgsmål, som de umiddelbart skal svare på. Det er faktisk ganske imponerende, at man med et begrænset antal spørgsmål til elever på ca. 15 år, kan konstruere et indeks, der virker i samtlige lande. Selve beregningen af ESCS ændrer sig lidt fra runde til runde, men et gennemgående træk er, at man altid har stillet spørgsmål om forældrenes uddannelse og beskæftigelse. Indekset ESCS er konstrueret så det har et gennemsnit på ca. nul og en spredning af størrelsesorden 1 for de deltagende OECD lande. Indekset ESCS har vist sig at være kraftigt korreleret med alle tre domæner, dvs. læsning, matematik og naturvidenskab. Der er brugt PISA scoren for læsning i nedenstående figurer. Men billedet er fuldstændig identisk, hvis man havde brugt scoren for matematik.

I PISA 2009 indgik 285 skoler, og for hver skole er gennemsnittet af elevernes læsescore og deres ESCS beregnet. Herved fås 285 punktpar, og disse punktpar er brugt til at illustrere sammenhængen mellem den socioøkonomiske baggrund og scoren for læsning. Scoren for læsning er tilsvarende faslagt således, at gennemsnittet for OECD landene er ca. 500, og den tilhørende spredning er på 100.

Sammenhængen mellem skolernes gennemsnitlige socioøkonomiske baggrund og tilhørende læsescore er ganske tydelig. Har skolen en høj ESCS værdi vil den tilhørende score også være høj og vice versa. For fuldstændighedens skyld er den tilsvarende sammenhæng vist for 2006. (Figur 2a og 2b).

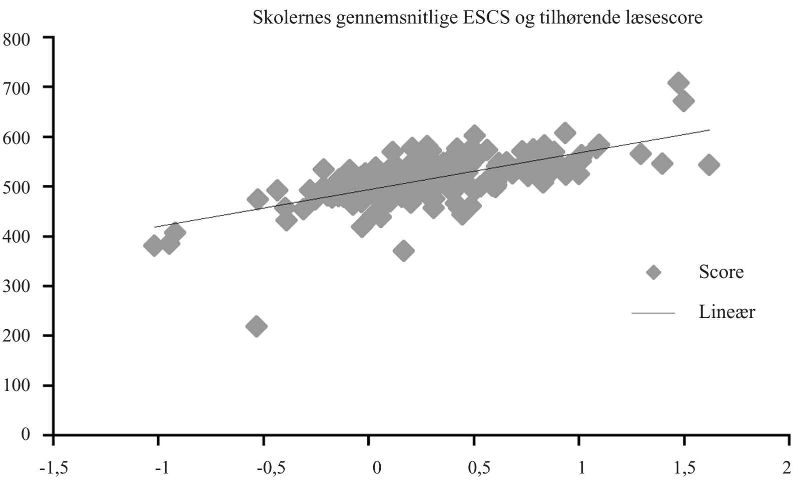
Igen er der en overbevisende sammenhæng mellem ESCS indekset og læsescoren.

Så i langt de fleste analyser på PISA data er det et uundgåeligt krav, at man skal inddrage ESCS indekset. Ovenstående figurer viser også meget klart, at hvis man sammen-



Figur 2a. Sammenhæng mellem ESCS og læsescore på skoleniveau, 2009.

Kilde: Egne beregninger på 2009 datasættet.



Figur 2b. Sammenhæng mellem ESCS og læsescore på skoleniveau, 2006.

Kilde: Egne beregninger på 2009 datasættet.

ligner skolernes gennemsnitskarakterer, så er det i praksis det samme som at sammenstille forældres socioøkonomiske placering. Så de bedste skoler (målt på karakterer) vil som hovedregel være i kommuner med en overvægt af veluddannede og højtlønnede personer.

Tabel 4. Udvikling i matematikscore og ESCS for årene 2006 og 2009.

2006	2009		Ændring i % fra 2006 til 2009
Mat. score			
Dansk	520,3	511,8	1,6
Etnisk	461,1	445,6	3,4
ESCS			
Dansk	0,376	0,367	2,4
Etnisk	-0,178	-0,221	24,2

Kilde: Egne beregninger på PISA datasættene.

Etnisk baggrund

I PISA rapporterne er det tilsvarende dokumenteret, at elever med anden etnisk baggrund som hovedregel får en lavere score. Også dette gælder i stort set alle de deltagende lande og også for alle tre domæner (læsning, matematik og naturvidenskab). I det følgende er eleverne opdelt i to grupper: danskere og etniske. Inddelingen er baseret på elevens besvarelse på to centrale spørgsmål: »I hvilket land blev du og dine forældre født?« og »Hvilket sprog taler du det meste af tiden derhjemme?«. Dermed bliver »dansker« defineret som en elev, der taler dansk i hjemmet og hvor mindst en af forældrene er født i Danmark. Resten bliver dermed defineret som etniske.

Udviklingen for de to grupper (danskere og personer af anden etnisk herkomst) mht. score i matematik og ESCS er vist i tabel 4.

De danske elever har haft et fald i matematikscore fra 520,3 til 511,8 i procent, som altså er signikant. Elever af anden etnisk herkomst har haft et noget større fald. I 2006 scorede de i gennemsnit 461,1. Dette er faldet til 445,6 i 2009, og i procent er faldet ca. dobbelt så stort som hos de danske elever.

Når man ser på den tilsvarende udvikling for indekset for familiens økonomiske, sociale og kulturelle status, så er der også her tale om fald for begge grupper af elever. Dette leder uundgåeligt til, at man må opstille nogle hypoteser, som man burde undersøge nærmere.

Stikprøve designet i 2009 inddeler skoler efter etnicitet. Men skoler med mange etniske elever er også skoler med elever med generelt lave ESCS værdier. Det vil så betyde, at når man udtrækker skoler med mange etniske elever, så får man også generelt udtrukket elever med mindre ESCS værdier. Dette vil så igen betyde at den samlede stikprøve bliver skæv i forhold til den meget vigtige variabel ESCS. Denne hypotese er ikke mulig at teste på basis af de offentliggjorte datasæt med tilhørende rapporter. Det kræver en nøjere gennemgang af selve designet og den gennemførte stikprøveudtrækning.

Den næste hypotese man må overveje er, om opgaverne som stilles i matematik er skrevet i et så vanskeligt sprog, at især elever af anden etnisk herkomst har svært ved at læse opgaven. Hvis man først har svært ved at læse opgaven, så når man jo ikke at vise de matematiske kompetencer, som opgaven egentligt forsøger at teste i. Eksempelvis hvis opgaven omhandler, hvordan en tømrer skal løse en kompliceret opførelse af rækværk rundt om en bygning. Men de egentlige matematiske kompetencer omhandler beregning af en cirkels omfang. Det er derfor muligt, at det alene er den sproglige formulering der bevirker, at de etniske elever ikke løser opgaven. Dette kunne være årsagen til, at de etniske elever har et væsentligt større fald i matematik end de danske elever. Undersøgelsen af denne hypotese kræver detaljeret kendskab til de ca. 80 opgaver, som er stillet, og disse opgaver er forståeligt nok skjult for offentligheden. I den forbindelse bør man notere, at en nærmere analyse af den etniske del af PISA 2009 undersøgelsen viser, at tosprogede elever indhenter de danske elever, Tranæs 2011.

Opsummering

Den samlede vurdering af matematik niveauet i 2009 undersøgelse er:

– Der er et relativt stort frafald af elever på over 10%.
– Der er flere piger end drenge, der deltager i PISA testene
– Elever af anden etnisk herkomst har et større fald i matematikscore end de danske elever
– ESCS indekset er faldet i 2009 undersøgelsen i forhold til 2006 undersøgelsen
– Udviklingen i PISA-K er markant anderledes end udviklingen i de nationale undersøgelser.

Umiddelbart ledes man til at tro, at man må forkaste resultaterne i 2009 undersøgelsen på matematik domænet, da de alene afspejler, at designet er ændret.

Et godt princip, når man skal måle udviklinger over tid med stikprøver, er at bruge den »samme vægt«. Skal man følge ens egen udvikling over tid mht. om en motionsplan virker, så brug den samme vægt. At skifte en gammel badevægt ud med en digital vægt midt i forsøget med motion, vil uundgåeligt ødelægge muligheden for at vurdere udviklingen over tid. Et såkaldt trendbrud, som alle aktører inden for stikprøvedesign frygter. I PISA sammenhæng er »den samme vægt« udtryk for, at man bruger det samme stikprøvedesign over tid. Det må undre mange, at man har tilladt denne markante ændring af stikprøvedesignet, vel vidende at dette ofte bevirker trendbrud. Lige nu har ændringen i stikprøvedesignet rejst så mange spørgsmål om validiteten af udviklingen, at det i en årrække fremover vil være vanskeligt at foretage præcise og kvalificerede vurderinger af udviklingen i folkeskolen målt med PISA test.

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Nationaløkonomisk Tidsskrift 149 (2011): 136-140

Festtale ved Nationaløkonomisk Forenings middag i Kolding i januar 2008

Erling Olsen

Here we are again
Happy as could be
All good pals and
Jolly good company!

Ja, undskyld min sangstemme, men er det ikke herligt? I 135 år har Nationaløkonomisk Forening med passende mellemrum kunnet samle os til foredrag og diskussioner om nationaløkonomiske emner og – med måske lidt for lange – mellemrum kunnet få os til at rive et par dage ud af kalenderen for at drage ud i landet, snakke fag og hygge os med hinanden. Som her i aften.

Hvem er så alle disse good pals?

Vi er vel to ret homogene grupper. Den største består af fagøkonomer uddannet ved nogle af vore højere læreanstalter, lad os bare kalde dem teoretikerne. Den anden gruppe består af mennesker, som i kraft af deres høje placering i det danske samfund mener at have – eller burde have – forstand på nationaløkonomi. Lad os bare kalde dem praktikerne.

Gennemgående har teoretikerne og praktikerne haft det rigtig godt med hinanden. Men engang imellem har der ved sammenkomsterne været tegn på visse praktikeres opfattelse af teoretikerne som nogle verdensfjerne nørder og urealistiske dommedagsprofeter. Hvilket dog ikke har forhindret dem i at pynte på deres bestyrelser med nogle af de højst respekterede professorers navne.

Tilsvarende har der lejlighedsvis været tegn på, at nogle teoretikere – inspireret af John Maynard Keynes – har anset praktikerne for mennesker, som baserede deres virke på en forældet teori. Hvilket dog sjældent har forhindret dem i at takke ja til de vel aflagte bestyrelsesposter.

Redaktionen har med samtykke af hans søn Tore Olsen ønsket at hædre det mangeårige medlem af foreningen ved at optrykke hans festtale.

En af de virkelige åndsaristokrater, professor Frederik Zeuthen, holdt sig fri af alle bestyrelsesposter, men han nød samværet i Nationaløkonomisk Forening med de praktikere, som han respekterede. Men ve den praktiker, som kom til at sige noget sludder. Blandt mine første indtryk fra foreningen var et møde for ca. 60 år siden. På talerstolen stod dr. Rudolph Christiani, seniorpartner i en af datidens største entreprenørvirksomheder, Christiani & Nielsen. På tilhørerpladserne sad Frederik Zeuthen med et stadig mere forpint udtryk i sit ansigt. Pludselig hørtes hans gennemtrængende stemme hviske: »Det må være en meget dygtig mand, den Nielsen«.

I foreningens første halve århundrede var Københavns universitet ene leverandør af fagøkonomer. Så kom Handelshøjskolen i København, nu CBS, i 1917. I 1936 oprettedes et økonomisk og juridisk fakultet ved det såkaldte jungleuniversitet i Århus. I 1964 kom Odense, nu Syddansk, Universitet og i henholdsvis 1972 og 1974 fulgte Roskilde og Ålborg efter.

På Bjerget så man på denne udvikling med blandede følelser. På den ene side havde man svært ved at forstå, hvorledes der kunne gives nogen en forsvarlig indføring i nationaløkonomi uden for det københavnske latinerkvarter. På den anden side åbnedes der nogle stillinger til gode kandidater, som man gerne havde ansat, men ikke havde normeringer til, og endelig gav det muligheder for at slippe af med nogle afvigere.

Det kunne være formidabelt dygtige lærere som Poul Nyboe Andersen, om hvem det hed sig, at han med samme ord kunne forklare nøjagtig det samme til Maren i Kæret og præsidenten for Den internationale Valutafond, så Maren forstod det, uden at præsidenten fandt det banalt. Han gled ud på Handelshøjskolen. Til Århus udskiltes nogle af de inspirerende, yngre lærere, som efter ældre kollegers mening beslaglagde alt for meget af de studerendes tid og interesse. Det drejede sig blandt andre om Jørgen Pedersen, som mod sine foresattes instrukser læste Keynes med sine studerende, og Jørgen Gelting, der havde forsøgt sig med en teori om det balancerede budgets multiplikatorvirkning, som kun Jørgen P. forstod. De røg begge til Århus. Til Odense afsattes en række pæne, vel afrettede økonomer, medens marxisterne forvistes til Roskilde og Ålborg.

Som tiden gik, glattedes modsætningerne dog ud, og igen kunne alle hygge sig med hinanden i Nationaløkonomisk Forening.

Langt de fleste sikrede sig også et abonnement på Nationaløkonomisk Tidsskrift. Heri publiceres foredrag holdt i foreningen, videnskabelige artikler fra ambitiøse økonomer, som ønsker at meritere sig, og seriøse anmeldelser af relevante bøger, alt under streng kvalitetskontrol fra en sagkyndig redaktion. Ved foreningens 100 års jubilæum udsendtes et særnummer af tidsskriftet, men artiklerne var tørre og saglige uden så meget som et halmstrå til en festtaler. Det eneste opmuntrende var Svend Aage Hansens billedgalleri.

Gennem alle årene er det lykkedes skiftende redaktioner at fastholde tidsskriftet som det førende, danske fagskrift for økonomer. Såvel præsentationen af emner og metoder som selve udtryksformen er løbende fulgt med tiden, men den snigende globalisering har sat sine spor. Det har for det første betydet, at det nationaløkonomiske er blevet fortrængt af det samfundsøkonomiske. For det andet, at selve tidsskriftet er blevet fortrængt som primær publikationskilde for karrierebevidste danske økonomers artikler. Nu tæller det mere at publicere internationalt.

Når det drejer sig om foreningens aktiviteter, går mine erindringer ikke længere tilbage end til tiden umiddelbart efter Den 2. Verdenskrig. Til gengæld står de temmelig klart over for indtrykket af de aktiviteter, som foreningen udfolder i dag. Særligt tydelige er forskellene i tid, sted, påklædning, forplejning og ledelse ved afviklingen af foreningens almindelige møder.

Den gang startede man kl. 20 med det traditionelle akademiske kvarter. Man skulle hjem til aftensmaden, inden man kunne gå til møde. I dag begynder man præcis kl. 17 for at nå mødet, inden man skal hjem til aftensmaden.

Den gang forgik møderne i Odd Fellow Palæets fornemme sale. I dag foregår møderne på Bispetorvet i den let nedslidte Alexandersal.

Den gang klædte man sig standsmæssigt på, inden man gik til møde i foreningen. I dag kommer man i hvad som helst.

Den gang gik man efter foredraget over i en fornem spisesal, og medens diskussionen fandt sted, serverede smokingklædte tjenere – mod klækkelig betaling – højt belagt smørrebrød samt kaffe med eller uden avec. I dag stilles nogle humpler og lidt drikkelse gratis til rådighed for dem, som kommer en halv time før mødet.

Hvad mere var: Vores daværende formand, Carl Iversen, praktiserede en helt anden mødeledelse end vores nuværende, Michael Møller.

Fysisk var Carl Iversen en meget lille mand, men på mange måder havde han et betydeligt format. Han var den bedste underviser på politstudiet, fuld af relevante anekdoter og talte engelsk som en indfødt (amerikaner). Han var i besiddelse af et imponerende, internationalt netværk samt et vældigt organisationstalent. Intet under, at han blev vor forening en effektiv formand og endte som universitetets rektor. Men det var i professorvældets tid, og i pagt med tiden krævede han udpræget respekt om sin person og den forening, han var formand for.

Derfor kunne han bliv temmelig ubehagelig, hvis man kom ham på tværs eller ikke levede op til hans krav. Det gjorde de fleste studerende bange for ham, og ved foreningens møder skulle der virkelig rettes ind efter formanden.

Men Carl Iversen havde også nogle gode, menneskelige egenskaber. Han havde arbejdet sig op fra ganske små kår og forstod til fulde, at studenter ikke kunne have råd til at deltage i de dyre spisninger efter foredragene. Men det skulle ikke forhindre dem i at overvære debatterne. Derfor fik han opstillet nogle stole langt spisesalens vægge. Der kunne så studenterne sidde for at sluge visdommen, medens foreningens ældre medlemmer sad ved bordene for at sluge det højt belagte.

Respekt for foredragsholderne og høvisk tale var også noget, som Carl Iversen forlangte. Det bragte mig engang i vanskeligheder, fordi jeg mente at have et frisprog over for ambassadør Bartels, der en halv snes år forinden havde været en skattet manuduktør under mit førstedelsstudium. Lige efter krigen fik vi brug for privatmanuduktion, fordi mange lærere strøg af sted til udlandet og aflyste deres forelæsninger, da de med Carl Iversens ord »kun kunne tjene deres land på et sted ad gangen«.

Nu optrådte Bartels som foredragsholder i foreningen, og da han kom i tidnød, udbrød han: »Her må jeg springe et afsnit over. Det var desværre det bedste«. Det fristede mig til en beklagelse, fordi jeg gennem årene havde læst det meste af, hvad Bartels havde skrevet, og hver gang fået det indtryk, at netop det bedste afsnit måtte være gået ud. Det tog Bartels med et smil, men Iversen blev rasende.

Da vi forlod mødet rakte jeg ham hånden, men han nægtede at tage min, og de følgende tre dage så han lige igennem mig, hver gang vi mødtes på universitetet. Til sidst kaldte han mig ind på lærerværelset og forklarede mig i stærkt ophidsede vendinger, at sådan kunne man altså ikke opføre sig i hans forening og over for hans foredragsholdere. Til sidst sank han udmattet ned i sin stol og sagde med et stille smil. »Nå ja, man må jo indrømme, at den sad«. Sådan kunne Carl Iversen også være.

Ind imellem – men ikke i foreningen – kunne han ret beset være lige så hyggelig og afslappet som Michael Møller.

De ydre rammer for foreningens særlige arrangementer var også højst forskellige den gang fra nu. Det stod klart for mig, da jeg for at blive fagligt opdateret sad henslængt i en af DSBs vel apterede kupeer på vej til Koldingfjords fortræffelige konferencelokaler, raffinerede mad og luksuriøse indkvartering.

Tanken gik da tilbage til en lignende faglig opdatering i sidste halvdel af 1940erne. Den fandt sted på Krogerup højskole, hvor Nyboe Andersen og Hal Koch regerede. Vi drog derop på Kystbanens 3. klasses træbænke, spiste beskedent på højskolemaner, lod os indkvartere i de primitive elevværelser og fandt det hele i sin orden. Så der er virkelig sket noget på både efterspørgsels- og udbudssiden.

At det fagligt blev så vellykket, skyldtes ikke mindst Carl Iversens forarbejde. Han havde sammensat et formidabelt mødeprogram, blandt andet ved at trække sin gamle lærer, Bertil Ohlin, ned fra Stockholm.

Ohlin var en af de større stjerner på det økonomisk-teoretiske firmament. I sine unge dage havde han været den yngste professor ved Københavns universitet, men vendte hurtigt tilbage til sit fædreland. Nu var han som mange andre ældre økonomer blevet politiker, men han evnede stadig at tryllebinde sine fagfæller.

Jeg kan ikke huske hans indlæg. Kun at det var fremragende. Men jeg husker den elegante måde, hvorpå han venligt afviste en indvending fra den unge Ivar Nørgaard. For at styrke sin argumentation havde den unge mand pyntet sit indlæg med et citat af Carl Iversen. Ohlin svarede ved at rose sin opponent og påpege, at Iversen-citatet stammede fra ham selv. »Jag är farfar til hr. Nørgaard«, erklærede Ohlin, og så drysse-de stjernestøvet ned over alle Carl Iversens elever.

Vi forlod i hvert fald Krogerup i opløftet stemning. »Vor 75 år gamle forening kan endnu«, hørte jeg en ældre kollega sige, Mon ikke det går lige sådan i morgen. Nu er jeg blevet den ældre kollega, og efter alt, hvad jeg hidtil har hørt, kan jeg med fuld overbevisning sige: »Vor 135 år gamle forening kan endnu«.

Skal vi ikke tage vore glas, rejse os op og give den et leve: Tre korte og så det lange.

Errata

I Nationaløkonomisk Tidsskrift 2010, nr. 3 bragtes en kommentar fra Peter Birch Sørensen om »Finanskrisen og den økonomiske videnskab«. Desværre var der stærkt meningsforstyrrende fejl i indlæggets to tabeller. Redaktionen har derfor valgt at bringe det rettede indlæg i sin helhed.

Redaktionen beklager dette over for forfatter og læsere.

Nationaløkonomisk Tidsskrift 149 (2011): 142-157

Finanskrisen og den økonomiske videnskab

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Den internationale finanskrise, der kulminerede i efteråret 2008, kom som en overraskelse for det store flertal af økonomer. Krisen var så voldsom, at aktiviteten på flere centrale finansielle markeder tørrede helt ud. Uden de omfattende indgreb fra stater og centralbanker ville vi utvivlsomt have oplevet et totalt sammenbrud af det globale finansielle og økonomiske system.

Denne alvorlige forskrækkelse har udløst dyb selvransagelse hos mange økonomer. Paul Krugman, der i 2008 modtog Nobelprisen i økonomi, stillede forrige år i New York Times spørgsmålet: »Hvordan kunne økonomerne tage så meget fejl?« Den hårde debat, som Krugmans artikel udløste, er blot ét blandt mange eksempler på de voldsomme faglige kontroverser blandt økonomer, som finanskrisen har igangsat. Debattørerne kan groft sagt inddeles i to lejre. På den ene side står de, der ser et behov for en fundamental nyorientering af økonomisk teori. På den anden side finder man dem, der mener, at de centrale træk ved finanskrisen udmærket kan forklares ved brug af gængs økonomisk teori. I det følgende vil jeg give mit eget bidrag til denne diskussion.

Finanskrisen begyndte så småt i foråret 2007, hvor nogle finansielle institutioner meldte om tab relateret til de såkaldte subprime-lån til mindre kreditværdige amerikanske boligejere. Mange af disse låntagere havde fået bevilget boliglån med afdragsfrihed og i nogle tilfælde også meget lave renter i de første år af lånets løbetid, da de i praksis ikke havde råd til at betale normale renter og afdrag. Subprime-låntagerne var derfor i stort omfang afhængige af, at de kunne optage nye billige lån med sikkerhed i boligen for at kunne tilbagebetale de gamle lån på det tidspunkt, hvor de ellers skulle have begyndt at betale normale renter og afdrag. Dette forløb nogenlunde glat, så længe de amerikanske boligpriser blev ved med at stige, hvilket de havde gjort, så længe de fleste kunne huske tilbage. Fra midten af 2006 begyndte huspriserne i USA imidlertid så småt at falde, og faldet tog til i løbet af 2007. Det satte en stopper for trafikken med at finansiere tilbagebetaling af gamle lån via optagelse af nye lån, da sikkerheden i form af friværdien i boligerne forsvandt. På grund af manglende betalingsevne hos låntagerne opstod der derfor tab på obligationer udstedt på basis af subprime-lån.

Indlægget er baseret på et foredrag i Videnskabernes Selskab den 28. april 2011. Jeg takker Kim Abildgren, Anders Møller Christensen og Ib Hansen for nyttige kommentarer til en tidligere version af dette manuskript. Alle tilbageværende mangler er mit eget ansvar.

Vi ved alle, hvordan denne misere endte. Efter længere tids finansiel uro accelererede finanskrisen voldsomt den 15. september 2008, hvor den store amerikanske investeringsbank Lehman Brothers fik lov at gå ned. Efter Lehmans fallit frøs pengemarkederne helt til. Bankerne turde ikke længere låne ud til hinanden, da ingen havde overblik over, hvilke banker der stod til at lide tab som følge af det finansielle kaos. Centralbanker og regeringer måtte derfor gennemføre drastiske indgreb for at undgå et fuldstændigt sammenbrud af tilliden til det finansielle system.

Det er ikke nogen stor intellektuel udfordring at forklare, hvorfor den uansvarlige långivning på det amerikanske subprime-marked før eller siden måtte gå galt. Udfordringen består i at forstå, hvorfor problemer i et forholdsvis lille hjørne af det internationale finansielle system kunne bringe hele systemet på randen af det totale sammenbrud. Udlånene til de amerikanske subprime-låntagere udgjorde trods alt kun en meget beskeden andel af de samlede aktiver i det globale finansielle system. Der må have været nogle faktorer, som gjorde systemet meget ustabilt, siden den lille subprime-tue kunne vælte hele det store finansielle læs.

Spørgsmålet er, om man i gængs økonomisk teori kan finde gode forklaringer på, hvorfor det finansielle system var blevet så ustabilt? Svaret er et klart »Ja«. En økonom vil fokusere på, at den finansielle sektor kan være præget af incitamenter til overdreven gældsætning og risikotagning, og at priserne på finansielle aktiver ikke altid afspejler den samfundsmæssige investeringsrisiko. Af forskellige grunde, som jeg vender tilbage til, fik disse uheldige incitamenter og tendenser lov at slå stærkere igennem i de seneste årtier end tidligere.

Lad os se nærmere på, hvilke økonomiske incitamenter, der kan være tale om. Langt de fleste finansielle virksomheder drives på aktieselskabsform. Som påpeget af bl.a. den tyske økonom Hans-Werner Sinn (2010, kap. 4) kan aktionærernes begrænsede økonomiske ansvar give en tilskyndelse til overdreven risikotagning og gældsætning, hvis aktieselskabets kreditorer ikke er tilstrækkeligt velinformerede. Tabel 1 giver en forenklet illustration af Sinns pointe. I tabellen ses på to alternative investeringer, der begge indebærer en samlet investeringsudgift på 100, finansieret af en aktiekapital på 20 og et lån på 80, der skal forrentes med 5%. Den ene investeringsmulighed giver med 90 procents sandsynlighed et afkast på 7,2%, mens der er 10 procents sandsynlighed for at tabe 15% af den investerede kapital. Den anden investeringsmulighed er mere risikabel, da den ganske vist giver et afkast på 11,1% i den situation, hvor investeringen går godt, men til gengæld indebærer en 10 procents sandsynlighed for, at halvdelen af den investerede kapital går tabt. I den sidstnævnte situation går selskabet fallit, da både egenkapitalen og en del af fremmedkapitalen mistes. Tallene i tabellen viser de forventede investeringsafkast, beregnet som afkastet i de to situationer, hvor investeringen går henholdsvis godt og skidt, ganget med sandsynlig-

Tabel 1. Kapitalafkast og risikoprofil. (Samlet investering = 100, aktiekapital = 20, lånekapital = 80, lånerente = 5%).

	Investering med lav risiko: 90% sandsynlighed for afkast på 7,2% 10% sandsynlighed for afkast på -15%	Investering med høj risiko: 90% sandsynlighed for afkast på 11,1% 10% sandsynlighed for afkast på -50%
Forventet afkast af samlet investering	$\frac{0{,}9\times100\times1{,}072 + 0{,}1\times100\times0{,}85-100}{100} = 5\%$	$\frac{0{,}9\times100\times1{,}111+0{,}1\times100\times0{,}5-100}{100} = 5\%$
Forventet afkast til långivere	$\frac{0{,}9\times80\times1{,}05+0{,}1\times80\times1{,}05-80}{80} = 5\%$	$\frac{0{,}9\times80\times1{,}05+0{,}1\times50-80}{80} = 0{,}8\%$
Forventet afkast til aktionærer	$\frac{0{,}9\times(100\times1{,}072-80\times1{,}05) + 0{,}1\times(100\times0{,}85-80\times1{,}05)-20}{20} = 5\%$	$\frac{0{,}9\times(100\times1{,}111-80\times1{,}05)-20}{20} = 22\%$

hederne for de to udfald. Afkastraterne i de to projekter er valgt sådan, at både den mindre og den mere risikable investering giver et samlet forventet afkast på 5%. Ved gennemførelse af det mindre risikable projekt vil både långivere og aktionærer ligeledes få et forventet afkast på 5%, som det fremgår af første søjle i tabellen. Men hvor långiverne har fuld sikkerhed for at opnå et afkast på 5%, uanset om investeringen går godt eller skidt, så står aktionærerne til at tabe 19 ud af deres investerede kapital på 20, hvis projektet går dårligt. I så fald skal aktionærerne nemlig dels dække projektets tab på 15 og dels betale 4 i renter til långiverne. En risikoavers investor vil derfor foretrække en fredelig tilværelse som passiv kuponklipper frem for at stille risikovillig aktiekapital til rådighed for et projekt som det, der er beskrevet i første søjle i tabel 1.

Projektet i tabellens anden søjle er derimod langt mere interessant for aktionærerne. Det gælder på trods af, at projektet indebærer en større risiko uden at give et højere forventet samlet afkast. Det behagelige for aktionærerne er, at långiverne nu bærer størstedelen af tabet i den situation, hvor projektet slår fejl, da aktionærernes ansvar er begrænset til deres indskudte aktiekapital. Hvis projektet derimod går godt, får aktionærerne hele merafkastet ud over markedsrenten på de 5%. Aktionærerne kan dermed se frem til et respektabelt forventet afkast på 22%, mens de har en 10% risiko for at miste hele deres investerede kapital på 20. I det mindre risikable projekt har aktionærerne den samme risiko på 10% for at miste en kapital på 19, men her opnår de kun et forventet afkast på 5%. Aktionærerne vil derfor helt klart foretrække at gennemføre det mere risikable projekt, med mindre de er ekstremt risikoaverse.

På grund af risikoen for tab får långiverne kun et forventet afkast på 0,8% i det mere risikofyldte projekt. En oplagt indvending mod eksemplet i tabellen er derfor, at långiverne vil kræve en højere rente for at finansiere den mere risikable investering frem for det mindre risikable projekt. Hvis långiverne f.eks. justerer deres rentekrav, så de opnår det samme forventede afkast på 5% i de to investeringssituationer, vil aktionærerne være slået tilbage til start, da de i så fald ikke kan hæve deres forventede afkast op over 5% ved at vælge det mere risikable projekt.

Moderne økonomisk teori fremhæver imidlertid, at mangelfuld og asymmetrisk information ofte forhindrer denne disciplinerende rentemekanisme i at virke. Specielt i den finansielle sektor vil indskydere og långivere typisk kun have begrænset viden om risikoprofilen i de mange forskellige investeringsmuligheder, som en moderne finansiel virksomhed står overfor. Bankerne låner jo ud til et stort antal virksomheder og husholdninger, hvis kreditværdighed de undertiden selv har svært ved at vurdere. Endvidere investerer bankerne ofte store beløb i komplicerede strukturerede værdipapirer og afledte finansielle instrumenter. Selv de mere sofistiskerede långivere og indskydere kan derfor have meget svært ved at vurdere, hvorvidt og i hvilket omfang en bank har omlagt sine aktiver i retning af mere risikable investeringer. Banken selv har ingen interesse i at informere om en sådan porteføljeomlægning, da det vil udløse krav om højere rente fra bankens långivere, hvilket medfører lavere afkast til bankens aktionærer.

Problemet med at sikre en passende disciplinerende risikopræmie i forbindelse med lån til bankerne forstærkes af de offentlige indskydergarantiordninger. I tidligere tider oplevede man ofte under finansielle kriser, at mange banker gik ned, fordi et stort antal indskydere i panik trak deres indlån ud på samme tid. Garantiordninger kan forebygge sådanne panikdrevne stormløb mod bankerne. Til gengæld betyder de også, at indskydere med indlån under den garanterede grænse ikke har nogen tilskyndelse til at tjekke, om banken forvalter indskuddene på ansvarlig vis, da indlånene jo under alle omstændigheder er sikrede.

Indskydere og långivere, der ikke er dækket af en eksplicit garantiordning, vil heller ikke have incitament til at indsamle information om risikoen ved bankernes udlån og investeringer, hvis der er udbredte forventninger om, at staten vil træde til og dække deres tilgodehavender, såfremt banken bliver insolvent. Det er det velkendte »too-big-to-fail« problem: Staten kan føle sig presset til at redde nødlidende banker, eller i hvert fald til at holde deres kreditorer skadesløse, hvis en konkurs i en bank truer den generelle finansielle og økonomiske stabilitet. Finanskrisen leverede utallige eksempler på dette.

Informationsproblemer og eksplicitte eller implicitte garantier kan også give bankerne et incitament til at arbejde med en uhensigtsmæssigt lav egenkapital. Det er illustreret i tabel 2. Forudsætningerne i tabellens første søjle er helt identiske med forudsætningerne i første søjle af tabel 1, og de forventede afkastrater er derfor også de samme. 80% af investeringen finansieres med lånekapital, mens 20% finansieres med aktiekapital, og aktionærerne har kun udsigt til et pauvert forventet afkast på 5%, selvom de risikerer at miste 95% af deres kapital, hvis projektet slår fejl.

Finansieringsmodellen i anden søjle i tabel 2 er langt mere attraktiv for aktionærerne. Her finansieres kun 5% af investeringen med aktiekapital, idet långiverne leverer de resterende 95%. Da långiverne nu har sat mere på spil, står de til et tab på 10, hvis investeringen går dårligt, og deres forventede afkast falder derfor fra 5% til 3,4%. I forhold til situationen med lav gearing taber aktionærerne kun en lidt større andel af deres kapital, nemlig 100% i stedet for 95%, hvis investeringen går skidt, men deres forventede afkast når nu op på hele 34,5%.

Aktionærerne har altså opnået et langt gunstigere forhold mellem forventet afkast og risiko og vil derfor foretrække finansieringsmodellen med høj gearing, dvs. den høje belåningsgrad. Långiverne står derimod med en risiko for et større tab, og derfor kan man argumentere, at de vil kræve en højere lånerente end de 5%, der er forudsat i taleksemplet med den høje gearing. Et berømt teorem formuleret af Modigliani og

Tabel 2. Kapitalafkast og gearing. (Samlet investering = 100, 90% sandsynlighed for afkast på 7,2%, 10% sandsynlighed for afkast på -15%, lånerente = 5%).

	Lav gearing: Lånekapital = 80 Aktiekapital = 20	Høj gearing: Lånekapital = 95 Aktiekapital = 5
Forventet afkast af samlet investering	$\frac{0,9\times100\times1,072 + 0,1\times100\times0,85 - 100}{100} = 5\%$	$\frac{0,9\times100\times1,072 + 0,1\times100\times0,85 - 100}{100} = 5\%$
Forventet afkast til långivere	$\frac{0,9\times80\times1,05 + 0,1\times80\times1,05 - 80}{80} = 5\%$	$\frac{0,9\times95\times1,05 + 0,1\times85 - 95}{9,5} = 3,4\%$
Forventet afkast til aktionærer	$\frac{0,9\times(100\times1,072 - 80\times1,05) + 0,1\times(100\times0,85 - 80\times1,05) - 20}{20} = 5\%$	$\frac{0,9\times(100\times1,072 - 95\times1,05) - 5}{5} = 34,5\%$

Miller (1958) siger netop, at aktionærerne ikke kan tiltvinge sig en mere fordelagtig kombination af forventet afkast og risiko ved at øge selskabets gældsprocent, fordi långiverne vil tage sig betalt for den højere risiko for tab, som de løber.

Modigliani-Miller teoremet forudsætter imidlertid, at långiverne er fuldt lige så velinformerede om selskabets risikoprofil som aktionærer og ledelse, og at lånekapitalen ikke er omfattet af eksplicitte eller implicitte statsgarantier. Men som eksemplet i tabel 1 viste, kan bankerne have et incitament til at underdrive, hvor risikable deres investeringer er. I eksemplet i tabel 2 kan det derfor tænkes, at långiverne undervurderer størrelsen af tabet i det ugunstige investeringsudfald, eller at de undervurderer sandsynligheden for, at tabet indtræffer. Hvis långiverne vurderer tabsrisikoen til at være tilstrækkeligt lille, så vil de forvente, at de under alle omstændigheder vil få deres udlån tilbagebetalt med rente, med mindre investeringens egenkapitalandel falder ned under et kritisk minimumsniveau. Selvom den sande tabsrisiko er givet ved tallene i tabel 2, kan långiverne altså fejlagtigt tro, at deres risiko ikke øges mærkbart ved, at gearingsgraden af investeringen øges fra 80 til 95%. I så fald vil de heller ikke se nogen grund til at kræve en højere rente.

Men selv hvis långiverne indser, at den højere gearing påfører dem væsentligt højere risiko for tab, vil de mangle incitament til at kræve en højere lånerente, hvis de er dækkede af eksplicitte eller implicitte statslige garantier, der kompenserer dem for eventuelle tab. Dermed er der ingen markedsmekanisme til at modvirke bankernes incitament til at vælge en meget høj gearing med deraf følgende høj risiko for fallit.

Myndighederne er naturligvis opmærksomme på dette problem og har derfor igennem mange år stillet krav til bankerne om, at deres aktiver er bakket op af en vis minimal egenkapitalandel. Spørgsmålet er derfor, hvordan balancen mellem de omtalte skæve incitamenter og bankreguleringen kunne tippe, så vi i sidste årti fik en finanskrise af hidtil uset omfang. Forklaringen skal søges i et samspil af mange komplekse faktorer, men de fleste er enige om, at især tre forhold spillede en vigtig rolle.[1] For det første fremvoksede der især i USA et omfattende såkaldt skyggebanksystem, der ikke var underkastet den traditionelle bankregulering med minimumskrav til egenkapitalen. Mange banker oprettede nye investeringsselskaber eller stillede garantier for sådanne selskaber, der specialiserede sig i investering i forskellige nye typer af værdipapirer. Værdipapirerne var i stort omfang udstedt på basis af lån, som blev bevilget men efterfølgende frasolgt af de traditionelle banker. En stadig større del af den samlede kreditgivning blev således kanaliseret via værdipapirmarkederne uden om det traditionelle banksystem.

De store amerikanske investeringsbanker som f.eks. Lehman Brothers var en del af skyggebanksystemet og opererede med egenkapitalprocenter på 3-4 % af deres samle-

1. En mere udførlig dansk fremstilling af årsagerne til finanskrisen kan findes i Berg og Bech (2009).

de aktiver. En egenkapitalprocent på 4 betyder, at hver gang der investeres for en dollar aktiekapital, bliver der investeret for 24 dollars af lånte midler. I den situation skal værdien af de erhvervede aktiver kun falde med 4%, før egenkapitalen er udraderet, og långiverne begynder at lide tab. Der blev således løbet store risici, tilskyndet af de meget høje forventede afkastrater, som denne ekstreme grad af gearing typisk indebærer. Hvis investeringerne gik godt, scorede aktionærerne store gevinster, og hvis de gik skidt, var det primært långiverne eller skatteyderne, der måtte bære tabet.

For det andet opbyggede mange banker i årene op til finanskrisen et stigende indlånsunderskud, dvs. deres udlån og investeringer oversteg i stigende grad deres indlån. Indlånsunderskuddet var typisk finansieret via kortfristede lån og gældspapirer, mens provenuet af disse lån fortrinsvis var placeret i mere langfristede og dermed mindre likvide aktiver. Bankerne blev derved i stigende omfang afhængige af, at andre investorer og finansielle institutioner var villige til løbende at refinansiere deres kortfristede gæld. Da denne mulighed for refinansiering pludselig faldt bort, som det skete under finanskrisen, blev nogle banker tvunget til at foretage brandudsalg af deres aktiver. Det førte til drastiske kursfald på mange værdipapirer, hvorved andre banker blev tvunget til at nedskrive værdien af deres aktiver og dermed kom i vanskeligheder.

Bankernes grundlæggende forretningsmodel har altid været at omdanne likvide kortfristede indlån til mindre likvide langfristede udlån og investeringer. Denne transformation af korte indlån til lange udlån er overordentlig nyttig og vigtig for det økonomiske system, men den indebærer selvsagt også en stor risiko. Hvis tilliden til en bank svigter, og indskyderne ikke er dækket af en garantiordning, vil de løbe storm mod banken for at trække deres penge ud. Dermed går banken ned, da den ikke med øjeblikkeligt varsel kan omsætte sine langfristede aktiver til likvider. De føromtalte problemer med manglende information hos indskydere og långivere kan i ugunstige situationer betyde, at selv fornuftigt drevne solvente banker går fallit på grund af likviditetsmangel, hvis de udsættes for et stormløb, der udspringer af manglende tillid. Denne dyrekøbte erfaring førte efter 1930'ernes store depression til, at de fleste lande indførte generelle indskydergarantiordninger.

Men i årene op til finanskrisen var det, som om man havde glemt problemet med den iboende ustabilitet i bankernes forretningsmodel. De store indlånsunderskud i mange banker var jo netop finansieret af kortfristet gæld, der ikke var sikret af garantiordninger. Da tilliden svigtede under finanskrisen, oplevede banker med indlånsunderskud derfor en ny form for stormløb, idet de pludselig ikke kunne få fornyet de kortfristede lån, de var vant til at optage hos andre banker og finansielle institutioner. Hvor de klassiske bankkriser tidligere i historien typisk bestod i, at almindelige borgere og virksomheder trak deres penge ud af bankerne, så oplevede vi under finanskrisen i efteråret 2008, at det finansielle system foranstaltede et stormløb mod sig selv. Alle finansielle institutioner holdt sig tilbage fra at udlåne til hinanden, da de frygtede selv at komme til at mangle likviditet. De grundlæggende mekanismer var imidlertid de samme som under et klassisk bank run. Mekanismerne er beskrevet i et fremragende videnskabeligt bidrag af Douglas Diamond og Philip Dybvig (1983), der både påviser de samfundsmæssige fordele ved bankernes transformation af korte indlån til lange udlån og samtidig demonstrerer, hvordan tillidssvigt kan føre til skadelige bank runs, som kan forebygges af indskydergarantiordninger. Da finanskrisen nåede sit klimaks, måtte staterne træde til med omfattende garantier for alle indskydere og kreditorer for at redde det finansielle system fra det totale sammenbrud. De udvidede garantiordninger var en nødvendig nødløsning i den konkrete situation, men de har også forstærket det såkaldte moral hazard problem, der består i, at garantier mod tab eliminerer indskydernes og långivernes tilskyndelse til at overvåge, om bankerne investerer pengene ansvarligt. Som fremhævet i et vigtigt bidrag fra John Kareken og Neil Wallace (1978) kan moral hazard problemet i sig selv gøre banksystemet mere risikobetonet og ustabilt.

Et tredje væsentligt forhold, som viste sig at øge ustabiliteten i det finansielle system i årene op til finanskrisen, var fremkomsten af stadigt mere komplicerede typer af værdipapirer, hvis risikoegenskaber var svære at gennemskue. De såkaldte asset-backed securities, dvs. værdipapirer udstedt med basis i boliglån og andre former for lån, blev samlet i puljer, som dannede grundlag for udstedelse af nye værdipapirer, der igen blev samlet i puljer som basis for en ny runde af udstedelser, og så fremdeles. Formålet med disse komplicerede konstruktioner var at mindske den risiko, der knyttede sig til det enkelte værdipapir. Puljerne af værdipapirer blev også inddelt i forskellige risikoklasser. Ideen var, at hvis der opstod tab på de oprindelige bagvedliggende udlån, så skulle tabene i første omfang bæres af ejerne af obligationerne i den mest udsatte risikoklasse, inden obligationsejerne i den næstmest udsatte risikoklasse kunne begynde at lide tab, osv. På den måde mente man, at obligationerne i de mindre udsatte risikoklasser var meget sikre papirer, selvom alle obligationerne f.eks. var udstedt på basis af subprime-lån til mindre kreditværdige boligejere med tvivlsom betalingsevne. Man forestillede sig ikke, at et meget stort antal låntagere kunne komme i vanskeligheder på samme tid, således at selv obligationsejerne i de mest gunstigt stillede risikoklasser ikke kunne få deres tilgodehavender. Men det var netop, hvad der skete, da boligpriserne vendte overalt i USA, så subprime-låntagere ikke længere kunne finansiere tilbagebetaling af gamle boliglån ved at optage nye lån.

Formodningen var altså, at man via de nye såkaldte strukturerede værdipapirer havde fået spredt risikoen mere effektivt ud i det finansielle system, så risikoen for den enkelte investor var blevet mindre. De nye syntetiske værdipapirer var imidlertid så komplicerede, at de færreste var i stand til at gennemskue, hvilke pengestrømme de var baseret på, og hvor store sandsynlighederne var for, at de pågældende pengestrømme faktisk ville materialisere sig. Den vurdering overlod man til de store kreditvurderingsbureauer, hvilket skulle vise sig at være en skæbnesvanger fejl. Da finanskrisen brød ud, blev mange værdipapirer, som rating-bureauerne havde vurderet som helt sikre, pludseligt nærmest værdiløse. Det medvirkede selvsagt til at forstærke den finansielle panik. Hvordan kunne rating-bureauerne tage så meget fejl? En af forklaringerne er formentlig, at erfaringerne med og dermed det statistiske grundlag for at vurdere de mange nye komplicerede finansielle produkter var meget begrænsede.

Men en økonom vil også pege på, at den grundlæggende konstruktion omkring rating-bureauerne indebærer et incitamentsproblem, som kan tilskynde dem til at være overoptimistiske i deres vurderinger. Rating-bureauerne betales af de institutioner, der udsteder de værdipapirer, som skal vurderes. Disse institutioner er naturligvis interesserede i, at papirerne får en god rating, så de kan sælges til en høj pris. I forbindelse med konstruktionen af de mange nye strukturerede værdipapirer baseret på f.eks. subprime-lån skete det ofte, at udstederne af papirerne på forhånd betalte rating-bureauerne for at rådgive om, hvordan de bagvedliggende puljer af lån og aktiver skulle kombineres, således at det planlagte nye strukturerede værdipapir fik den højest mulige rating. Efterfølgende blev det selvsamme rating-bureau så bedt om – og betalt for – at afgive en rating af det nye værdipapir, det selv havde været med til at konstruere. Ikke overraskende viste denne rating sig typisk at være god.

Hermed være ikke sagt, at rating-bureauerne altid overvurderer de aktiver, de skal bedømme. Bureauerne har naturligvis også en interesse i at beskytte deres renommé og sikre deres troværdighed. Men det kræver evne og vilje til langsigtet tænkning, hvis denne disciplinerende mekanisme skal virke, og langsigtet tænkning var ikke i høj kurs i årene op til finanskrisen.

Ifølge den historie, jeg har fortalt, skyldtes finanskrisen grundlæggende en mangelfuld offentlig regulering af det finansielle system. Men hvorfor svigtede reguleringen? Det er der flere forklaringer på, men den væsentligste årsag er nok, at der også i det politiske system er et incitamentsproblem. Hvis et enkelt land strammer sin finansielle regulering, vil det mindske indtjeningsmulighederne i landets finanssektor. Da mange finansielle aktiviteter er særdeles mobile over landegrænserne, kan en strammere national regulering let føre til, at en masse gode højtlønnede job flytter ud af landet. Det betyder lavere indtjeningsmuligheder for andre lønmodtagere og virksomheder i landet og lavere skatteindtægter. Den internationale konkurrence om at tiltrække velaflønnede mobile finansielle aktiviteter medfører derfor, at det enkelte land vil være tilbageholdende med at indføre en stram finansiel regulering. Problemet skærpes i takt med, at globaliseringen skrider frem, og de finansielle aktiviteter bliver stadigt mere mobile. Resultatet kan blive en såkaldt »dårlig ligevægt«, hvor alle lande egentlig gerne ville have en strammere regulering, men hvor ingen tør gå forrest af frygt for at miste indtjeningsmuligheder til andre lande. Dette problem er velbeskrevet i den økonomiske litteratur, jf. f.eks. Sinn (2003). Det kræver stærke internationale, politiske institutioner at dæmme op for problemet og sikre en effektiv regulering.

Lad mig opsummere, hvad jeg ovenfor har sagt om de mikroøkonomiske årsager til finanskrisen. I en situation med ufuldstændig og asymmetrisk information indebærer aktieselskabsformen med dens begrænsede ansvar for aktionærerne et incitament til overdreven låntagning og risikotagning. Informationsproblemet og det deraf følgende skæve incitament er særligt udtalt i banksektoren på grund af den høje kompleksitet af de aktiver, som bankerne investerer i. Samtidig ligger der en stor indbygget risiko i bankernes grundlæggende forretningsmodel, som bygger på en potentielt ustabil ligevægt, hvor kortfristede indlån omdannes til langfristede udlån. Ustabiliteten har historisk manifesteret sig i gentagne ødelæggende bank runs, som har ført til indførelsen af indskydergarantiordninger. Garantiordninger fjerner beklageligvis indskydernes og långivernes tilskyndelse til at overvåge, at bankerne forvalter deres midler ansvarligt. Det har derfor været nødvendigt at stille regulatoriske minimumskrav til størrelsen af bankernes egenkapital. Disse krav reducerer imidlertid bankaktionærernes forventede afkast og giver dem et incitament til at kanalisere kreditgivningen over i et skyggebanksystem, der ikke er omfattet af kapitalkravene. Det var netop, hvad der i stort omfang skete i årene op til finanskrisen. Den ekstreme gearing i det voksende skyggebanksystem kombineret med et stigende indlånsunderskud i mange banker betød sammen med den stigende kompleksitet og deraf følgende uoverskuelighed i det finansielle system, at systemet blev stadig mere sårbart over for ubehagelige overraskelser. Derfor kunne problemer på det forholdsvis begrænsede marked for amerikanske subprime-lån bringe hele det globale finansielle system på randen af det totale sammenbrud.

Denne skitse til forklaring af finanskrisen er på mange måder forenklet, men jeg håber at have illustreret, at den mikroøkonomiske teori med dens fokus på betydningen af informations- og incitamentsproblemer har gode bud på de grundlæggende årsager til, at krisen opstod og blev så alvorlig.

Også den gængse makroøkonomiske teori kan bidrage til forklaringen. I makroteorien fokuserer man især på årsagerne til, at kapitalistiske markedsøkonomier gennemløber tilbagevendende konjunkturcykler. I et berømt bidrag foreslog makroøkonomen John Taylor (1993) en regel for den amerikanske centralbanks rentepolitik, som ifølge hans analyse ville bidrage til at mindske udsvingene i den økonomiske aktivitet og inflationen. Ifølge denne såkaldte Taylor-regel bør centralbanken hæve realrenten op over sit normale niveau, hvis inflationen overstiger det tilstræbte niveau, eller hvis den samlede produktion er højere end i en normal konjunktursituation. Omvendt bør centralbanken sænke realrenten under det normale niveau, når inflationen er mindre end tilstræbt, eller når produktionen er lavere end svarende til en normal konjunktursituation. Centralbankerne i USA og en række andre lande førte faktisk i mange år en rentepolitik, der var i god overensstemmelse med Taylor-reglen.

I en periode forud for finanskrisen holdt den amerikanske centralbank imidlertid den pengepolitiske rente noget under det niveau, som en konsekvent anvendelse af Taylor-reglen ville have tilsagt. Lavrentepolitikken blev indledt for at imødegå virkningerne af, at den såkaldte dot.com boble i aktiekurserne var bristet i år 2000, og af frygt for et tilbageslag i økonomien efter terrorangrebet den 11. september 2001. Det lave renteniveau bidrog imidlertid til at puste de amerikanske boligpriser op og stimulerede til et kraftigt byggeboom, som hen ad vejen øgede boligudbuddet og forstærkede det boligprisfald, der indtraf fra 2006. På basis af en nylig økonometrisk analyse har John Taylor (2009) hævdet, at udsvingene på det amerikanske boligmarked ville have været langt mindre, hvis Federal Reserve havde fulgt hans pengepolitiske regel. Andre iagttagere har lagt mere vægt på betydningen af de nye låneformer og den meget lemfældige kreditgivning forud for sammenbruddet, og atter andre har fremhævet, at de store opsparingsoverskud i Kina og en række andre asiatiske lande bidrog til at presse de lange renter usædvanligt langt ned i sidste årti. Der er dog næppe tvivl om, at den amerikanske centralbanks lavrentepolitik i perioden fra 2002 til 2005 bidrog til prisboblen på det amerikanske boligmarked og dermed til den efterfølgende finanskrise.

Både den mikroøkonomiske og den makroøkonomiske teori kan altså bidrage til at forklare finanskrisen. Jeg er derfor uenig med dem, der ser finanskrisen som et bevis for en fundamental krise i den økonomiske videnskab, jf. f.eks. Collander m.fl. (2009). Man kan tværtimod argumentere for, at finanskrisen i stort omfang skyldtes, at myndighederne ikke fulgte de principper for mikroøkonomisk regulering og makroøkonomisk stabiliseringspolitik, som hovedstrømmen af økonomisk teori foreskriver.

På den anden side er det naturligt og særdeles nyttigt, at finanskrisen har givet anledning til kritisk eftertanke i det fagøkonomiske miljø. Krisen har f.eks. intensiveret den faglige debat om relevansen af teorien om effektive finansielle markeder. Denne teori siger, at priserne på finansielle aktiver altid afspejler al relevant tilgængelig information om de fremtidige indtægtsstrømme, som aktiverne kan ventes at kaste af sig. Det betyder f.eks., at aktiekurserne altid afspejler den mest ædruelige vurdering af, hvor store fremtidige udbytter aktieselskaberne kan forventes at udbetale. Hypotesen indebærer, at den enkelte investor ikke skal gøre sig håb om at kunne »slå markedet«. Hvis man investerer ud fra en formodning om, at prisen på et aktiv er systematisk over- eller undervurderet, vil man blive skuffet: Aktiver har altid den pris, de skal have, givet det man ved på det pågældende tidspunkt.

Skeptikere såsom Robert Shiller (2003) har indvendt, at aktiekurserne synes at være langt mere volatile, end man skulle vente, hvis kurserne altid afspejler det bedste bud på de fremtidige aktieudbytter. Kan det virkelig være rigtigt, at forventningerne til de fremtidige udbytter svinger så meget som aktiekurserne, spørger han? Hertil svarer advokaterne for tesen om effektive markeder, at aktiekurserne udmærket kan svinge mere end de forventede udbytter, hvis der er hyppige udsving i investorernes villighed til at påtage sig risiko.

For en del år siden rejste Sanford Grossman og Joseph Stiglitz (1980) imidlertid en mere fundamental indvending mod teorien: Hvis de observerede aktivpriser altid korrekt afspejler al tilgængelig information, og ingen investor skal tro, at han er klogere end markedet, hvem vil så overhovedet påtage sig besværet med at indsamle den information, der er nødvendig for en korrekt værdiansættelse af de forskellige aktiver? Hvordan kan aktivpriserne afspejle al relevant information, når ingen har incitament til at fremskaffe den? Der må være nogle investorer, der arbejder på at skaffe sig information i håb om, at de kan tjene penge ved at købe aktiver, som forekommer at være undervurderede, og ved at sælge dem, der forekommer at være overvurderede.

Problemet for investorerne er, at fremtiden er fundamentalt usikker. Ingen kan derfor vide med sikkerhed, hvad den »sande« værdi af et aktiv er. Investorernes grad af tillid til fremtiden bliver dermed helt afgørende for aktivprisernes udvikling, som John Maynard Keynes (1936) allerede for mange år siden gjorde opmærksom på. Set i bagklogskabens ulideligt klare lys er det ikke svært at udpege perioder i den økonomiske historie, hvor udviklingen i f.eks. aktiekurser og boligpriser har været præget af en overdreven optimisme. Årene forud for den seneste finanskrise forekommer at være en sådan periode. Set i bakspejlet kan man også finde perioder, hvor aktivpriserne synes at have været drevet af urimeligt pessimistiske forventninger, jævnfør f.eks. de meget drastiske kursfald, der indtraf i kølvandet på den nylige krise. Det betyder dog ikke, at aktivprisernes udvikling drives af helt arbitrære forhold. Som Roman Frydman og Michael Goldberg (2011) har dokumenteret i en netop udkommen bog, påvirkes f.eks. aktiekurserne i meget høj grad af nye informationer, der må anses for relevante i en vurdering af virksomhedernes fremtidige indtjening. Disse forfattere påviser også, at selv om aktivpriserne gennemløber store og langvarige udsving, så har de en tendens til at vende tilbage til, hvad der opfattes som et normalt langtidsholdbart niveau. Frydman og Goldberg fremhæver dog samtidigt, at markedsdeltagerne over tid ændrer den vægt, som de tillægger de forskellige økonomiske forhold og nøgletal, når de danner deres forventninger til de fremtidige afkast af forskellige aktiver. Derfor skal man ikke gøre sig håb om at kunne beskrive forventningsdannelsen ved simple, mekaniske og uforanderlige beslutningsregler.

Det gør en væsentlig forskel, om man er tilhænger af tesen om effektive finansielle markeder, eller om man hælder til det mere pragmatiske syn på markederne, som f.eks. Frydman og Goldberg står for. Teorien om effektive markeder lægger op til, at myndighederne ikke skal bekymre sig om, hvorvidt markederne er over- eller undervurderede og dermed ikke bør søge at påvirke aktivpriserne i en bestemt retning. Hvis man er mere skeptisk over for markedernes evne til at sætte de »rigtige« aktivpriser, kan det være et argument for, at den økonomiske politik skal forsøge at læne sig mod vinden på f.eks. aktie- og boligmarkederne. Med andre ord kan det være et argument for, at den økonomiske politik søger at dæmpe de meget store udsving i aktivpriserne, som historisk har været med til at underminere den finansielle og makroøkonomiske stabilitet.

Teorien om effektive finansielle markeder er et eksempel på en anvendelse af den mere generelle hypotese om rationelle forventninger, som blev introduceret i makroøkonomisk teori af Robert Lucas (1972). Denne tese siger, at de økonomiske aktører ikke begår systematiske fejl, når de danner deres forventninger til den fremtidige udvikling i de økonomiske variable, der er relevante for dem. Når folk f.eks. gætter på den fremtidige inflation eller den fremtidige udvikling i boligpriserne, vil de altså ikke gennem længere tid systematisk overvurdere eller undervurdere prisudviklingen. I formelle økonomiske modelanalyser indebærer tesen om rationelle forventninger, at de økonomiske aktører danner deres forventninger, som om de kendte de økonomiske sammenhænge, der er indbygget i modellen.

Tesen om rationelle forventninger er den dominerende hypotese om forventningsdannelsen i moderne makroøkonomisk teori. Tesen kan være nyttig, når man vil analysere, om en bestemt økonomisk politik kan forventes at have den ønskede virkning. Hvis politikken kun virker, når husholdninger og virksomheder begår systematiske forventningsfejl, kan der være grund til at betvivle, hvor robuste dens effekter er. Mennesker kan jo lære af deres fejl, så en politik, der f.eks. kun virker, hvis folk systematisk undervurderer inflationen, er næppe langtidsholdbar.

Mere generelt kan tesen om rationelle forventninger være et nyttigt udgangspunkt i mange økonomiske analyser. Det har interesse at vide, hvordan det økonomiske system virker, når den økonomiske modelbygger ikke er klogere end de individer, hvis adfærd han søger at beskrive. På den anden side er det ikke nemt at forene tesen om rationelle forventninger med forløbet op til og under finanskrisen. I midten af sidste årti blev der f.eks. foretaget flere interviewundersøgelser, som viste, at de danske husholdninger forventede betydelige boligprisstigninger over en længere periode. Undersøgelserne pegede klart på, at forventningerne til den fremtidige udvikling var stærkt præget af de meget kraftige boligprisstigninger, der fandt sted i 2005 og 2006, jf. Dam m.fl. (2011). Disse prisstigninger blev i stort omfang ekstrapoleret ind i fremtiden, selvom de fra en nøgtern betragtning måtte forekomme at være løsrevet fra de underliggende økonomiske forhold. Lignende undersøgelser fra udlandet peger ligeledes i retning af, at forventningerne til fremtiden ofte er domineret af de nærmest foregående års erfaringer.

I mange sammenhænge kan det derfor være vildledende at basere sig på tesen om rationelle forventninger. Selvom tesen altså ikke bør skrottes helt, er der et klart behov for at supplere den med mere realistiske, men samtidig operationelle teorier om forventningsdannelsen. Heldigvis arbejdes der på mange fronter med denne problemstilling i den aktuelle økonomiske forskning.

Finanskrisen har også ført til, at der arbejdes på livet løs med at indbygge mere realistiske beskrivelser af den finansielle sektor i de makroøkonomiske modeller. Et godt og pædagogisk bud på, hvordan dette kan gøres, er f.eks. for nylig givet af Michael Woodford (2010), men han suppleres af en hærskare af andre makroøkonomer.

Selv om krisen har ført til skærpede kontroverser inden for den økonomiske videnskab, er jeg optimistisk på mit fags vegne. Uenighederne vil vise sig at være produktive og vil føre til nye erkendelser, ligesom 1930'ernes Store Depression blev startskuddet til en usædvanligt frugtbar periode for den økonomiske forskning. Vi ser allerede nu, hvordan det vælter frem med nye videnskabelige bidrag inspireret af begivenhederne under finanskrisen.

Vi kunne sandt for dyden godt have undværet krisen, men når den nu kom, er det rart at vide, at der arbejdes på at uddrage, hvad vi kan lære af den.

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