Measuring Real Capital Input in OECD Agriculture

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This paper provides a farm sector comparison of levels of capital input for 17 OECD countries. The estimates of capital input are derived by representing capital stock as a weighted sum of past investments. The weights correspond to the relative efficiencies of capital goods of different ages, so that the weighted components of capital stock have the same efficiency. We convert estimates of capital stock into estimates of capital services by means of capital rental prices. Comparisons of levels of capital input among countries require data on relative prices of capital input. We obtain relative price levels for capital input among countries via relative investment goods prices, taking into account the flow of capital input per unit of capital stock in each country.

Cet article se propose de comparer le niveau du capital dans l'agriculture de 17 pays de l'OCDE. Les estimations du niveau de capital sont déduites en calculant un stock de capital comme une somme pondérée des investissements passés. Les poids utilisés correspondent à l'efficacité relative des biens capitaux à différents âges, de telle sorte que les différentes composantes du stock du capital ait la même efficacité. Le stock de capital est déduit une estimation des services de capital en utilisant un taux de rentabilité. Cette comparaison des niveaux de capital entre pays nécessite des données sur les prix relatifs du capital. Ces prix dépendent des prix relatifs des biens capitaux mais aussi des flux de service générés dans chaque pays par une unité de capital.

INTRODUCTION

Our objective in this paper is to provide a farm-sector comparison of levels of capital input for 17 member countries of the Organisation for Economic Co-operation and Development (OECD) for the period 1973–99.[1] Measures of capital input are necessary for a description of technology. In a subsequent paper, we integrate these estimates into production accounts for agriculture, including real output and real factor input.[2] We apply the resulting measures of real product and real factor input to the study of total factor productivity and international competitiveness.

The starting point for construction of a measure of capital input is the measurement of capital stock. The estimates of capital input reported in this paper are derived by representing capital stock at each point in time as a weighted sum of past investments. The weights correspond to the relative efficiencies of capital goods of different ages, so that the weighted components of capital stock have the same efficiency.

The next step in developing measures of capital input is to construct estimates of prices of capital services. For each asset, the price of investment goods is a weighted sum of future service or rental prices, discounted by a factor that incorporates future rates of return. The weights are given by the relative efficiencies of capital goods of different ages. Our estimates of capital input incorporate the same data on relative efficiencies of capital goods into estimates of both capital stock and capital rental prices.

Finally, a comparison of levels of capital input among countries requires data on the relative prices of capital input among all the countries included in the comparison. We develop data on relative prices of capital input for all 17 countries. We obtain relative price levels for capital input among countries via relative investment goods prices, taking into account the flow of capital input per unit of capital stock in each country.

The paper is organized as follows. The next section describes the mathematical model and the underlying assumptions used to estimate capital input. The third section presents estimates of relative levels of capital input for all 17 countries. The final section concludes.

MEASURING CAPITAL INPUT

We require time series measures of capital input and capital service prices for each country in the comparison. Construction of these series begins with estimating the capital stock and rental price for each asset type in each country. We employ the perpetual inventory method to estimate capital stocks from data on investment. Implicit rental prices for each asset are based on the correspondence between the price of an asset and the discounted value of future service flows derived from that asset.

The capital stock is disaggregated by asset type: transportation equipment, machinery and non-residential structures. For the United States, data on investment in current and constant prices for each asset type are obtained from *Fixed Reproducible Tangible Wealth in the United States* (U.S. Department of Commerce). For members countries of the European Union, these data are from *Capital Stock Data for the European Union*, Vol. 17 (Statistical Office of the European Communities). Investment data for Canada are obtained from the Strategic Policy Branch, Agriculture and Agri-Food Canada.

Capital Stock

Under the perpetual inventory method, the capital stock at the end of each period, say, K_t, is measured as the sum of all past investments, each weighted by its relative efficiency d_τ:

$$K_t = \sum_{\tau=0}^{\infty} d_\tau I_{t-\tau} \tag{1}$$

We assume that the relative efficiency of capital goods declines with age, giving rise to needs for replacement of productive capacity. The proportion of investment to be replaced at age τ, or m_τ, is is equal to the decline in efficiency from age $\tau - 1$ to age τ:

$$m_\tau = -\left(d_\tau - d_{\tau-I}\right) \qquad \tau = 1,\ldots,L \tag{2}$$

These proportions represent mortality rates for capital goods of different ages. Replacement requirements at each point of time, say R_t, can be expressed as a weighted sum of past investments:

$$R_t = \sum_{\tau=1}^{\infty} m_\tau I_{t-\tau} \tag{3}$$

where the weights are the mortality rates.

Taking the first difference of Eq. 1 and substituting from Eqs. 2 and 3, we can write:

$$K_t - K_{t-1} = I_t - R_t \tag{4}$$

The change in capital stock in any period is equal to the acquisition of investment goods less replacement requirements.

To estimate replacement requirements, we must introduce an explicit description of the decline in efficiency. The relative efficiency of an asset τ years of age is given by the hyperbolic function:

$$\begin{aligned} d_\tau &= (L-\tau)/(L-\beta\tau) \qquad 0 \le \tau \le L \\ d_\tau &= 0 \qquad \tau > L \end{aligned} \tag{5}$$

where:
L = the service life of the asset
β = a curvature or decay parameter.

The decay function defined by Eq. 5 incorporates many of the commonly used forms of depreciation as special cases. The upper limit of β is unity. This corresponds to the "one-hoss shay" form of depreciation. As the value of β approaches zero, decay occurs at an increasing rate over time. If β is zero, the function corresponds to the formula for straight-line depreciation. Finally, if β is negative, decay occurs more rapidly in the early years of service corresponding to accelerated forms of depreciation such as geometric decay.

Little empirical evidence is available to suggest a precise value for β. However, two studies provide evidence that efficiency loss occurs more rapidly in the later years of service. Utilizing data on expenditures for repairs and maintenance of 745 farm tractors covering the period 1958–74, Penson, Hughes and Nelson (1977) found that the loss of efficiency was very small in the early years and increased rapidly as the end of the asset's service life approached. More recently, Romain, Penson and Lambert (1987) compared the explanatory power of alternative capacity depreciation patterns for farm tractors in a model of investment behavior that also includes the price of capital services. They found that the concave depreciation pattern better reflects actual investment decisions.

Taken together, these studies suggest that estimates of β should be restricted to the zero–one interval. Ultimately, the β values selected for this study are 0.75 for structures and 0.5 for machinery and transportation equipment. It is assumed that the efficiency of a structure declines slowly over most of its service life until a point is reached where the cost of repairs exceeds the increased service flows derived from the repairs, at which point the structure is allowed to depreciate rapidly. The decay parameter for machinery and transportation equipment assumes that the decline in efficiency is more uniformly distributed over the asset's service life.[3]

Asset Service Lives

Investment as used in this study is composed of different types of capital goods. Each type of capital good is a homogeneous group of assets for which the actual service life L is a random

variable. For each asset type, there exists some mean service life $\bar{L}$ around which there exists some distribution of actual service lives of the assets in the group. In order to determine the amount of capital available for production the actual service lives and their frequency of occurrence must be determined. It is assumed that this distribution may be accurately depicted by the standard normal distribution.[4]

One property of the normal distribution is related to the infinite nature of the distribution. Without adjustment the distribution would yield cases where assets were discarded prior to their purchase or assets with unrealistically long service lives. In order to avoid these extremes, the distribution is truncated at points two standard deviations before and after the mean. Thus the discard range encompasses approximately 95% of the area under the normal distribution.[5] The area under the truncated normal curve is then adjusted upward within the allowed range of asset lives. This allows calculation of the probability of service life L occurring, given the average age of the group of similar capital goods, the cut-off points of the distribution around the average age and the standard deviation of the distribution. In this study, two standard deviations correspond to 0.98 times the mean service life. This dispersion parameter is chosen to conform to the observation that assets are occasionally found that are considerably older than the mean service life and that a few assets are accidentally damaged when new.

Once the frequency of occurrence of a particular service life L is known, the efficiency function for that particular service life is calculated using the assumed value of β. This process is repeated for all other possible values of L. An aggregate efficiency function is then constructed as a weighted sum of the individual efficiency functions using as weights the frequency of occurrence. This function reflects not only changes in efficiency, but also the discard distribution around the mean service life of the asset.

Capital Service Prices

Firms add to capital stock so long as the present value of the net revenue generated by an additional unit of capital exceeds the purchase price of the asset. Following Coen (1975), this can be stated algebraically as:

$$\sum_{t=1}^{\infty}\left(p\frac{\partial y}{\partial K}-w\frac{\partial R_t}{\partial K}\right)(1+r)^{-t}>w \tag{6}$$

where:
p = the price of output
w = the price of investment goods
r = the real discount rate.

To maximize net present value, firms add to capital stock until this equation holds as an equality. This requires that[6]:

$$p\frac{\partial y}{\partial K}=rw+r\sum_{t=1}^{\infty}w\frac{\partial R_t}{\partial K}(1+r)^{-t}=c \tag{7}$$

The expression for c is the implicit rental price of capital corresponding to the mortality distribution m. The rental price consists of two components. The first term, $r\,w$, represents

the opportunity cost of invested funds. The second term, $r\sum_{t=1}^{\infty} w\frac{\partial R_t}{\partial K}(1+r)^{-t}$ is the present value of all future replacements required to maintain the productive capacity of the capital stock.

Let F denote the present value of the stream of capacity depreciation on one unit of capital according to the mortality distribution m:

$$F = \sum_{t=1}^{\infty} m_t (1+r)^{-t} \tag{8}$$

Since replacement at time t is equal to capacity depreciation at time t:

$$\sum_{t=1}^{\infty} w\frac{\partial R_t}{\partial K}(1+r)^{-t} = \sum_{t=1}^{\infty} F^t = \frac{F}{(1-F)} \tag{9}$$

and

$$c = \frac{rw}{(1-F)} \tag{10}$$

The real rate of return r in Eq. 10 above is calculated as the nominal yield on government bonds of all maturities less the rate of inflation as measured by the implicit deflator for gross domestic product. An *ex ante* rate is obtained by expressing observed real rates as an ARIMA process.[7] We then calculate F holding the required real rate of return constant for that vintage of capital goods. In this way, implicit rental prices c are calculated for each asset type.

CAPITAL INPUT, 1973–99

The measures of capital stock and capital rental prices presented in Tables 1 and 2 provide the basis for our estimates of capital input for each country.[8] Translog price indexes of capital are formed by aggregating over the various assets using cost-share weights based on asset-specific rental prices. These price indexes are reported in Table 3. The quantity indexes of capital input reported in Table 4 are formed implicitly as the ratio of the total value of capital service flows in each country to the corresponding translog price index. Although these quantity indexes do not have the form of translog index numbers, they are nonetheless well defined.

To compare levels of capital input among countries, we require data on the relative prices of capital input. A price index that converts the ratio of the nominal value of capital service flows between two countries into an index of relative real capital input is referred to as a purchasing power parity in the international comparisons literature. The dimensions of the purchasing power parities are the same as exchange rates, e.g., francs per dollar. However, the purchasing power parities reflect the relative prices of the components of aggregate capital input in each country.

Although we estimate the decline in efficiency of capital goods separately for all 17 countries, we assume that the relative efficiency of new capital goods is the same in each country. Accordingly, the appropriate purchasing power parity for new capital goods is the purchasing power parity for the corresponding component of investment goods output.[9] To obtain the purchasing power parities for capital input, we must take into account the flow of capital services per unit of capital stock in each country. This is accomplished by multiply-

Table 1. Capital stock, 1972–99 (millions of 1996 national currencies; except Italy, billions of national currencies)

Year	Belgium	Denmark	Germany	Greece	Spain	France	Ireland	Italy	Luxem-bourg	Nether-lands	Austria	Portugal	Finland	Sweden	United Kingdom	Canada	United States
Transportation equipment:																	
1972	9245	3326	11169	90193	316790	16322	249	4502	2062	1267	6651	19042	3867	6372	617	5774	21462
1973	10170	3789	11556	99592	353511	18135	275	4776	2177	1459	6768	22497	4069	6104	675	6739	21626
1974	11134	4372	11896	102409	386974	20079	267	5062	2180	1675	6962	26753	4254	5963	715	7521	21544
1975	11354	4950	12301	105222	414941	21108	255	5107	2172	1787	7162	31406	4325	5953	739	8598	21687
1976	12036	5698	12940	108644	428003	22453	266	5237	2086	1918	7631	34444	4325	5945	786	9593	22998
1977	12419	6320	13569	111232	435180	22859	282	5305	2318	2162	8130	37299	4265	5874	822	10504	24322
1978	13119	6639	13999	110691	429411	22868	293	5346	2401	2401	8176	38502	4162	5638	838	11387	25434
1979	13526	6703	14744	107278	409030	23424	305	5331	2254	2822	8485	39988	4154	5577	853	12389	26358
1980	13338	6432	15301	100793	379017	23747	294	5484	2463	2935	8763	40485	4153	5432	818	12553	26095
1981	12941	6061	16068	93597	333703	24630	293	5654	2290	3036	9011	40276	4206	5572	780	12359	25051
1982	12476	5732	16271	88948	302090	24522	277	5778	2176	3089	9568	38744	4161	5465	735	12052	23753
1983	12298	5276	16739	82243	265893	24252	257	5830	2022	3314	10380	36834	4079	5362	704	11779	22878
1984	12484	4880	16898	79204	235817	23729	240	5802	1828	3350	11196	33807	3963	5270	661	11327	21878
1985	12249	4635	17009	77469	208490	22804	221	5683	1702	3357	11831	30702	3981	5087	610	10392	20550
1986	11955	4439	16967	69862	187949	21440	205	5701	1560	3385	12232	30480	3931	4853	591	9474	19207
1987	12573	4130	17270	61614	177283	21073	196	5780	1519	3439	12917	32120	3875	4768	601	8601	18614
1988	12883	3792	17533	54860	175062	20272	200	5884	1518	3489	13586	36594	3851	4651	631	7739	18344
1989	13343	3671	17986	53491	177382	20966	219	6021	1527	3669	14196	40061	3867	4772	662	7005	18328
1990	14144	3638	18436	50692	180893	21826	249	6121	1448	3874	15047	44196	3808	4746	672	6236	18406
1991	13963	3629	19525	48023	181011	22063	256	6151	1428	4052	15771	47472	3561	4513	641	5712	18141
1992	13735	3558	20087	46185	175397	21957	261	6112	1412	4163	16179	50628	3274	4380	611	5245	17708
1993	13302	3514	19965	43925	167058	21489	253	5905	1413	4065	16365	52847	2958	4211	590	4719	17442
1994	12972	3400	19804	42178	159122	21440	254	5728	1395	4010	16521	55067	2730	4072	560	4256	17182
1995	12696	3320	19605	39958	152691	21435	260	5561	1352	3999	16620	57430	2528	3960	532	3971	17169
1996	12450	3256	19337	37384	147154	21482	269	5406	1288	4003	16659	60012	2371	3870	508	3633	17622
1997	12233	3207	19035	34574	142399	21595	283	5257	1207	4032	16647	62819	2260	3788	488	3445	18625
1998	12043	3173	18738	31703	138726	21861	301	5135	1118	4102	16592	65628	2185	3714	473	3310	19810
1999	11862	3152	18473	28870	135972	22249	323	5036	1023	4209	16504	68342	2136	3646	463	3217	20707

Table 1. Continued

Machinery:																	
1972	117295	22877	83187	643073	2233920	228827	982	47648	10631	16765	70518	96944	25880	60496	8760	15246	145700
1973	125072	26998	85561	723387	2476514	248817	1156	51751	11102	18184	73224	116377	27207	59867	8929	15994	154936
1974	130106	30996	85767	781976	2712878	267535	1216	55821	11466	19365	75463	141678	28352	58966	8824	17324	162219
1975	131416	34410	85884	847255	2892269	281611	1255	60048	11490	19973	77919	170403	29704	58860	8676	18866	166081
1976	136094	38203	86391	899293	3024831	294037	1404	66145	10826	20663	80465	194421	30982	59194	8607	20727	169813
1977	140260	42137	87843	942678	3103862	299030	1557	72142	10435	22035	84050	219346	31804	59593	8567	22055	172427
1978	147297	45910	89789	955357	3141780	305495	1702	77287	10839	23808	87057	235087	32245	59436	8588	23259	177512
1979	150172	49707	91322	965924	3111596	311518	1833	83051	11341	25530	89156	254107	32946	58897	8394	24764	182768
1980	151557	50845	91470	955096	3038883	313775	1891	89113	10842	26359	89874	275348	34087	58766	8011	25817	183111
1981	148904	50049	89906	942643	2879105	315275	2000	93130	10814	26824	89728	292692	35077	58767	7555	26849	180627
1982	148776	49481	88678	925753	2763792	317182	2031	95605	11517	27387	95086	302348	36200	59450	7249	26762	173112
1983	149040	48497	88389	912949	2616609	316217	2029	96984	11879	28166	101285	302948	36989	59968	7068	26173	164882
1984	149157	48255	87325	932137	2512796	314763	2007	98161	11949	28401	106752	301202	37698	60690	6805	25659	156605
1985	148718	48960	86206	949695	2405504	311486	1963	99230	11703	28824	112599	300018	38324	60996	6465	24910	146062
1986	148171	48852	85142	910476	2312843	306201	1886	99867	11411	29547	116590	319711	38336	60598	6285	24025	135477
1987	148090	47705	83752	858845	2248684	301905	1847	100126	11317	29572	119734	343860	37957	60352	6075	22985	128078
1988	147517	45932	82895	819194	2212941	301181	1846	101182	11333	30000	122852	380932	37439	60852	6066	21894	121684
1989	147251	45060	82683	784246	2183991	302330	1872	101896	11348	30660	125932	412131	37869	61729	6011	20741	117036
1990	149249	44834	83143	755318	2157823	303947	1905	101678	11464	31407	130542	448442	37809	61612	5884	19632	113490
1991	146460	43583	83066	725634	2110540	302246	1868	100674	11646	31959	134316	483442	36530	60260	5650	18429	109275
1992	144383	42385	82587	700027	2031682	297735	1839	99983	11800	32270	136350	519390	34256	58431	5458	17310	105235
1993	140634	41208	81133	677216	1931863	291645	1767	98359	12022	32212	137713	548435	31998	56328	5363	17085	101711
1994	137114	40244	79832	658338	1838668	287687	1709	97461	12117	31965	139893	577717	30085	54767	5174	16708	98325
1995	133833	39521	78562	635196	1758475	284296	1671	96539	12109	31935	141666	608716	28761	53445	5013	16299	94944
1996	130649	38903	77163	608422	1687770	281575	1653	95595	11991	31974	142992	641846	27796	52324	4892	15948	92261
1997	127544	38400	75787	578765	1625850	279652	1654	94538	11767	32137	143961	676869	27161	51268	4799	15980	90282
1998	124501	38052	74619	547813	1574501	279184	1676	93630	11471	32496	144643	711739	26782	50299	4748	15881	89108

Table 1. Continued

Non-residential structures:																	
1972	60889	80486	140018	3920591	16079498	116327	6892	199429	45961	11489	64607	452227	77803	25150	10451	21434	137314
1973	65793	86156	140663	4019712	16482045	124946	7103	200937	46358	12689	65233	479716	78953	25815	10841	21679	139753
1974	69784	91282	141696	4066361	16852529	133078	7188	202142	46859	13716	66346	513280	79872	26383	11218	22069	143157
1975	72295	95918	142864	4134577	17187669	140048	7254	203820	47664	14474	67759	552262	81330	27090	11454	22482	144295
1976	76103	101250	144183	4203079	17485159	146689	7437	205220	49228	15336	69155	588566	82714	27844	11580	22825	146414
1977	80205	107667	145693	4312399	17788676	151998	7667	205970	48075	16670	70713	632222	84025	28807	11650	23228	148848
1978	85411	114379	147204	4401297	18081585	157700	7922	206472	47524	18245	72098	674811	85558	29697	11760	23685	152873
1979	89509	122226	148364	4514301	18298483	163580	8249	206426	47037	19895	73092	724652	87125	30461	11879	24179	156740
1980	93971	126037	149345	4586552	18356780	171968	8454	212127	47052	21242	73853	776310	88964	32720	12076	25020	158180
1981	96598	127706	150003	4637939	18276881	179573	8720	217849	47137	22398	74514	824155	90419	34743	12203	26039	157822
1982	99771	129444	150718	4679684	18292056	186373	8953	223738	46906	23466	76682	868293	92526	36797	12396	26928	156734
1983	103067	130936	151622	4718920	18257870	192455	9095	230178	47313	24675	78990	905306	94644	38881	12581	27464	154817
1984	106033	133447	152299	4798732	18364002	198266	9230	236911	47195	25553	81338	947756	96163	41004	12791	27995	152771
1985	109602	137180	152896	4879326	18451179	203719	9356	243572	46839	26501	83833	985348	97635	43170	12840	27854	149558
1986	113580	140170	153214	4897507	18567450	208520	9433	250230	46079	27761	85756	1050383	99119	45047	13011	27601	146473
1987	117714	142367	153404	4895083	18720150	213544	9542	256720	45432	28649	87586	1117461	100282	46882	13168	27614	143674
1988	121502	143959	153577	4910606	18912560	219569	9688	264906	44897	29813	89371	1194679	101707	48907	13476	27667	140327
1989	125202	146169	153763	4921068	19123634	226287	9889	272347	44604	31114	90959	1265703	102585	51178	13783	27674	137195
1990	129902	148838	154006	4930409	19343999	233036	10148	278550	44285	32432	92987	1340958	103429	52981	14012	27393	134120
1991	132521	149695	154182	4931417	19516024	238285	10341	284577	44014	33641	94825	1419715	104003	54256	14091	27091	131020
1992	135426	151029	154187	4927726	19588989	242255	10557	289367	43725	34694	96413	1502188	104054	55190	14170	26753	127634
1993	137369	151848	153837	4916997	19637762	245107	10662	293950	43503	35473	97939	1577622	103761	55931	14238	26385	124527
1994	139302	152653	153566	4901539	19679285	248346	10815	298488	43153	36178	99619	1655613	103240	56769	14194	26128	121590
1995	141205	153580	153255	4877326	19735893	251550	11013	303082	42722	36984	101233	1740174	102666	57636	14161	25956	118473
1996	143013	154475	152846	4844813	19798012	254770	11258	307735	42200	37805	102768	1832355	102338	58514	14152	25968	115846
1997	144725	155354	152393	4804644	19865392	258072	11551	312364	41589	38675	104240	1932358	102271	59344	14159	26069	113269
1998	146339	156271	151962	4758675	19946618	261747	11904	317197	40917	39639	105659	2037718	102418	60135	14199	26128	110982

Table 2. Capital service prices, 1973–99

Year	Belgium	Denmark	Germany	Greece	Spain	France	Ireland	Italy	Luxem-bourg	Nether-lands	Austria	Portugal	Finland	Sweden	United Kingdom	Canada	United States
Transportation equipment:																	
1973	0.0689	0.0316	0.0506	0.0035	0.0201	0.0353	0.0288	0.0180	0.0385	0.0757	0.0401	0.0051	0.0300	0.0239	0.0292	0.0508	0.0553
1974	0.0807	0.0414	0.0519	0.0043	0.0234	0.0434	0.0341	0.0257	0.0463	0.0843	0.0444	0.0053	0.0356	0.0250	0.0415	0.0568	0.0649
1975	0.0773	0.0415	0.0494	0.0046	0.0244	0.0451	0.0438	0.0300	0.0495	0.0916	0.0453	0.0057	0.0460	0.0322	0.0493	0.0582	0.0679
1976	0.0783	0.0447	0.0571	0.0051	0.0234	0.0478	0.0490	0.0328	0.0561	0.0929	0.0461	0.0065	0.0478	0.0351	0.0577	0.0598	0.0722
1977	0.0887	0.0485	0.0626	0.0058	0.0287	0.0567	0.0601	0.0375	0.0574	0.0934	0.0499	0.0123	0.0510	0.0393	0.0669	0.0633	0.0743
1978	0.1020	0.0622	0.0597	0.0070	0.0384	0.0625	0.0709	0.0447	0.0689	0.0966	0.0526	0.0191	0.0562	0.0441	0.0739	0.0781	0.0816
1979	0.1147	0.0702	0.0660	0.0093	0.0401	0.0656	0.0777	0.0483	0.0770	0.1069	0.0576	0.0247	0.0612	0.0458	0.0831	0.0908	0.0977
1980	0.1296	0.0882	0.0767	0.0122	0.0466	0.0749	0.0784	0.0478	0.0907	0.1190	0.0679	0.0264	0.0673	0.0616	0.0976	0.0922	0.1101
1981	0.1538	0.1055	0.0826	0.0151	0.0554	0.0998	0.0867	0.0522	0.1041	0.1380	0.0856	0.0310	0.0708	0.0673	0.1077	0.1130	0.1288
1982	0.1417	0.1157	0.0866	0.0182	0.0670	0.1139	0.0953	0.0605	0.1010	0.1417	0.0772	0.0365	0.0765	0.0742	0.1135	0.1145	0.1282
1983	0.1364	0.0940	0.0814	0.0203	0.0748	0.1160	0.1051	0.0698	0.0949	0.1293	0.0669	0.0554	0.0814	0.0853	0.1263	0.1186	0.1216
1984	0.1499	0.1061	0.0934	0.0223	0.0882	0.1075	0.1062	0.0779	0.1071	0.1479	0.0761	0.0676	0.0879	0.0877	0.1420	0.1494	0.1526
1985	0.1489	0.1097	0.0986	0.0260	0.0998	0.1192	0.1352	0.0891	0.0865	0.1610	0.0827	0.0729	0.0967	0.0954	0.1567	0.1613	0.1583
1986	0.1421	0.1158	0.0924	0.0348	0.1135	0.1304	0.1430	0.0991	0.1069	0.1505	0.0806	0.0994	0.0997	0.0987	0.1024	0.1644	0.1469
1987	0.1545	0.1345	0.0848	0.0404	0.1121	0.1361	0.1514	0.1047	0.1182	0.1628	0.0877	0.1162	0.1077	0.1060	0.1190	0.1695	0.1564
1988	0.1658	0.1306	0.1021	0.0494	0.1345	0.1485	0.1733	0.1187	0.1294	0.1815	0.0903	0.1164	0.1128	0.1084	0.1221	0.1604	0.1694
1989	0.1672	0.1389	0.1121	0.0576	0.1543	0.1624	0.1766	0.1345	0.1326	0.1880	0.0993	0.1354	0.1192	0.1132	0.1281	0.1664	0.1659
1990	0.1610	0.1461	0.1397	0.0866	0.1564	0.1751	0.1649	0.1394	0.1294	0.1945	0.1131	0.1340	0.1439	0.1328	0.1384	0.1766	0.1660
1991	0.1798	0.1446	0.1131	0.1131	0.1467	0.1765	0.1616	0.1418	0.1463	0.1932	0.1086	0.1523	0.1296	0.1280	0.1413	0.1785	0.1652
1992	0.1778	0.1555	0.1081	0.1265	0.1465	0.1762	0.1754	0.1578	0.1474	0.1835	0.1110	0.1370	0.1345	0.1390	0.1490	0.1792	0.1661
1993	0.1665	0.1457	0.1045	0.1434	0.1439	0.1710	0.1773	0.1557	0.1370	0.1742	0.1005	0.1383	0.1421	0.1556	0.1670	0.1809	0.1684
1994	0.1760	0.1579	0.1103	0.1542	0.1711	0.1869	0.1687	0.1639	0.1448	0.1834	0.1032	0.1497	0.1504	0.1420	0.1762	0.2044	0.1947
1995	0.1912	0.1671	0.1193	0.1516	0.1947	0.1898	0.1888	0.1914	0.1743	0.1878	0.1123	0.1586	0.1583	0.1567	0.1935	0.2185	0.1927
1996	0.1851	0.1590	0.1146	0.1871	0.1745	0.1848	0.1856	0.1809	0.1851	0.1814	0.1018	0.1637	0.1444	0.1444	0.1922	0.2095	0.1959
1997	0.1884	0.1535	0.1199	0.2058	0.1739	0.1817	0.1825	0.1695	0.2075	0.1841	0.0976	0.1653	0.1466	0.1441	0.1847	0.2118	0.1916
1998	0.1815	0.1530	0.1162	0.2477	0.1783	0.1776	0.1607	0.1782	0.2208	0.1833	0.1135	0.1686	0.1483	0.1456	0.1784	0.2180	0.1824
1999	0.1835	0.1576	0.1134	0.2611	0.1802	0.1811	0.1584	0.1913	0.2464	0.1759	0.1161	0.1818	0.1532	0.1501	0.1755	0.2284	0.1879

Table 2. Continued

Machinery:																	
1973	0.0548	0.0273	0.0582	0.0033	0.0134	0.0274	0.0221	0.0121	0.0279	0.0492	0.0442	0.0038	0.02300	0.0237	0.0311	0.0404	0.0323
1974	0.0633	0.0365	0.0597	0.0044	0.0158	0.0366	0.0282	0.0182	0.0328	0.0582	0.0494	0.0041	0.02808	0.0270	0.0468	0.0465	0.0407
1975	0.0576	0.0356	0.0540	0.0043	0.0183	0.0354	0.0358	0.0198	0.0337	0.0621	0.0491	0.0046	0.03721	0.0317	0.0527	0.0509	0.0445
1976	0.0566	0.0382	0.0612	0.0044	0.0199	0.0357	0.0353	0.0211	0.0386	0.0620	0.0496	0.0048	0.03889	0.0325	0.0604	0.0518	0.0477
1977	0.0657	0.0413	0.0666	0.0046	0.0255	0.0409	0.0440	0.0247	0.0397	0.0603	0.0547	0.0095	0.04227	0.0344	0.0640	0.0522	0.0487
1978	0.0783	0.0541	0.0649	0.0055	0.0364	0.0439	0.0522	0.0297	0.0489	0.0641	0.0601	0.0138	0.04643	0.0371	0.0666	0.0675	0.0536
1979	0.0887	0.0614	0.0729	0.0072	0.0234	0.0459	0.0625	0.0324	0.0580	0.0759	0.0650	0.0173	0.05118	0.0406	0.0757	0.0805	0.0643
1980	0.1008	0.0784	0.0866	0.0098	0.0412	0.0536	0.0632	0.0335	0.0717	0.0878	0.0777	0.0192	0.06175	0.0523	0.0852	0.0818	0.0777
1981	0.1235	0.0940	0.0933	0.0128	0.0469	0.0797	0.0711	0.0368	0.0836	0.1070	0.0988	0.0230	0.06978	0.0588	0.0969	0.0997	0.0914
1982	0.1115	0.1025	0.0961	0.0147	0.0564	0.0891	0.0768	0.0424	0.0798	0.1057	0.0922	0.0302	0.07580	0.0636	0.0968	0.0992	0.0900
1983	0.1045	0.0785	0.0901	0.0164	0.0636	0.0862	0.0816	0.0491	0.0729	0.0890	0.0799	0.0471	0.08214	0.0702	0.1131	0.1032	0.0848
1984	0.1176	0.0891	0.1015	0.0189	0.0781	0.0799	0.0878	0.0562	0.0840	0.1052	0.0895	0.0627	0.09419	0.0756	0.1231	0.1332	0.1152
1985	0.1144	0.0924	0.1049	0.0213	0.0726	0.0894	0.1116	0.0651	0.0827	0.1132	0.0961	0.0626	0.09976	0.0848	0.1334	0.1369	0.1186
1986	0.1064	0.0987	0.0991	0.0268	0.0831	0.0934	0.1154	0.0735	0.0791	0.1036	0.0932	0.0773	0.09774	0.0862	0.1139	0.1335	0.1010
1987	0.1186	0.1161	0.0908	0.0303	0.0788	0.1016	0.1126	0.0756	0.0912	0.1118	0.1003	0.0867	0.10458	0.0919	0.1305	0.1362	0.1096
1988	0.1295	0.1106	0.1064	0.0381	0.1000	0.1104	0.1249	0.0865	0.1012	0.1277	0.1026	0.0857	0.10615	0.0984	0.1293	0.1239	0.1218
1989	0.1300	0.1195	0.1166	0.0438	0.1199	0.1204	0.1286	0.1010	0.1027	0.1326	0.1125	0.0966	0.11807	0.1038	0.1358	0.1248	0.1183
1990	0.1225	0.1256	0.1268	0.0668	0.1197	0.1329	0.1090	0.1077	0.0963	0.1388	0.1278	0.0930	0.14587	0.1292	0.1423	0.1316	0.1203
1991	0.1407	0.1235	0.1242	0.0889	0.1072	0.1329	0.1093	0.1083	0.1123	0.1361	0.1232	0.1130	0.12570	0.1195	0.1319	0.1406	0.1170
1992	0.1377	0.1349	0.1208	0.0982	0.1073	0.1305	0.1247	0.1241	0.1120	0.1269	0.1193	0.0915	0.12309	0.1168	0.1300	0.1405	0.1145
1993	0.1229	0.1241	0.1172	0.1109	0.1043	0.1201	0.1263	0.1196	0.0987	0.1161	0.1065	0.0901	0.11686	0.1086	0.1419	0.1438	0.1121
1994	0.1307	0.1358	0.1243	0.1177	0.1230	0.1285	0.1159	0.1215	0.1059	0.1270	0.1079	0.0955	0.13309	0.1126	0.1553	0.1677	0.1336
1995	0.1457	0.1444	0.1332	0.1069	0.1444	0.1317	0.1360	0.1471	0.1271	0.1310	0.1170	0.1024	0.12836	0.1271	0.1677	0.1763	0.1338
1996	0.1384	0.1353	0.1282	0.1345	0.1217	0.1268	0.1330	0.1342	0.1271	0.1234	0.1066	0.1055	0.11459	0.1146	0.1602	0.1653	0.1391
1997	0.1406	0.1287	0.1333	0.1437	0.1191	0.1237	0.1302	0.1205	0.1378	0.1250	0.1025	0.1050	0.11482	0.1142	0.1472	0.1693	0.1389
1998	0.1325	0.1274	0.1296	0.1760	0.1220	0.1195	0.1093	0.1272	0.1386	0.1229	0.1185	0.1062	0.11507	0.1155	0.1363	0.1761	0.1331
1999	0.1334	0.1311	0.1269	0.1794	0.1224	0.1232	0.1081	0.1381	0.1504	0.1141	0.1212	0.1174	0.11836	0.1200	0.1294	0.1925	0.1366

Table 2. Continued

Non-residential structures:																	
1973	0.0266	0.0101	0.0258	0.0011	0.0028	0.0131	0.0042	0.0043	0.0144	0.0214	0.0123	0.0012	0.0081	0.0085	0.0170	0.0212	0.0150
1974	0.0311	0.0161	0.0242	0.0013	0.0035	0.0193	0.0080	0.0053	0.0174	0.0280	0.0147	0.0014	0.0106	0.0099	0.0334	0.0251	0.0210
1975	0.0236	0.0123	0.0157	0.0011	0.0038	0.0169	0.0095	0.0058	0.0149	0.0291	0.0136	0.0020	0.0147	0.0126	0.0312	0.0234	0.0192
1976	0.0207	0.0130	0.0218	0.0011	0.0037	0.0154	0.0064	0.0056	0.0150	0.0270	0.0121	0.0013	0.0133	0.0111	0.0338	0.0243	0.0193
1977	0.0276	0.0143	0.0259	0.0011	0.0052	0.0174	0.0079	0.0069	0.0182	0.0235	0.0141	0.0036	0.0129	0.0108	0.0311	0.0233	0.0177
1978	0.0394	0.0252	0.0216	0.0015	0.0114	0.0171	0.0103	0.0071	0.0269	0.0258	0.0169	0.0060	0.0126	0.0110	0.0299	0.0332	0.0204
1979	0.0487	0.0307	0.0276	0.0022	0.0100	0.0172	0.0171	0.0084	0.0342	0.0359	0.0207	0.0070	0.0139	0.0121	0.0350	0.0415	0.0284
1980	0.0606	0.0453	0.0394	0.0045	0.0112	0.0218	0.0161	0.0086	0.0455	0.0462	0.0310	0.0066	0.0204	0.0191	0.0402	0.0354	0.0375
1981	0.0830	0.0579	0.0444	0.0038	0.0134	0.0430	0.0196	0.0111	0.0635	0.0628	0.0501	0.0075	0.0255	0.0234	0.0479	0.0481	0.0462
1982	0.0669	0.0616	0.0444	0.0041	0.0189	0.0462	0.0181	0.0124	0.0516	0.0588	0.0391	0.0123	0.0278	0.0259	0.0482	0.0461	0.0401
1983	0.0554	0.0303	0.0360	0.0046	0.0201	0.0382	0.0208	0.0131	0.0424	0.0405	0.0246	0.0226	0.0289	0.0283	0.0666	0.0496	0.0321
1984	0.0675	0.0388	0.0473	0.0046	0.0283	0.0334	0.0216	0.0169	0.0530	0.0552	0.0322	0.0284	0.0333	0.0321	0.0860	0.0768	0.0605
1985	0.0615	0.0403	0.0509	0.0055	0.0182	0.0388	0.0378	0.0226	0.0497	0.0659	0.0376	0.0247	0.0401	0.0395	0.1004	0.0840	0.0656
1986	0.0518	0.0444	0.0423	0.0077	0.0271	0.0409	0.0432	0.0293	0.0432	0.0519	0.0335	0.0252	0.0380	0.0375	0.0577	0.0778	0.0489
1987	0.0645	0.0609	0.0320	0.0129	0.0221	0.0526	0.0456	0.0292	0.0546	0.0596	0.0400	0.0272	0.0417	0.0424	0.0752	0.0842	0.0594
1988	0.0752	0.0521	0.0486	0.0151	0.0432	0.0590	0.0586	0.0382	0.0642	0.0759	0.0420	0.0217	0.0473	0.0476	0.0628	0.0737	0.0721
1989	0.0735	0.0604	0.0587	0.0143	0.0628	0.0667	0.0576	0.0499	0.0640	0.0800	0.0512	0.0294	0.0531	0.0536	0.0615	0.0739	0.0643
1990	0.0632	0.0654	0.0629	0.0307	0.0647	0.0776	0.0525	0.0511	0.0550	0.0863	0.0660	0.0318	0.0809	0.0800	0.0640	0.0820	0.0640
1991	0.0805	0.0588	0.0576	0.0489	0.0502	0.0743	0.0490	0.0450	0.0700	0.0829	0.0595	0.0543	0.0606	0.0606	0.0535	0.0866	0.0571
1992	0.0760	0.0693	0.0473	0.0577	0.0512	0.0736	0.0671	0.0591	0.0676	0.0725	0.0538	0.0356	0.0504	0.0502	0.0543	0.0835	0.0510
1993	0.0575	0.0549	0.0402	0.0714	0.0400	0.0645	0.0584	0.0510	0.0515	0.0615	0.0391	0.0318	0.0369	0.0368	0.0682	0.0834	0.0473
1994	0.0640	0.0659	0.0460	0.0785	0.0563	0.0728	0.0466	0.0506	0.0577	0.0731	0.0399	0.0298	0.0496	0.0465	0.0825	0.1031	0.0683
1995	0.0795	0.0731	0.0550	0.0759	0.0759	0.0758	0.0661	0.0742	0.0758	0.0761	0.0485	0.0346	0.0602	0.0598	0.0917	0.1037	0.0660
1996	0.0703	0.0605	0.0499	0.0807	0.0472	0.0700	0.0596	0.0544	0.0703	0.0664	0.0361	0.0356	0.0449	0.0449	0.0780	0.0885	0.0694
1997	0.0709	0.0504	0.0556	0.0900	0.0413	0.0659	0.0536	0.0393	0.0748	0.0666	0.0305	0.0328	0.0439	0.0430	0.0601	0.0891	0.0695
1998	0.0609	0.0465	0.0505	0.1171	0.0419	0.0608	0.0300	0.0364	0.0682	0.0625	0.0456	0.0318	0.0441	0.0430	0.0474	0.0880	0.0650
1999	0.0601	0.0479	0.0465	0.1080	0.0401	0.0639	0.0270	0.0421	0.0717	0.0521	0.0465	0.0413	0.0476	0.0463	0.0394	0.1009	0.0704

Table 3. Translog price indexes of capital input

Year	Belgium	Denmark	Germany	Greece	Spain	France	Ireland	Italy	Luxem-bourg	Nether-lands	Austria	Portugal	Finland	Sweden	United Kingdom	Canada	United States
1973	0.3934	0.1856	0.4776	0.0153	0.0770	0.2060	0.1041	0.0921	0.2090	0.3813	0.3960	0.0341	0.1932	0.2034	0.2036	0.2475	0.2343
1974	0.4559	0.2727	0.4730	0.0183	0.0941	0.2788	0.1632	0.1142	0.2503	0.4583	0.4483	0.0394	0.2430	0.2307	0.3407	0.2857	0.3009
1975	0.4032	0.2354	0.3847	0.0168	0.1036	0.2663	0.1996	0.1307	0.2304	0.4873	0.4405	0.0504	0.3278	0.2754	0.3550	0.2935	0.3120
1976	0.3905	0.2513	0.4653	0.0175	0.1060	0.2650	0.1649	0.1329	0.2449	0.4792	0.4354	0.0410	0.3204	0.2785	0.3978	0.3007	0.3290
1977	0.4622	0.2742	0.5227	0.0186	0.1417	0.3036	0.2043	0.1589	0.2780	0.4567	0.4841	0.0956	0.3313	0.2936	0.4010	0.3032	0.3286
1978	0.5682	0.4123	0.4819	0.0231	0.2550	0.3219	0.2518	0.1729	0.3835	0.4875	0.5386	0.1491	0.3475	0.3156	0.4066	0.3965	0.3649
1979	0.6558	0.4841	0.5648	0.0322	0.2061	0.3347	0.3501	0.1975	0.4742	0.5943	0.5959	0.1800	0.3828	0.3441	0.4670	0.4751	0.4529
1980	0.7607	0.6675	0.7172	0.0561	0.2662	0.3953	0.3415	0.2004	0.6136	0.7035	0.7475	0.1841	0.4974	0.4564	0.5307	0.4636	0.5542
1981	0.9568	0.8298	0.7871	0.0535	0.3135	0.6145	0.3988	0.2513	0.8102	0.8799	1.0094	0.2153	0.5845	0.5187	0.6135	0.5796	0.6595
1982	0.8395	0.8923	0.8020	0.0584	0.4162	0.6822	0.3995	0.2833	0.6916	0.8590	0.8973	0.3109	0.6361	0.5649	0.6169	0.5747	0.6296
1983	0.7643	0.5438	0.7116	0.0684	0.4515	0.6422	0.4421	0.3092	0.5890	0.6905	0.7262	0.5283	0.6753	0.6242	0.7742	0.6016	0.5717
1984	0.8757	0.6547	0.8517	0.0713	0.6073	0.5887	0.4647	0.3694	0.7161	0.8449	0.8389	0.6783	0.7740	0.6766	0.9199	0.8101	0.8370
1985	0.8390	0.6799	0.8966	0.0861	0.4471	0.6632	0.7010	0.4542	0.6750	0.9389	0.9179	0.6307	0.8721	0.7714	1.0384	0.8581	0.8762
1986	0.7624	0.7379	0.8035	0.1166	0.6067	0.6965	0.7707	0.5459	0.6140	0.8235	0.8753	0.7113	0.8433	0.7738	0.7137	0.8326	0.7236
1987	0.8733	0.9445	0.6864	0.1736	0.5204	0.7844	0.7928	0.5537	0.7509	0.9052	0.9621	0.7857	0.9133	0.8366	0.8723	0.8673	0.8116
1988	0.9702	0.8468	0.8899	0.2030	0.8976	0.8594	0.9698	0.6769	0.8662	1.0681	0.9906	0.7063	0.9810	0.9039	0.7941	0.7860	0.9265
1989	0.9666	0.9525	1.0164	0.2033	1.2508	0.9464	0.9672	0.8385	0.8686	1.1141	1.1127	0.8650	1.0948	0.9695	0.8062	0.7956	0.8746
1990	0.8886	1.0190	1.1139	0.3930	1.2810	1.0585	0.8652	0.8733	0.7700	1.1769	1.3027	0.8811	1.5164	1.2701	0.8433	0.8553	0.8816
1991	1.0500	0.9500	1.0391	0.6024	1.0248	1.0456	0.8249	0.8195	0.9505	1.1472	1.2353	1.2724	1.2098	1.1073	0.7480	0.9002	0.8351
1992	1.0172	1.0854	0.9435	0.7087	1.0397	1.0305	1.0648	1.0085	0.9284	1.0484	1.1819	0.9267	1.0892	1.0409	0.7505	0.8880	0.7974
1993	0.8680	0.9135	0.8724	0.8665	0.8529	0.9387	0.9701	0.9156	0.7467	0.9394	1.0124	0.8722	0.9164	0.9252	0.8804	0.8981	0.7724
1994	0.9351	1.0561	0.9505	0.9526	1.1558	1.0217	0.8110	0.9198	0.8228	1.0521	1.0285	0.8749	1.1278	0.9982	1.0151	1.0672	0.9729
1995	1.0760	1.1534	1.0629	0.9345	1.5190	1.0515	1.0828	1.2390	1.0458	1.0878	1.1411	0.9724	1.2412	1.1687	1.1155	1.1042	0.9616
1996	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1997	1.0136	0.8796	1.0686	1.1162	0.8965	0.9653	0.9227	0.8195	1.0739	1.0098	0.9398	0.9630	0.9891	0.9857	0.8394	1.0156	0.9970
1998	0.9285	0.8364	1.0108	1.4299	0.9118	0.9208	0.5967	0.7967	1.0201	0.9786	1.1389	0.9569	0.9931	0.9940	0.7196	1.0334	0.9466
1999	0.9297	0.8612	0.9661	1.3411	0.8814	0.9540	0.5582	0.8919	1.0884	0.8797	1.1645	1.1355	1.0510	1.0428	0.6441	1.1457	0.9894

Table 4. Capital input (millions of 1996 national currencies; except Italy, billions of national currencies)

Year	Belgium	Denmark	Germany	Greece	Spain	France	Ireland	Italy	Luxem-bourg	Nether-lands	Austria	Portugal	Finland	Sweden	United Kingdom	Canada	United States
1973	22079	8288	18884	432345	1058612	40594	557	17172	4974	3063	10548	29065	6958	8851	2303	5511	33949
1974	23657	9261	19254	456987	1124366	44101	606	17895	5086	3351	10880	32617	7193	8775	2371	5849	35412
1975	24797	10211	19374	473050	1186955	47429	619	18620	5170	3604	11183	36904	7392	8680	2396	6261	36632
1976	25169	11072	19491	493161	1238022	49918	626	19360	5223	3747	11522	41949	7624	8697	2397	6775	37287
1977	26188	12056	19697	510913	1275862	52223	668	20409	5203	3910	11900	46227	7839	8764	2404	7325	38245
1978	27105	13076	20036	528903	1302495	53270	715	21407	5117	4210	12400	50705	7986	8835	2409	7770	39062
1979	28563	14028	20415	537483	1320316	54453	757	22259	5143	4574	12782	54038	8084	8816	2424	8184	40278
1980	29334	15015	20749	547249	1321588	55694	799	23163	5144	4969	13071	58004	8234	8774	2404	8681	41463
1981	29854	15373	20881	549174	1307718	56560	817	24393	5120	5181	13201	62130	8450	8837	2352	8964	41558
1982	29660	15351	20813	548326	1273807	57423	850	25307	5099	5335	13239	65647	8638	8948	2283	9187	40976
1983	29804	15335	20722	546257	1253396	58090	863	25978	5149	5484	13948	68192	8859	9104	2245	9183	39547
1984	30054	15206	20786	543985	1226426	58264	864	26487	5198	5698	14777	69620	9036	9245	2231	9079	38059
1985	30326	15258	20716	552780	1210192	58307	863	26976	5171	5792	15521	70846	9175	9418	2210	8962	36597
1986	30474	15537	20627	561602	1192437	58016	860	27446	5096	5909	16296	71727	9316	9537	2158	8649	34663
1987	30627	15681	20502	552760	1180015	57372	850	27889	4981	6085	16830	76126	9379	9556	2142	8304	32725
1988	31036	15628	20371	540833	1177471	57095	850	28292	4916	6158	17296	81374	9385	9614	2123	7967	31416
1989	31303	15450	20310	532337	1183024	57284	859	28915	4878	6301	17754	88909	9395	9763	2150	7623	30260
1990	31621	15465	20349	526404	1191196	58029	878	29463	4860	6504	18191	95322	9485	10002	2170	7292	29396
1991	32381	15600	20470	522045	1200014	58864	904	29803	4839	6722	18822	102378	9517	10093	2166	6937	28704
1992	32172	15493	20591	517237	1203567	59063	912	30023	4837	6904	19353	109290	9377	9981	2125	6614	27848
1993	32048	15410	20595	512916	1197274	58748	923	30202	4834	7033	19670	116495	9066	9792	2093	6311	26960
1994	31569	15297	20371	508417	1186964	58089	918	30206	4847	7061	19891	122607	8731	9555	2080	6137	26201
1995	31161	15209	20173	504096	1178581	57815	919	30326	4831	7071	20200	128835	8466	9403	2042	5962	25477
1996	30799	15160	19973	498217	1171512	57614	927	30443	4792	7120	20460	135499	8267	9282	2009	5822	24789
1997	30439	15115	19745	490995	1164391	57499	941	30515	4728	7180	20660	142695	8118	9179	1983	5694	24320
1998	30076	15081	19514	482802	1158310	57494	960	30534	4640	7262	20813	150401	8025	9080	1962	5669	24058
1999	29709	15073	19306	473909	1154291	57729	986	30589	4535	7381	20935	158278	7977	8992	1951	5630	23961

ing the purchasing power parity for investment goods by the ratio of the price of capital input for the comparison and numeraire countries.

Table 5 presents purchasing power parities for capital input for all countries relative to the U.S. These results are based on translog multilateral indexes of relative prices in the base year.[10] The base-year purchasing power parities are then extrapolated to earlier and later years in the sample via translog time series indexes of capital service prices for the individual countries. This approach serves to adjust the levels of the price and quantity series in relation to the numeraire country while preserving their original time paths.

In Table 6, we report the value of capital services for all countries expressed in the currency of the numeraire country, the U.S. All countries in the comparison had substantially higher levels of capital input relative to the U.S. in 1999 than they had at the beginning of the sample period in 1973. The most dramatic gain in capital input was for Portugal, with the level of capital input relative to the U.S. increasing more than 600%. The Netherlands increased its relative level of capital input by a factor of three. Five countries, including Denmark, France, Ireland, Italy and Austria, more than doubled their levels of capital input relative to the U.S.

All our time series comparisons of relative capital input presented in Table 6 are in current prices. This facilitates comparison for any single year, but it makes it impossible to compare relative levels in different years. Such comparisons are of obvious interest, and they can be constructed by making use of time series indexes for the U.S. We provide these comparisons in Table 7. The values reported in Table 7 are obtained by dividing the entries in Table 6 by the U.S. price index of capital input. All the entries in this table are directly comparable. For example, in Table 7 Belgium's level of capital input in 1973 of $581 million can be directly compared with Denmark's level in 1999 of $1845 million to infer that Denmark's 1999 level of capital input was 3.17 times Belgium's 1973 level.

From Table 6, we observed that all the countries in the comparison increased their level of capital input relative to the U.S. over the sample period. Table 7 points to both relative and absolute increases in capital input for 14 of the 16 countries in the comparison. Only Luxembourg and the United Kingdom had lower levels of capital input in 1999 than at the beginning of the period in 1973. However, over this same period, the level of capital input in U.S. agriculture was reduced by nearly one-third.

During the 1970s, U.S. agriculture experienced rapid growth, fueled by growth in exports that resulted from increased global liquidity,[11] rising incomes and production shortfalls in other parts of the world.[12] In addition, domestic forces, including a drop in interest rates and rising inflation, contributed to an increase in borrowing for the purchase of land and equipment. For a significant part of the 1970s, real interest rates were close to zero and at times negative. During this period of expansion, roughly 1973–81, capital input in U.S. agriculture increased an average 2.5 percentage points per year.[13]

However, the environment changed in the early 1980s. By then, the OECD countries were vigorously pursuing anti-inflationary polices. The change to restrictive monetary policy initiated by the Federal Reserve pushed up interest rates sharply. The dollar appreciated on foreign exchange markets, and world export prices fell. The average real interest cost on variable-rate debt rose to nearly 16% in 1981–83. Real interest rates remained high thereafter, as the stringency of the Federal Reserve policy was enhanced because of the large fiscal deficits. This macroeconomic policy mix of fiscal stimulus combined with monetary restraint proved disastrous to export-dependent sectors of the U.S. economy, including agriculture.[14]

Table 5. Purchasing power parities for capital input (national currencies per U.S. dollar)

Year	Belgium	Denmark	Germany	Greece	Spain	France	Ireland	Italy	Luxem-bourg	Nether-lands	Austria	Portugal	Finland	Sweden	United Kingdom	Canada	United States
1973	63.813	6.470	3.095	23.443	37.673	5.022	0.241	582.032	33.730	3.553	13.091	17.249	3.312	5.881	0.677	1.700	1.000
1974	57.585	7.404	2.387	21.788	35.856	5.292	0.294	562.283	31.465	3.326	11.541	15.495	3.246	5.195	0.882	1.528	1.000
1975	49.108	6.163	1.872	19.291	38.068	4.875	0.347	620.683	27.931	3.410	10.937	19.125	4.221	5.981	0.886	1.514	1.000
1976	45.108	6.239	2.147	19.070	36.946	4.600	0.271	598.510	28.148	3.180	10.251	14.747	3.913	5.736	0.941	1.471	1.000
1977	53.448	6.817	2.415	20.284	49.447	5.276	0.337	716.039	31.997	3.034	11.410	34.457	4.050	6.052	0.950	1.485	1.000
1978	59.175	9.231	2.005	22.625	80.131	5.038	0.374	701.753	39.743	2.917	11.432	48.414	3.826	5.860	0.867	1.749	1.000
1979	55.020	8.731	1.893	25.417	52.180	4.219	0.419	645.750	39.597	2.865	10.191	47.074	3.396	5.147	0.803	1.688	1.000
1980	52.157	9.838	1.965	36.232	55.086	4.073	0.334	535.502	41.872	2.771	10.446	39.355	3.606	5.579	0.745	1.346	1.000
1981	55.129	10.277	1.812	29.051	54.514	5.320	0.328	564.358	46.459	2.913	11.855	38.680	3.561	5.328	0.724	1.414	1.000
1982	50.668	11.577	1.934	33.226	75.810	6.187	0.344	666.636	41.543	2.979	11.039	58.506	4.059	6.079	0.763	1.469	1.000
1983	50.804	7.770	1.890	42.847	90.558	6.415	0.419	801.046	38.962	2.637	9.838	109.464	4.746	7.398	1.054	1.693	1.000
1984	39.756	6.390	1.545	30.516	83.205	4.016	0.301	653.754	32.354	2.204	7.763	96.004	3.715	5.476	0.856	1.558	1.000
1985	36.388	6.339	1.554	35.194	58.512	4.322	0.433	767.854	29.133	2.339	8.114	85.266	3.999	5.964	0.923	1.576	1.000
1986	40.036	8.330	1.686	57.676	96.151	5.496	0.577	1117.539	32.089	2.484	9.370	116.449	4.682	7.245	0.768	1.852	1.000
1987	40.889	9.507	1.284	76.605	73.525	5.519	0.529	1010.666	34.990	2.435	9.182	114.683	4.521	6.984	0.837	1.720	1.000
1988	39.793	7.466	1.458	78.447	111.096	5.297	0.567	1082.280	35.356	2.517	8.281	90.310	4.254	6.609	0.667	1.365	1.000
1989	41.993	8.896	1.764	83.229	163.986	6.178	0.599	1419.979	37.557	2.781	9.853	117.154	5.029	7.509	0.718	1.464	1.000
1990	38.306	9.442	1.918	159.617	166.628	6.856	0.532	1467.359	33.031	2.914	11.445	118.408	6.911	9.761	0.745	1.561	1.000
1991	47.780	9.293	1.889	258.296	140.726	7.149	0.535	1453.638	43.045	2.999	11.458	180.497	5.820	8.984	0.697	1.735	1.000
1992	48.473	11.119	1.796	318.239	149.519	7.379	0.723	1873.357	44.030	2.870	11.479	137.664	5.488	8.843	0.733	1.792	1.000
1993	42.701	9.661	1.715	401.714	126.618	6.940	0.680	1755.961	36.557	2.655	10.152	133.767	4.767	8.115	0.887	1.871	1.000
1994	36.523	8.867	1.483	350.596	136.228	5.996	0.452	1400.408	31.983	2.361	8.188	106.527	4.657	6.951	0.812	1.765	1.000
1995	42.521	9.798	1.678	348.007	181.150	6.244	0.610	1908.526	41.131	2.470	9.191	119.790	5.186	8.234	0.903	1.848	1.000
1996	38.000	8.169	1.518	358.079	114.674	5.710	0.542	1481.253	37.818	2.183	7.745	118.463	4.018	6.775	0.778	1.609	1.000
1997	38.635	7.207	1.627	400.910	103.123	5.529	0.501	1217.530	40.735	2.211	7.301	114.428	3.986	6.698	0.655	1.639	1.000
1998	37.274	7.218	1.621	540.893	110.460	5.555	0.341	1246.654	40.755	2.257	9.319	119.752	4.215	7.114	0.592	1.757	1.000
1999	35.707	7.110	1.482	485.376	102.161	5.506	0.306	1335.247	41.601	1.941	9.116	135.959	4.268	7.140	0.507	1.864	1.000

Table 6. Value of capital services, 1973–99 (millions of U.S. dollars)

Year	Belgium	Denmark	Germany	Greece	Spain	France	Ireland	Italy	Luxem-bourg	Nether-lands	Austria	Portugal	Finland	Sweden	United Kingdom	Canada	United States
1973	136	238	2914	283	2163	1666	241	2716	31	329	319	57	406	306	693	802	7954
1974	187	341	3816	384	2950	2324	336	3635	40	462	423	83	539	390	916	1093	10654
1975	204	390	3981	412	3229	2591	356	3922	43	515	450	97	574	400	960	1214	11428
1976	218	446	4223	453	3552	2876	380	4300	45	565	489	116	624	422	1013	1385	12266
1977	226	485	4264	469	3656	3005	406	4528	45	589	505	128	641	425	1015	1496	12568
1978	260	584	4816	539	4145	3404	481	5273	49	704	584	156	725	476	1129	1762	14254
1979	340	778	6091	680	5215	4319	633	6806	62	949	747	207	911	589	1410	2303	18244
1980	428	1019	7575	847	6387	5405	817	8666	75	1261	935	271	1136	718	1712	2989	22979
1981	518	1241	9071	1011	7521	6533	995	10861	89	1565	1124	346	1387	860	1993	3674	27408
1982	491	1183	8631	964	6994	6331	987	10756	85	1539	1076	349	1354	832	1847	3594	25799
1983	448	1073	7803	872	6249	5816	910	10026	78	1436	1029	329	1261	768	1649	3262	22609
1984	662	1558	11460	1272	8952	8540	1335	14967	115	2185	1597	492	1883	1142	2399	4722	31855
1985	699	1637	11957	1353	9247	8947	1397	15957	120	2325	1756	524	2001	1218	2488	4880	32066
1986	580	1376	9831	1135	7524	7352	1149	13407	97	1958	1522	438	1678	1019	2006	3889	25082
1987	654	1558	10960	1253	8351	8154	1274	15280	107	2262	1763	522	1895	1145	2233	4188	26559
1988	757	1773	12432	1399	9513	9264	1453	17696	120	2614	2069	636	2164	1315	2527	4587	29107
1989	721	1654	11701	1300	9023	8774	1387	17074	113	2524	2005	656	2045	1260	2416	4143	26467
1990	734	1669	11816	1296	9157	8959	1429	17535	113	2626	2070	709	2081	1301	2457	3994	25914
1991	712	1595	11260	1217	8739	8608	1393	16802	107	2571	2029	722	1978	1244	2324	3600	23970
1992	675	1512	10816	1152	8369	8248	1343	16162	102	2522	1992	736	1861	1175	2177	3277	22206
1993	651	1457	10478	1106	8064	7947	1316	15749	99	2488	1962	760	1743	1116	2077	3029	20824
1994	808	1822	13055	1381	10070	9897	1648	19840	125	3147	2498	1007	2114	1372	2599	3710	25491
1995	789	1790	12777	1354	9883	9736	1631	19687	123	3114	2508	1046	2026	1335	2523	3563	24498
1996	810	1856	13156	1391	10216	10090	1711	20552	127	3262	2642	1144	2058	1370	2581	3618	24789
1997	799	1845	12967	1367	10123	10039	1732	20539	125	3279	2659	1201	2015	1351	2540	3528	24247
1998	749	1748	12167	1276	9561	9531	1677	19513	116	3149	2544	1202	1891	1269	2386	3335	22773
1999	774	1826	12582	1309	9959	10003	1801	20432	119	3345	2674	1322	1965	1313	2480	3461	23707

Table 7. Value of capital services, 1973–99 (millions of 1996 U.S. dollars)

Year	Belgium	Denmark	Germany	Greece	Spain	France	Ireland	Italy	Luxem-bourg	Nether-lands	Austria	Portugal	Finland	Sweden	United Kingdom	Canada	United States
1973	581	1015	12439	835	9232	7109	1028	10809	132	1403	1362	245	1732	1306	2959	3424	33949
1974	623	1134	12683	859	9805	7723	1118	11278	134	1535	1405	275	1790	1295	3045	3634	35412
1975	653	1250	12761	872	10351	8306	1142	11723	137	1651	1444	312	1840	1281	3078	3890	36632
1976	662	1355	12838	890	10796	8742	1156	12197	138	1717	1488	354	1898	1284	3080	4210	37287
1977	689	1476	12974	909	11126	9146	1234	12877	138	1791	1536	390	1951	1294	3089	4552	38245
1978	713	1601	13198	935	11358	9329	1319	13499	135	1928	1601	428	1988	1304	3095	4828	39062
1979	752	1717	13447	953	11514	9536	1397	14016	136	2095	1650	456	2012	1301	3113	5086	40278
1980	772	1838	13668	975	11525	9753	1475	14564	136	2276	1688	490	2049	1295	3088	5394	41463
1981	786	1882	13754	987	11404	9905	1508	15362	135	2373	1704	524	2103	1304	3021	5570	41558
1982	781	1879	13709	994	11108	10056	1568	15956	135	2444	1709	554	2150	1321	2933	5708	40976
1983	784	1877	13649	998	10930	10173	1592	16379	136	2512	1801	576	2205	1344	2884	5706	39547
1984	791	1862	13692	1001	10695	10203	1595	16695	137	2610	1908	588	2249	1365	2866	5641	38059
1985	798	1868	13646	1017	10553	10211	1594	16996	137	2653	2004	598	2284	1390	2839	5569	36597
1986	802	1902	13587	1034	10399	10160	1588	17283	135	2707	2104	605	2319	1408	2772	5374	34663
1987	806	1920	13505	1022	10290	10047	1569	17551	132	2787	2173	643	2334	1411	2751	5160	32725
1988	817	1913	13419	1003	10268	9999	1569	17791	130	2821	2233	687	2336	1419	2728	4951	31416
1989	824	1891	13378	990	10316	10032	1586	18178	129	2886	2292	751	2338	1441	2762	4736	30260
1990	832	1893	13404	980	10388	10162	1621	18513	129	2979	2349	805	2361	1476	2787	4531	29396
1991	852	1910	13483	972	10465	10309	1668	18708	128	3079	2430	864	2369	1490	2783	4311	28704
1992	847	1897	13564	961	10496	10343	1684	18820	128	3163	2499	923	2334	1473	2730	4110	27848
1993	843	1886	13566	951	10441	10288	1703	18904	128	3222	2540	983	2257	1445	2689	3921	26960
1994	831	1873	13419	940	10351	10173	1694	18871	128	3234	2568	1035	2173	1410	2672	3813	26201
1995	820	1862	13288	928	10278	10125	1697	18913	128	3239	2608	1088	2107	1388	2623	3705	25477
1996	810	1856	13156	913	10216	10090	1711	18954	127	3262	2642	1144	2058	1370	2581	3618	24789
1997	801	1850	13006	894	10154	10069	1737	18963	125	3289	2667	1205	2021	1355	2548	3538	24320
1998	791	1846	12854	872	10101	10069	1772	18937	123	3327	2687	1270	1998	1340	2521	3523	24058
1999	782	1845	12717	847	10066	10110	1821	18941	120	3381	2703	1336	1986	1327	2506	3498	23961

Over the 1981–89 period, economic growth in the U.S. farm sector slowed to less than 1% per year.[15] This compares with a robust 2.4% average annual rate of growth over the 1973–81 subperiod. Output growth results from input growth (capital, labor and materials inputs) and/or growth in productivity. The contribution of each input equals the product of the input's growth rate and its respective share in total cost (see Gollop and Jorgenson 1980). When weighted by its share in production costs, the growth of capital input over the 1973–81 period added 0.35 percentage points per year to output growth. Capital input's contribution to output growth was negative during the 1981–89 period averaging –0.7 percentage points per year. Over the full 1973–99 period, capital input in U.S. agriculture declined at an average 1.34% annual rate. The contraction in capital input contributed an average –0.15 percentage points per year to output growth.

CONCLUDING REMARKS

We have compared 17 OECD countries on the basis of levels of capital input in agriculture. Internal consistency of a measure of capital input requires that the same pattern of relative efficiency is employed in measuring both the level of capital stock and the rental price of capital services. Our time series of capital stocks and capital rental prices assume a hyperbolic efficiency function concave to the origin. The concave decay pattern is based on the observation that efficiency of an asset is relatively high during the early years of service and only after some time does the asset begin to deteriorate. The same patterns of decline in efficiency are used for both capital stock and the rental price of each asset, so that the requirement for internal consistency of measures of capital input is met.

In order to compare levels of capital input in different countries, we require conversion factors that reflect the comparative value of their currencies. The OECD regularly constructs estimates of the purchasing power of OECD currencies. Here we make use of purchasing power parities for investment goods output, taking into account the flow of capital input per unit of capital stock in each country. These conversion factors are used to express the value of capital input in each country in dollars.

In a subsequent paper, we integrate these estimates of capital input into production accounts for agriculture, including real output and real capital input. We use the measures of real output and real factor input to compare levels of productivity or technology among countries. Differences in levels of technology are associated with competitiveness. Future research will focus on the role of capital deepening in productivity convergence among countries.

NOTES

[1]The countries are Belgium, Denmark, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, the Netherlands, Austria, Portugal, Finland, Sweden, the United Kingdom, Canada and the U.S.

[2]Ball et al (2004).

[3]To determine the effects of a change in the value of β on estimates of capital stock, various values of β were used to construct a series of capital stocks. Changes in the value of β produce significant changes in the magnitude of the estimates of capital stocks. However, there is much similarity in the rates of growth in the series over the time interval. Thus, the choice of β, while having a pronounced effect on the level of capital stocks, has little impact on the long-term trend.

[4]Very little data exist on the form of the distribution around the mean service life. The only study available was conducted by Winfrey (1935) detailing the actual service lives of a group of assets. Winfrey's S-3 distribution had a bell-shaped appearance somewhat akin to the normal distribution. No rigorous

tests were performed to determine if this distribution was, in fact, a normal distribution but, based on this admittedly sparse evidence, it is assumed that there exists a normal distribution about the mean life of a particular type of asset. This assumption is used mostly for convenience since tables of values for the normal distribution are readily available.

[5]As derived from a table of normal values.

[6]If $r > 0$, then $\sum_{t=1}^{\infty}(1+r)^{-t} = \frac{1}{1-\left(\frac{1}{1+r}\right)} - 1 = \frac{1}{r}$. Substituting this result in Eq. 6 and rearranging terms yields Eq. 7.

[7]Observed real rates are expressed as an AR(1) process. We use this specification after examining the correlation coefficients for autocorrelation, partial and inverse autocorrelation, and performing the unit root and while noise tests. We centered each time series by subtracting its sample mean. The analysis was performed on the centered data.

[8]The estimates of capital input are available from the authors as an electronic data product.

[9]Purchasing power parities for investment goods are from OECD (1999, 162).

[10]For a discussion of translog multilateral price indexes, see Caves, Christensen and Diewert (1982).

[11]Until 1981, a greatly increased flow of private funds was funneled at negative real rates to developing country borrowers. This "recycling" of OPEC surpluses added to the export boom.

[12]U.S. farm exports surged from an average $4.8 billion in 1950–70 to $9.4 billion in 1972 and $17.7 billion in 1973. Exports continued to increase through 1981, when they peaked at $43.3 billion.

[13]Ball et al (1997) report that nearly half of the growth of output over this period was accounted for by growth in inputs. In contrast, productivity growth was the principal factor responsible for economic growth in the farm sector over the entire postwar period.

[14]The value of U.S. farm exports fell from $43.3 billion in 1981 to $26.2 billion in 1986, as declining volume combined with declining export prices.

[15]The production accounts are available at the USDA/ERS website http://www.ers.usda.gov/data/agproductivity.

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