The application of annual chain-linking to the Gross National Income system

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Summary

Gross National Income (GNI) is important to UK national accounts users because it measures the total income earned by a country's residents and is useful for international comparisons. Annual chain-linking will be applied to the Gross National Income system with effect from September 2003. This article outlines the complexities encountered under the fixed base system and how the new method of annual chain-linking improves the consistency of calculations. It is important to note that the values shown in this article have been constructed to illustrate the calculations not to estimate the effect of annual chain-linking.

Introduction and Background

Real Gross Domestic Income (RGDI), Gross National Income (GNI) and Gross National Disposable Income (GNDI) are all derived from Gross Domestic Product (GDP). For definitions of these and other terms used in this article, see Box 1.

The construction of RGDI, GNI and GNDI are illustrated here because the calculations of deflated or real GDP in the UK national accounts are changing from September 2003 due to the introduction of annual chain-linking. This has implications for the estimation of GNI, RGDI and GNDI. Annual chain-linking will replace the present fixed base aggregations used to calculate real GDP. Annual chain-linking is a method for aggregating the volume measures which are used to estimate economic growth and is in the process of being implemented in national accounts systems (Tuke and Reed 2001). The application of annual chain-linking methodology to most GDP components is relatively straightforward. The exceptions are components, which are presented as a 'difference series', where the components are additive. For example, this occurs in Changes in Inventories where it is not possible to produce a chained volume measure difference series. As can be seen from Table 2, RGDI, GNI and GNDI are estimated using difference series so this affects these calculations.

RGDI estimates the purchasing power of the total incomes generated by UK residents on domestic territory. As can be seen from Diagram 1 this takes into account the rate at which the prices of exports are traded against prices of imports from the rest of the world (RoW). This is known as the terms of trade effect, which is added to real GDP to obtain RGDI. This is done because it directly affects the income of individuals and their purchasing power. For example, if the price of UK exports fell (relative to the price of imports) more exports will have to be sold by UK residents to obtain the same amount of imports, as a result their purchasing power would go down. Additionally a change in the terms of trade effect results in a divergence between real GDP and RGDI. The difference in this change between GDP and RGDI is sometimes referred to as a "trading gain (or loss)" and is another way of describing the terms of trade effect.

Diagram 1 (see page 43) shows GDP and GDI are identical at current prices. However, they are conceptually different when expressed as volume measures. Real GDP is estimated using separate volume measures of exports and imports. However, RGDI attempts to estimate changes in the purchasing power implied by relative changes in trade prices. In contrast to RGDI real GNI has a broader definition of income. Real GNI includes primary incomes earned by UK residents from abroad and excludes primary income earned in the UK by foreign residents. Hence GNI is important to UK national accounts users because it measures the total income earned by UK residents and can be usefully compared to other countries.

To obtain real GNDI, net current transfers are applied to GNI and again this is shown in Diagram 1. GNDI measures the real disposable income of a country's nationals including transfers as opposed to GDI and GNI, which represent the measures of real income generated by UK residents.

The rest of this article compares the fixed base and annual chain-linking calculations of RGDI, GNI and GNDI, which shows how annual chain-linking method will resolve some of the anomalies. Estimates are only used for demonstration purposes, as comparison of results of the two methods is not part of the scope of this article. It is important to note that the estimates shown in the tables should not be considered as indicative of the figures that will be published in *Blue Book* 2003.

Box 1 Definitions of UK National Accounts Aggregates and Components

Current Prices (CP) **(Nominal prices)**	These are the current values of goods or services in a given time period.
Constant Prices (KP) **(Real Prices)**	These are values of goods or services in prices of a given time period so that the changes in volumes can be seen and the effects of price changes are stripped out.
Gross Domestic Product or GDP	Gross Domestic Product (GDP) is an integral part of the UK national accounts and provides an estimate of the total economic activity of UK residents on domestic territory.
Terms of trade effect ("Trading gain or loss")	This is the ratio between the change in the prices for imports and the change in the prices for exports. An increase in the terms of trade implies that the receipts from the same quantity of exports will finance an increased volume of imports (ONS 1998).
Real Gross Domestic Income (RGDI)	This is calculated by adding the terms of trade effect to deflated GDP to estimate the income generated by economic activity adjusted for price changes (ONS 1998).
Gross National Income (GNI) and Net National Income	This measures the total income earned by a country's residents wherever in the world it may originate. For example part of the profits from an UK firm based in the USA will be included in the calculation of National Income rather then that of GDP (ONS 1998). Net National Income deducts the effects of depreciation of the national capital stock.
Real current transfers from the rest of the world	Current transfers are payments or transfers of ownership, which are not made in exchange for any economic activity. For example this includes overseas aid and private gifts (ONS 1998).
Real Gross National Disposable Income (Real GNDI) and Net National Disposable Income	This is the total disposable income of the countries residents. The calculation of this is given in diagram 1. Net National Disposable Income deducts the effects of depreciation of the national capital stock.
Changes in Inventories	A series, which shows the difference between the inventory or stock closing levels and the opening levels. This is a component of the expenditure measure of GDP and is published as a 'difference series'.
Net Primary Incomes	This deducts primary incomes payable to non-resident units plus primary incomes receivable from the rest of the world. Primary incomes include interest, distributed income of corporations, dividends and reinvested earnings on direct foreign investment.
Net Current Transfers	This deducts current transfers abroad from current transfers received from abroad.

Diagram 1 Summary of the calculations used in the UK National Accounts

For both fixed base and annual chain-linking methods the following calculations are used to estimates RGDI, GNI and GNDI:

Current Prices	Volume Measures
CP GDP	Real GDP
= GDI	+ terms of trade effect = Real GDI
+ CP Net primary incomes = CP GNI	+ Real Net primary incomes = Real GNI
+ CP net current transfers = CP GNDI	+ Real net current transfers = Real GNDI

Fixed base method

The fixed base method is the present approach used to calculate aggregate real GDP. It involves updating a base year used for weights at 5-yearly intervals to give a new structure of weights. A link year is then used to link the current weighted interval with the previous weighted interval. The most recent base year is also used as the reference year. For a more detailed description of the method, see Tuke and Reed (2001).

Table 1 shows the calculation of the terms of trade effect. This calculation is dependent on both export and import deflators. The export deflator is derived by dividing current price exports by real exports. Similarly, the import deflator is derived by dividing current price imports by real imports. The terms of trade effect is derived as the difference from deflating current price exports by the export deflator (real exports) and deflating current price exports by import deflator. All terms of trade effect calculations are expressed in 1995 prices.

Terms of trade effect = (CP export /implied import deflator) 100 – Real export

Although adding or subtracting volume measures with different deflators has theoretical limitations, this method avoids the problem of having to link negative and positive series on different price bases together (Note: the differences in table 1 are due to rounding).

Table 1 Calculation of the Terms of trade effect (fixed base)

United Kingdom **£ million**

ESA95 codes	CDIDs	1986	1987	1988	1989	1990	1991	1992	1993
Current price exports	IKBH	97,679	106,564	107,554	121,609	133,887	135,940	144,091	163,640
Real exports (1995 prices)	IKBK	133,617	141,734	142,596	149,058	157,166	156,961	163,745	170,916
Current price imports	IKBI	100,893	111,449	124,657	142,690	148,257	142,061	151,659	170,125
Real imports (1995 prices)	IKBL	134,297	144,880	163,417	175,558	176,508	168,554	180,012	185,954
Implied imports deflator		75	77	76	81	84	84	84	91
Exports deflated by the imports deflator (1995 prices)		130,019	138,530	140,996	149,621	159,400	161,291	171,029	178,866
TGL Terms of trade	**YBGJ**	**–3,598**	**–3,204**	**–1,600**	**563**	**2,234**	**4,330**	**7,284**	**7,950**

		1994	1995	1996	1997	1998	1999	2000
Current price exports	IKBH	180,508	203,509	223,091	231,622	228,801	236,609	265,135
Real exports (1995 prices)	IKBK	186,655	203,509	220,268	238,492	245,761	258,863	285,124
Current price imports	IKBI	185,255	207,051	227,216	231,436	237,948	252,187	283,623
Real imports (1995 prices)	IKBL	196,526	207,051	226,999	248,969	272,924	296,669	331,396
Implied imports deflator		94	100	100	93	87	85	86
Exports deflated by the imports deflator (1995 prices)		191,490	203,,509	222,878	249,169	262,432	278,343	309,794
TGL Terms of trade	**YBGJ**	**4,835**	**0**	**2,610**	**10,677**	**16,671**	**19,480**	**24,670**

Source: ONS

Table 2 shows the calculation of RGDI using terms of trade, GNI and GNDI from 1994 onwards in the fixed base system. There are small discrepancies between the published figures for GNI and the sum of its components for the years 1997, 1998 and 2000 due to rounding issues.

Table 3 shows how real GNDI is calculated for 1986 to 1994. This is achieved through re-referencing real components from 1995 prices to 1990 prices, aggregating components in 1990 prices, then re-referencing back to 1995 to obtain real GNDI in 1995 prices. For the period shown in Table 3 the link year is 1994.

To illustrate this a re-referencing example for a GNI component in 1986 is as follows:

Real GNI (1990) = Real GNI (1986) / Real GNI (1990) x CP GNI (1990)

A similar procedure is applied to current transfers from RoW as shown in Table 3.

Table 2 National and domestic product (Fixed Base 95 prices), Annual National Accounts Table 1.1.

United Kingdom **£ million**

ESA95 codes		CDIDs	1994	1995	1996	1997	1998	1999	2000
B.1*g	**Gross Domestic Product**	**ABMI**	**698,915**	**719,176**	**738,046**	**763,459**	**785,777**	**804,713**	**829,517**
TGL	Terms of trade	YBGJ	4,835	0	2,610	10,677	16,671	19,480	24,670
GDI	Real Gross Domestic Income	YBGL	703,750	719,176	740,656	774,136	802,448	824,193	854,187
D.1+D.4	Real employment, property and entrepreneurial income from the RoW	YBGI	3,459	2,101	1,170	3,727	11,758	2,327	8,420
–	Subsidies (receipts) *less* taxes	–QZPB	–2,679	–5,220	–5,181	–2,576	–3,082	–4,990	–6,428
D.21+D31 +D.29–D.39	(payments) on production from/to RoW Other subsidies on production to/from RoW	–IBJN	287	293	248	198	242	357	353
B.5*g	**Gross National Income**	**YBGM**	**704,817**	**716,350**	**736,893**	**775,486**	**811,362**	**821,887**	**856,529**
D.5,6,7	Real current transfers from RoW (receipts *less* payments)	–YBGP	–2,385	–2,649	–1,848	–3,062	–4,485	–4,069	–5,656
B.6*g	**Gross National Disposable Income**	**YBGO**	**702,432**	**713,701**	**735,045**	**772,424**	**806,877**	**817,818**	**850,873**

Source: UK National Accounts, The Blue Book

Table 3 Re-referencing Real GNDI to 1990 from 1986–1994

United Kingdom **£ million**

	CDIDs	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Real Gross National Income (95 prices)	YBGM	579,949	600,627	635,157	648,297	652,065	647,921	656,292	672,069	704,817	716,350
Current price Gross National Income	ABMZ	380,793	416,656	465,985	509,209	549,183	579,330	606,729	637,626	681,612	716,350
Real Gross National Income (re-ref to 1990 until 1994)		**488,445**	**505,861**	**534,943**	**546,010**	**549,183**	**545,693**	**552,743**	**566,031**	**593,612**	***716,350***
Real current transfers from RoW (receipts *less* payments) (1995 prices)	–YBGP	1,569	480	–463	–340	255	2,555	–1,377	–773	–2,385	–2,649
Current price current transfers from RoW (receipts *less* payments)	–YBGF	1,034	333	–340	–267	215	2,287	–1,275	–734	–2,309	–2,649
Real current transfers (re-ref to 1990 until 1994)		**1,323**	**405**	**–390**	**–287**	**215**	**2,154**	**–1,161**	**–652**	**–2,011**	***–2,649***
Real Gross National Disposable Income (1995 prices)	YBGO	581,522	601,110	634,696	647,959	652,323	650,481	654,916	671,298	702,432	713,701
Current price Gross National Disposable Income	RPMB	381,424	416,989	465,645	508,942	549,398	581,617	605,454	636,892	679,303	713,701
Real Gross National Disposable Income (re-ref to 1990 until 1994)		**489,768**	**506,266**	**534,552**	**545,723**	**549,398**	**547,847**	**551,582**	**565,379**	**591,601**	**713,701**

Source: ONS

Table 4 shows the calculation of RGDI using terms of trade, GNI and GNDI similar to that of Table 2 but using a different time period. GDP, terms of trade and RGDI are all referenced to 1995, however GNI and real current transfers are re-referenced to 1990 before being aggregated to form GNDI. This demonstrates how part of the fixed base method uses re-referencing before carrying out calculations and part of it does not.

Annual Chain-linking method

In annual chain-linking, the base year is updated every year as opposed to the fixed base method where the base year is updated every five years. Calculations are carried in previous years prices (PYP) and the aggregated PYPs chain-linked together to give 'chained volume measures' (CVM). For further information on the construction of PYPs and other such calculations behind annual chain-linking see Tuke and Reed (2001).

All the calculations for RGDI, GNI and GNDI will be carried out consistently in previous years' prices including the terms of trade adjustment applied to GDP.

Table 5 shows how the values in previous year's prices (PYP) for the terms of trade effect are calculated. Real exports are supplied in previous years' prices from the export compilation system. Exports deflated by the implied imports deflator are converted into previous years' prices by referencing each CVM annual value to the previous year. PYP exports (point 2 in Table 5) are then subtracted from PYP

Box 2
Annual Chain-linking terminology

Chained Volume Measures (CVM)	This is the term which will be used to describe components of real GDP and will replace the term constant price (KP) in September 2003 following the introduction of annual chain-linking.
Previous Years' Prices (PYP)	These are values in previous years' prices (and referenced to the previous year) as opposed to values in current or constant prices.

Table 4 UK national and domestic product from 1986 to 1994 with re-referencing to 1990 in parts

£ million

ESA95 codes		CDIDs	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
B.1*g	**Gross Domestic Product (1995 prices)**	**ABMI**	**582,362**	**608,604**	**640,219**	**654,019**	**659,171**	**650,085**	**651,566**	**667,804**	**698,915**	**719,176**
TGL	Terms of trade (1995 prices)	YBGJ	–3,598	–3,204	–1,600	563	2,234	4,330	7,284	7,950	4,835	–
GDI	Real Gross Domestic Income (1995 prices)	YBGL	578,764	605,400	638,619	654,583	661,405	654,415	658,850	675,753	703,750	719,176
D.1+D.4	Real employment, property and entrepreneurial income from the RoW (1995 prices)	YBGI	6,693	1,322	1,026	–1,007	–3,537	–3,696	138	–201	3,459	2,101
–D21+D.31	Subsidies (receipts) *less* taxes (payments) on production from/to RoW (1995 prices)	–QZPB	–5,557	–6,111	–4,506	–5,314	–5,846	–2,848	–2,755	–3,695	–2,679	–5,220
+D.29–D.39	Other subsidies on production to/from RoW (1995 prices)	–IBJN	49	16	18	35	43	50	59	212	287	293
GNI	Gross National Income (ref to 1995)	YBGM	579,949	600,627	635,157	648,297	652,065	647,921	656,292	672,069	704,817	716,350
	Gross National Income (re-ref to 1990 until 1994)		**488,445**	**505,861**	**534,943**	**546,010**	**549,183**	**545,693**	**552,743**	**566,031**	**593,612**	**716,350**
	Real current transfers from RoW (receipts *less* payments) (re-ref to 1990 until 1994)	–YBGP	1,323	405	–390	–287	215	2,154	–1,161	–652	–2,011	2,649
	Gross National Disposable Income (re-ref to 1990 until 1994) from Table 3		**489,768**	**506,266**	**534,552**	**545,723**	**549,398**	**547,847**	**551,582**	**565,379**	**591,601**	**713,701**

Source: ONS

exports deflated by the implied imports deflator (point 7 in Table 5) to give the PYP terms of trade effect (point 8 in Table 5).

Terms of trade effect PYP = Export deflated by implied Import deflator PYP – Export PYP.

Table 6 incorporates the results from Table 5 illustrating the PYPs required for the calculation of GNI.

Table 5 Calculation of the Terms of trade effect (using values in previous years' prices)

United Kingdom							**£ million**
	1994	1995	1996	1997	1998	1999	2000
1 – Current price exports **(calculated in the export system)**	180,508	203,509	223,091	231,622	228,801	236,609	265,135
2 – PYP Exports (calculated in the export system)	**178,709**	**196,807**	**220,268**	**241,549**	**238,682**	**240,999**	**260,612**
3 – Current price imports	185,255	207,051	227,216	231,436	237,948	252,187	283,623
4 – CVM import	196,526	207,051	226,999	248,969	272,924	296,669	331,396
5 – Implied import deflator **(calc 3 / calc 4)*100**	94	100	100	93	87	85	86
6 – Exports deflated by the imports deflator	1,915	2,035	2,229	2,492	2,624	2,783	3,098
7 – PYP Exports Deflated by Imports Deflator (re-referencing CVM values to previous year)	**175,190**	**191,838**	**222,878**	**249,407**	**243,951**	**242,673**	**263,344**
8 – PYP Terms of Trade (PYP Exports deflated by Imports Deflator minus PYP Exports (calc 7 – calc 2)	**–3,519**	**–4,969**	**2,610**	**7,859**	**5,270**	**1,674**	**2,732**

Source: ONS

Table 6 Calculation of GDI, GNI and GNDI using values in previous years' prices

United Kingdom							**£ million**
	1994	1995	1996	1997	1998	1999	2000
PYP Gross Domestic Product	672,251	701,078	738,046	788,459	834,777	880,094	930,276
PYP Terms of Trade	–3,519	–4,969	2,610	7,859	5,270	1,674	2,732
PYP Real Gross Domestic Income	668,732	696,109	740,656	796,318	840,047	881,768	933,008
PYP Real employment, property and entrepreneurial income from the RoW	3,287	2,034	1,170	3,835	12,323	2,485	9,176
PYP Subsidies (receipts) *less* taxes (payments) on production from/to RoW	–3,426	–6,525	–5,181	– 2,059	–3,363	–5,963	–3,302
PYP Other subsidies on production to/from RoW	291	292	248	202	252	363	306
PYP Gross National Income	**668,884**	**691,910**	**736,893**	**798,296**	**849,259**	**878,653**	**939,188**
PYP Real Current transfers from RoW (receipts less payments)	–2,265	–2,565	–1,848	–3,151	–4,700	–4,346	–6,165
PYP Gross National Disposable Income	**666,619**	**689,345**	**735,045**	**795,145**	**844,559**	**874,307**	**933,023**

Source: ONS

Table 7 UK national and domestic product following the introduction of annual chain-linking

United Kingdom **£ million**

ESA95 codes		CDIDs	1994	1995	1996	1997	1998	1999	2000
B.1*g	**CVM Gross Domestic Product**	**ABMI**	**800778**	**823,992**	**845,613**	**874,729**	**900,300**	**921,996**	**950,415**
TGL	"CVM" terms of trade = CVM GDI – CVM GDP	YBGJ	–13,860	–20,001	–17,608	–9,678	–4,340	–2,699	0
GDI	CVM Real gross domestic income	YBGL	786,919	803,991	828,004	865,052	895,960	919,297	950,415
D.1+D.4	CVM Real employment, property and entrepreneurial income from the RoW	YBGI	3,825	2,324	1,294	4,122	13,004	2,574	9,312
–D.21+D31	CVM Subsidies (receipts) *less* taxes (payments) on production from/to RoW	–QZPB	–1,697	–3,307	–3,282	–1,632	–1,952	–3,161	–4,072
+D.29–D.39	CVM Other subsidies on production to/from RoW	–IBJN	237	242	205	164	200	295	292
B.5*g	**CVM Gross National Income**	YBGM	791,595	803,553	826,597	868,786	908,238	918,850	955,947
D.5,6,7	CVM Real current transfers from RoW (receipts *less* payments)	–YBGP	–2,638	–2,930	–2,044	–3,387	–4,961	–4,501	–6,256
B.6*g	**CVM Gross National Disposable Income**	YBGO	788,978	800,641	824,585	865,417	903,277	914,354	949,691

Source: ONS

Table 7 shows how Table 1.1 in the *Blue Book* might look after the introduction of chain-linking where all components and aggregates have been chain-linked.

Although the PYP for the terms of trade effect can be found, it cannot be chained as an aggregate. The reason for this is similar to that of the fixed base method, linking negative and positive data together is problematic. A representation of terms of trade as a chained volume measure is therefore calculated by subtracting GDP (CVM) from GDI (CVM). It is important to note that the values shown in Table 7 have been constructed to illustrate the calculations not to estimate the effect of annual chain-linking.

Conclusion

GNI is important to UK national accounts users because it measures the income earned by a country's residents and it enables international comparisons. There were difficulties encountered calculating the terms of trade effect in the present fixed base system. Although adding or subtracting volume measures with different deflators has theoretical limitations, the fixed base method has the advantage of avoiding the problem of having to link negative and positive series of different price bases together. Annual chain-linking approaches this problem found in the terms of trade effect by directly subtracting the chained volume measure of GDP from the chained volume measure of RGDI. The result of this new system will be to improve the consistency of calculations for the GNI system overall.

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