Estimating Unaccounted Income in India
Using Transport as a Universal Input

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An alternative methodology to measure the scale of unaccounted income in India (shadow economy) using transport as the universal input is developed. Based on input–output tables and National Accounts Statistics, annual demand for road freight transport is estimated. Correspondingly, annual supply of road freight transport is obtained based on availability of diesel for road freight transport, stock of goods carriages, average freight transport capacity per vehicle, average annual distance travel, and average fuel efficiency per vehicle. The mismatch of supply and demand is broadly considered the unaccounted for portion of the gross domestic product. The methodology is tested for two successive input–output tables and three consecutive financial years. Since the analysis is based on assumptions, a comparative static analysis is carried out to check the sensitivity of estimates to changes in the assumptions.

We are grateful to the anonymous reviewer for giving useful comments and suggestions on an earlier draft of this paper. The usual disclaimer applies.

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There has been a lot of interest in understanding and measuring the size of unaccounted incomes in economies.[1] In India, the department of revenue had commissioned three studies to understand the size and characteristics of unaccounted incomes in India (Government of India 2012). By its every definition, unaccounted income is not directly measurable. Any method used to measure the size of unaccounted incomes has to use some proxies and derive an estimate based on assumptions. Given the inherent difficulties in measuring unaccounted incomes, it would be useful to find additional ways of characterising or new proxies for measuring. The present paper is an attempt to propose a new method to measure unaccounted income, so as to add an additional dimension to the discussion on unaccounted incomes.

Acharya (1983) classifies literature on unaccounted income into two broad groups: (i) those dealing with incomes which should have been reported to tax authorities but were not; and (ii) extent of under-reporting of national income (or gross domestic product or GDP) and output because of non-reporting (or under-reporting) of incomes and output. While these two concepts will have overlaps, they do not coincide.[2] Since under-reporting in GDP can limit the scope of study for a variety of aspects of the economy, the present attempt focuses on this aspect.

While there are a number of established methods in the literature, each of these has faced some criticism. Briefly, the available approaches are classified into three broad categories: the "monetary method" (or "currency demand approach"), the "latent variable method," and the "global indicator method."

The monetary method works on the assumption that the unaccounted segment of the economy works primarily through cash and that the velocity of money is the same between the accounted and unaccounted segments of the economy (Ardizzi et al 2014; Ahumada et al 2007; Tanzi 1983; Gupta and Gupta 1982; Feige 1979; Gutmann 1977). Apart from the other difficulties with this method, given the transformation in the economy where new instruments have replaced cash as a medium of exchange and existence of money laundering, it now appears that the assumptions underlying the currency demand approach can be questioned. The second set of methods predicts the value of the latent variable based on observable variables (Frey and Week-Hannemann 1984; Aigner et al 1988; Schneider 2005; Chaudhuri et al 2006). These methods yield an index which throws light on the changes in latent variable over time. To get an actual estimate of the level in any given year, they need to be calibrated using some alternative estimates. The third set of approaches is referred to as the global indicator approach which uses some "universal input" to measure the amount of unaccounted incomes.[3] Two examples of this approach exist in the literature—one based on consumption of electricity (Kaufmann and Kaliberda 1996) and one based on use of labour (Contini 1982). In these cases, there is need to identify a benchmark year where the extent of unaccounted incomes is zero or close to zero. Alternatively, these measures can provide an estimate of the extent to which the unaccounted incomes have changed over the years.[4]

The present paper proposes to add an approach within the category of "global indicator" method. It aims to use "road freight transport" as the universal input on the basis of which unaccounted incomes in the economy can be measured. The rationale for using road freight transport as a global indicator can be summarised as follows:

(i) Road freight transport services are used as inputs by all sectors of the economy.

(ii) Services of transport sector cannot be stored. Whenever there is demand for transport, it is supplied. Therefore, if one can measure supply credibly, it can be taken as a measure of demand for the service. Further, since demand for road freight transport is a derived demand, we can infer the output produced in the rest of the economy from these estimates of size of road freight transport sector.

(iii) The strong relationship between transportation output and economic growth has been established in literature (Lahiri et al 2003; Norwood and Casey 2002). Lahiri and Yao (2006) shows that transportation sector plays an important role in propagation of business cycles in the United States (US) economy. The study finds one-to-one correspondence between cycles in the transportation sector and those in the aggregate economy. Often transportation sector output index is used to forecast economic growth cycles (Lahiri et al 2003). *Brookings–Financial Times* Tracking Indexes for the Global Economic Recovery (TIGER) considers electricity consumption and freight volumes to track manufacturing activity in 20 countries (Prasad and Foda 2015).

The input–output (I–O) table for the Indian economy presents sectoral interactions (commodity to commodity flow matrix) across 130 sectors, which covers all sectors of the economy. All sectors used land transport as an input. The only exceptions being ownership of dwellings and public administration. This establishes universality of land (road) transport as an input for income generation. When electricity is already established as a universal input for estimation of unaccounted income (Kaufman and Kaliberda 1996; Gupta and Mehta 1982), this approach has been criticised on a number of counts: first, since electricity demand would be expected to vary across sectors in the economy, any change in the sectoral composition of GDP would induce changes in electricity demand quite unrelated to the extent of unaccounted incomes in the economy. It has also been pointed out that for sectors such as electricity, the relationship might be unstable—more related to the weather condition than to actual output. Moreover, given gap between demand and supply (deficit) in the availability of electricity, this may not be the only source of energy in some countries—a fact that can significantly undermine the applicability of such an approach. This criticism is summarised rather well in Hanousek and Palda (2004: 9):

> The one-to-one or constant relationship between electricity use and GDP is a stylized-fact gleaned from developed economies where there is a stable sectoral composition of GDP. Each sector has its specific electricity demand for every $1 of GDP the sector produces. Developed economies have not known the sort of price fluctuation and massive restructuring of energy-use technologies that economies in transition have known.

The labour market approach suggests that the size of the unaccounted economy can be gauged from official labour force participation rates, if they are inexplicably low compared to a benchmark where the black economy is of limited significance. The accuracy of the estimates of the unaccounted economy using this method depends on availability of reliable data on labour force participation rate. The reliability of the data source becomes crucial for the accuracy of the estimates regarding the hidden economy. In India and other developing countries where there is a considerably large and thriving informal sector, and where the government does not have extensive programmes providing unemployment benefits, assigning appropriate interpretation to the statistics on labour force participation rates is difficult. For implementing this approach, we need to assume that the economy is in "full employment" (anyone not working in the formal sector therefore would be working in the informal sector). This assumption is far from applicable in India.

The proposed approach using road freight transport as the universal input has two advantages over the electricity-based approach. First, it does not rely on changes in the relation between GDP and the universal input over time. It provides an estimate for a given year from information available for that year alone. Second, unlike in electricity, the demand for services will be exactly equal to the supply of the services. Thus, this approach can provide an alternative way of looking at unaccounted incomes.

Methodology

This methodology, as mentioned earlier, is based on the idea that since transport services are not storable, the supply of transport services would necessarily be equal to the demand for the same. Any difference between the supply and the revealed demand therefore can be treated as unaccounted demand for transport services which in turn would be a reflection of unaccounted incomes in the rest of the economy. To derive the extent of unaccounted incomes therefore, we need to estimate demand for and supply of road freight transport services. The methodology adopted for deriving the estimates of demand and supply are discussed below.

Supply of road freight transport: The supply of road freight transport services in a year can be derived from the stock on road goods carriages (G_{ki}) for that year (say, *i*th year), their average freight transport capacity (C_k), and their average annual distance travelled (S_k).[5] If we assume that there are "n" types of goods carriages on road, the supply of road freight transport services (in tonne kilometre) could be written as:

$$\text{Supply of Road Freight Transport } (T_S) \text{ for ith year} = \sum_{k=1}^{n} G_{ki} C_k S_k \quad \ldots(1)$$

where,

G_{ki} is the stock of on road goods carriages of *k*th category of goods carriages in the *i*th year, C_k is the average freight transport capacity of *k*th category of goods carriages, and S_k is the annual average distance travelled by *k*th category of goods carriages.

To arrive at the stock of goods carriages on the roads, we need a benchmark on the average age of trucks in India. Existing studies do not provide any estimates of the average age of trucks on Indian roads.[6] To attempt an iterative estimate, we consider 15 years as average life of a goods vehicle. Then estimated stock of goods carriages would be 22.52 lakh of medium and heavy commercial vehicles (M&HCVs) and 31.47 lakh of light commercial vehicles (LCVs) (as on 31 March 2012). With some assumptions on annual distance travelled and goods carried, the supply of road freight transport services would be 2,988 billion tonne kilometre (BTKM).[7] However, for these goods carriages to ply, the estimated annual demand for diesel would be 46.21 billion litre.[8] The total demand for diesel in road transport would be 69.13 billion litre (including 22.92 billion litre from road passenger transport). However, the availability of diesel for road transport in 2011–12 is only 47.32 billion litre and it is not adequate to meet the mentioned demand for diesel.

Given this difficulty, we use an alternative approach where, availability of diesel is used to determine supply of road freight transport services. By matching the physical demand (D_d) and supply of diesel (D_s) for road freight transport (equation 2), we get the maximum years' stock of goods carriages that could be supported by the available supply of diesel. In other words, given S_k and F_k we estimate G_{ki}, by matching demand and supply (availability) of diesel for road freight transport.

$$D_s = D_d = \sum_{k=1}^{n} G_{ki} S_k F_k \qquad \text{...(2)}$$

Demand for road freight transport: Demand for road freight transport for a point of time can be estimated as follows:

$$\text{Demand for Road Freight Transport} = \sum_{j=1}^{m} (TI_j * V_j) \qquad \text{...(3)}$$

where,

TI_j is the transport intensity of the *j*th sector, and it is the ratio of demand for road freight transport to total output for the sector

V_j is the value of output of the *j*th sector.

Transport intensity here is measured with respect to output and not value added, since the latter would be more sensitive to changes in relative prices. Transport demand should be related to the physical movement of goods which would be related to outputs rather than value added per se.

Since value of output for services sectors is not available from the National Accounts Statistics (NAS), for services sectors we have estimated the value of output as follows:

$$V_s = GDP_s * (TO_s/GVA_s) \qquad \text{...(4)}$$

where,

V_s is the value of output of the *s*th service sector, GDP_s is the GDP of the *s*th service sector (available from NAS), TO_s is the total output of the *s*th service sector (available from I–O table) GVA_s is the gross value added by the *s*th service sector (available from I–O table).

We have compressed I–O table 2007–08 (commodity to commodity) from original 130 commodities and services to 17 sectors. This compression is done for ease of handling. The 17 sectors considered are—one sector for agriculture and allied activities, including mining and quarrying, 14 sectors for manufacturing, and two services sectors—one sector for services other than road transport services (including railways) and one for road transport services (including via pipeline). The rationale for working with a greater disaggregation in manufacturing can be explained as follows: demand for road transport (as percentage of total output) is not only higher for manufacturing sector as compared to other two sectors (agriculture, including mining and quarrying and services sector, other than road transport services) but also transport intensity (as measured by demand for road transport as percentage of total output) varies across manufacturing sub-sectors substantially (coefficient of variation is 0.43). Therefore, to capture the dynamics of road freight transport demand in manufacturing sector, we have taken 14 sub-sectors.

In our analysis, we have assumed that in sectors other than services sectors, demand for road freight transport is same as the input road transport services as given in the I–O table.[9] For services sectors, it is assumed that the demand for freight services is derived from their demand for input goods. This is estimated as follows:

$$DLT_s = \sum_{g} SLT_g * X_{gs} \quad \text{where } SLT_g = DLT_g/TO_g \qquad \text{...(5)}$$

where,

DLT_s is the demand for road freight transport in *s*th category of service sector; DLT_g is the demand for road freight transport in *g*th category of goods sector; SLT_g is the share of road freight transport in total output of *g*th category of goods sector; TO_g is the total output of *g*th category of goods sector; X_{gs} is the demand for *g*th category of goods sector by *s*th category of service sector.

It may be noted that since the I–O table shows relationship between inputs and outputs for the year for which it is constructed, to avoid problems related to changes in relative prices, the analysis is undertaken in 2007–08 prices.

Finally, if estimated supply of road freight transport is greater than demand, it is considered evidence of under-reported demand. Corresponding to this unreported demand, there would be under-reported GDP.

Results

Estimation of supply: Sector-wise consumption of diesel (high speed diesel oil, HSDO) is available from *Indian Petroleum and Natural Gas Statistics 2010–11* (MOPNG 2012). The availability of diesel for road transport is residually determined in Table 1 (p 110) by first excluding bulk sales of diesel (railways, industry, etc) and then other sectoral uses of diesel from total sales of diesel for a year. Since sector-wise diesel sales data is not available for 2011–12, we have estimated the sectoral consumptions of diesel for 2011–12 based on total sales of diesel in 2011–12 (that is, 64,750 thousand tonne) and sector-wise percentage share in total sales for 2010–11.[10]

Road transport consists of road passenger transport and road freight transport. Since reliable estimate on demand for diesel in road passenger transport is not available, we have derived the same based on a few assumptions (Table 2).[11] Using data on category-wise number of registered motor vehicles, the demand for diesel in passenger road transport is estimated based on some assumptions on the share of vehicles run on diesel and the consumption of diesel by these vehicles (Table 2).[12]

Table 1: Sector-wise Consumption (End use) of Diesel ('000 tonne)

	2007–08	2008–09	2009–10	2010–11	2011–12
Railways	2,036	2,166	2,261	2,371	2,559
	(4.27)	(4.19)	(4.02)	(3.95)	
Aviation and shipping	622	747	670	562	607
	(1.3)	(1.44)	(1.19)	(0.94)	
Agriculture	9,330	6,153	6,829	7,337	7,919
	(19.57)	(11.9)	(12.14)	(12.23)	
Power generation	3,243	4,316	4,686	4,890	5,278
	(6.8)	(8.35)	(8.33)	(8.15)	
Mining and quarrying	925	1,025	1,248	1,366	1,474
	(1.94)	(1.98)	(2.22)	(2.28)	
Manufacturing industry*	2,368	4,264	4,754	4,946	5,338
	(4.97)	(8.25)	(8.45)	(8.24)	
Miscellaneous and unknown end use	3,558	2,160	1,956	2,171	2,343
	(7.46)	(4.18)	(3.48)	(3.62)	
Private sales and private imports	31	62	94	112	121
	(0.07)	(0.12)	(0.17)	(0.19)	
Road transport	25,556	30,817	33,744	36,235	39,110
	(53.61)	(59.6)	(60.0)	(60.4)	
Total	47,669	51,710	56,242	59,990	64,750
Availability of diesel for road transport (in billion litre) (1 tonne=1210 litre)	30.92	37.29	40.83	43.84	47.32

* - Manufacturing industry includes chemical and fertilisers, civil engineering, electricals/electronics, mechanical, metallurgical, textile, and other consumer and industrial goods.
Figure in the parenthesis show the percentage share in total diesel sales.
Source: MoPNG (2012).

Given the availability of diesel for road transport, that is, 47.32 billion litre in 2011–12, only 24.40 billion litre (or 51.56% of total available supply for road transport) is available for road freight transport. However, the demand for diesel in road freight transport is derived based on stock of goods carriages (as on 31 March 2012), category-wise average fuel efficiency and average annual distance travelled of goods carriages (Appendix I, p 114, for assumptions). These estimates are derived for alternative assumptions on the average age of the vehicles. In Table 3, we present the stock of goods carriages (as shown in second and third columns of Table 3) by varying the average age of the vehicles ranging from 1 year to 10 years and the corresponding demand for diesel. Table 3 shows that the availability of diesel is not enough to meet the demand for diesel for six years' cumulative stock of goods carriages.

Once physical availability (supply) and demand for diesel for road freight transport is matched, we estimate the supply of road freight transport based on category-wise average gross vehicle weight and average distance travelled per annum by goods carriages. The estimated supply of road freight transport in 2011–12 is 1,537.51 BTKM: 1,513 BTKM from six years' cumulative stock of goods carriages (Table 4, p 111) and additional 24.51 BTKM from goods carriages having vintage more than six years.[13]

Table 2: Estimation of Demand for Diesel in Passenger Road Transport—2011–12

Category of Passenger Vehicle	No of Registered Vehicles: Period	No of Registered Vehicles: Nos (A)	Annual Diesel Consumption (billion litre)	Annual Diesel Consumption (litre/vehicle)	Average Distance Travelled (km/day)
Buses (on road stock of vehicles: 13 years)*	1999–2012	8,42,496	10.03 @	21,080	258
Taxis (9 years)*	2003–12	11,37,015	4.15 **	3,650	179
Three wheelers (13 years)*	1999–2012	27,66,100	5.05 @@	1,825	175
Passenger cars (9 years)	2003–12	1,09,75,380	2.02 #	918	45
Jeeps (9 years)	2003–12	8,07,041	1.06 $	1,314	45
Omni vans/buses (9 years)*	2003–12	1,39,949	0.61 $	4,380	120
Total			22.92		

* Excluding Delhi, as all commercial public transport vehicles (including taxis, three wheelers and Omni vans/buses) are run on CNG.
@ We assume that 13% of the stock of buses is public buses, and 87% buses are private buses, and private buses are run half the distance an average public bus runs in a day (assumption based on MoRTH 2011b).
\# We assume that 20% of total passenger cars are run on diesel (following Chugh and Cropper 2014).
$ In India, except in Delhi, jeeps and omni vans/buses are mostly run on diesel.
** For taxis, we assume that the daily diesel consumption is @10 litre/day (informal interviews with taxi drivers).
@@ - For three-wheelers, we assume that the daily diesel consumption is @5 litre/day (informal interviews with auto-rickshaw drivers).

Table 3: Estimation of Demand for Diesel in Road Freight Transport—2011–12

Stock of Goods Carriages (in year)	Stock of Goods Carriages (as on 31 March 2012) (in lakh)		Diesel Demand in Road Freight Transport (in billion litre/year)*			Diesel Demand in Passenger Road Transport (in billion litre/year)	Total Demand for Diesel in Road Transport (billion litre)	Annual Diesel Availability for Road Transport in 2011–12 (billion litre)
	M&HCVs	LCVs	M&HCVs	LCVs	Total			
1 year	2.96	2.98	5.10	0.70	5.80	22.92	28.72	47.32
2 years	5.52	6.74	9.51	1.59	11.11	22.92	34.03	47.32
3 years	7.09	9.08	12.22	2.14	14.36	22.92	37.28	47.32
4 years	8.90	11.67	15.33	2.76	18.09	22.92	41.01	47.32
5 years	11.12	14.28	19.15	3.37	22.52	22.92	45.44	47.32
6 years (+1)	11.05	21.17	19.03	5.00	24.03	22.92	46.96	47.32
7 years (+2)	13.38	22.89	23.05	5.41	28.46	22.92	51.38	47.32
8 years (+3)	16.84	22.26	29.01	5.26	34.26	22.92	57.19	47.32
9 years (+4)	17.97	23.70	30.95	5.60	36.55	22.92	59.47	47.32
10 years (+5)	20.54	26.30	35.38	6.21	41.59	22.92	64.51	47.32

*- Estimated based on methodology described in Equation 1.
Source: Estimated by authors.

Estimation of demand: We have compiled the GDP (2004–05 series) for all the 17 sectors (both at current and constant 2004–05 prices) from NAS (CSO 2012, 2013). Except for services sectors, we have also compiled the gross value of output (at constant 2004–05 prices) from NAS database (CSO 2013).

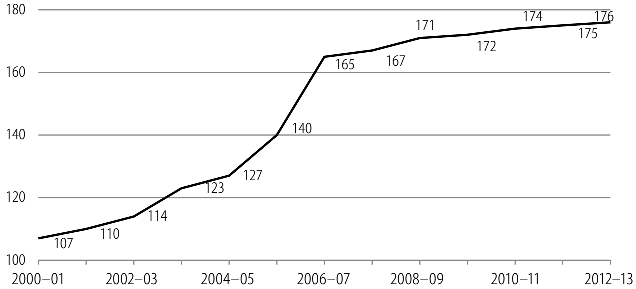
Based on the methodology described in equations 3–5, we have estimated the demand for road freight transport for all the 17 sectors in Table 5 (p 111). For 2011–12, total demand for road freight transport services is estimated to be ₹2,48,936 crore (in 2007–08 prices). The table also establishes the universality of road transport as an input for income generation.

The value of demand for road freight transport (as we estimate in Table 5) is converted into physical units (in BTKM) by using average tariff rate of road freight transport (in rupees per tonne km). The average tariff of road freight transport for 2011–12 is derived from available information and a few assumptions (for details see Appendix II, P 115). The estimated average road freight rate is converted to 2007–08 prices by using Road Freight Index of Transport Corporation of India Limited (TCIL) (Figure 2). In Table 6, we have estimated the demand for road freight transport in physical unit for 2009–10 to 2011–12 using the I–O table of 2007–08.

Unaccounted GDP for India (2011–12): Here, we compare the physical demand and supply of road freight transport (in BTKM) and estimate the unaccounted supply of road freight transport (Row G in Table 7). Corresponding to this unaccounted supply of road freight transport, we have also estimated unaccounted GDP (Row H in Table 7) and it is 25% of total (accounted and unaccounted) GDP for 2011–12. In other words, the estimated unaccounted GDP is 34% of official estimate of GDP for 2011–12 (Table 7).

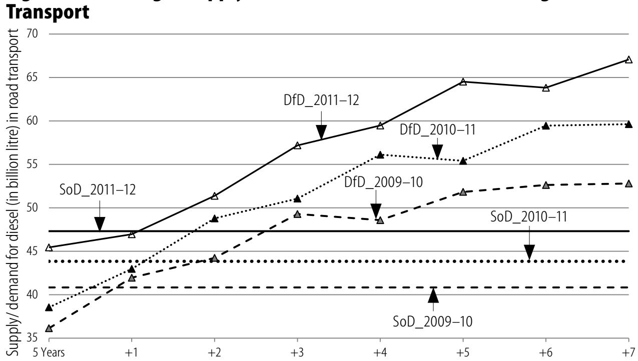
Supply of road freight transport provided by the present stock of goods carriages ideally should be equal to the demand for road freight transport and any discrepancy between them could be due to under-reporting of road freight transport in GDP. Since there is no incentive for individual entity to under-report the rate of freight (in rupees per tonne km transported) there are always incentives for under- or non-reporting of goods (freight) carried through road. Since the transport sector is kept out of the present value added tax (VAT) system, claiming input tax credit against input goods and services is not permissible. Therefore, non-reporting sales are the ideal strategy for transporters, as depending on their sales income tax liability is calculated. However, since transporters cannot issue VAT invoices, there is no incentive for

Figure 1: Road Freight Index of Transport Corporation of India Limited—2000–01 to 2012–13



Data Source: http://www.tcil.com/tcil/indian-road-freight-index.html (viewed on 7 October 2014).

Figure 2: Matching of Supply and Demand for Diesel in Road Freight Transport



DfD implies demand for Diesel and SoD implies Supply of Diesel.
Source: Estimated by authors.

Table 4: Estimation of Supply of Road Freight Transport—2011–12

Age of Vehicle	Stock of Vehicles (in lakh) (as on 31 March 2012)		Annual Distance Travelled (in lakh km)		Annual Freight Transported (in billion tonne km)		
	M&HCVs	LCVs	M&HCVs	LCVs	M&HCVs	LCVs	Total
1 Year	2.96	2.98	447	164	360	24	384
2 Years	5.52	6.74	834	371	671	54	725
3 Years	7.09	9.08	1,071	499	862	73	935
4 Years	8.90	11.67	1,344	642	1,082	93	1,175
5 Years	11.12	14.28	1,679	785	1,351	114	1,466
6 Years	11.05	21.17	1,669	1,165	1,343	170	1,513
7 Years	13.38	22.89	2,021	1,259	1,626	183	1,810
8 Years	16.84	22.26	2,543	1,224	2,047	178	2,225
9 Years	17.97	23.70	2,714	1,303	2,184	190	2,374
10 Years	20.54	26.30	3,102	1,447	2,496	211	2,707

Source: Estimated by authors.

Table 5: Estimation of Demand for Road Freight Transport for 2011–12 Based on 2007–08 Input–Output Table

Sector Description (A)	Value of Output (at 2007-08 Prices) (₹ Crore) 2011-12 (B)	Demand for Road Freight Transport/ Total Output 2007-08 (C)	Demand for Road Freight Transport (₹ Crore) (at 2007–08 Prices) 2011-12 (D)=(B*C)
Agriculture and mining	14,41,219	0.016	22,844
Food products	6,66,714	0.029	19,067
Beverages and tobacco products	74,467	0.032	2,372
Textile products	4,72,864	0.067	31,775
Wood and wood products, furniture, fixture, etc	1,02,092	0.042	4,246
Paper and printing, etc	1,38,355	0.061	8,472
Leather and fur products	51,051	0.044	2,269
Rubber, petroleum products, etc	7,31,878	0.014	10,357
Chemical and chemical products	5,01,795	0.042	21,118
Non-metallic products	2,00,528	0.055	11,110
Basic metals	7,29,126	0.029	20,946
Metal products and machinery	5,23,334	0.028	14,442
Electrical machinery	2,62,118	0.031	8,143
Transport equipment	4,68,308	0.030	13,824
Other manufacturing	2,55,890	0.078	19,938
Non-land transport services as input	59,07,936	0.006	32,572
Land (road) transport services as input	8,21,589	0.007	5,441
Total			2,48,936

*- Estimated value of output (at 2007–08 prices) for 2011–12 (₹ crore) = value of output (at 2004–05 prices) for 2011–12 (₹ crore) * (GDP at current prices for 2007–08/GGDP at constant 2004-05 prices for 2007–08).
Sources: Column C: Input – Output Transaction Table for 2007–08 (CSO 2012).

Table 6: Estimation of Demand for Road Freight Transport (Based on I–O Table 2007–08)

Description	2011–12
Demand for road freight transport (in ₹ crore) (prices in 2007–08) (A)	2,48,936
Road freight index (RFI) deflator (B)*	1.048
Road freight rate (₹ per tonne km) (respective year's prices) (C)#	2.275
Road freight rate (₹ per tonne km) (prices in 2007–08) (D) [C*(1/B)]	2.171
Demand for road freight transport (in billion tonne km) (E) [A/(D*100)]	1,147

* - e g, $RFI_{2011-12}/RFI_{2007-08}$.
# - For details estimation method see Appendix II.
Source: Estimated by authors.

Table 7: Estimation of Unaccounted GDP for India (Based on I–O Table 2007–08*)

Description	2011–12
Demand for road freight transport (in ₹ crore) (prices in 2007–08) (A)	2,48,936
Demand for road freight transport (in billion tonne km) (B) (source Table 6)	1,147
Gross domestic product (in ₹ crore) (prices in 2007–08) (C)	61,43,246
GDP supported by per unit of road freight transport (₹ crore/billion tonne km) (prices in 2007–08) (D) [C/B]	5,355.93
Estimated supply of road freight transport (in billion tonne km) (E)	1,537.51
Unaccounted supply of road freight transport (F) [(E-B)/E*100] (%)	25.40
Estimated GDP (₹ crore) (prices in 2007–08) (G) [D*E]	82,34,789
Estimated share of unaccounted GDP (H) [(G-C)/G*100] (%)	25.40

Source: Computed by authors.

others to report engagement of transport services. If there is under-reporting in road freight transport (which is the most important means of transporting goods from one place to another), there is the possibility of under-reporting in production or output too. Income generated from unreported production/output is also kept out of books of accounts. Given the presence of large unorganised sector in Indian economy and vast market for locally produced consumer goods, selling goods in cash (without invoice) is not impossible. Therefore, there are incentives for some firms to under-report raw materials and corresponding production (output) and the process leads to generation of unaccounted income. If a sector's output is predominantly used for final consumption, the possibility of not reporting purchase of raw materials and corresponding output would be higher.

A compilation of previous estimates of unaccounted income of India is presented in Table 8. The table shows that estimates vary across methods of estimation. As compared to old estimates, current estimates show less variation across methods. Our estimate is in line with other estimates of unaccounted income in India.

Sensitivity Analysis

Since the analysis is based on some assumptions, it would be useful to examine the sensitivity of the estimates to changes in assumptions made. Table 9 presents these results. Since studies often suggest higher values for average distance travelled and average carrying capacity, the table considers cases where these parameters are increased by 10%. However, since fuel efficiency is based on weighted average declared fuel efficiency of different varieties of goods carriages, for older vehicles, the fuel consumption would be higher; so we consider a 10% decrease in fuel efficiency. Table 9 shows that a 10% increase in average daily distance covered by goods carriages will increase the estimated unaccounted income by 9.26%. However, an increase in average daily distance travel will support a smaller stock of goods carriages and at the same time it will result in larger supply of road freight transport (in BTKM). The rise in supply of road freight transport exceeds the fall in stock of goods carriages and it results in larger supply of road freight transport implying an increase in unaccounted GDP. Similarly, a 10% fall in average fuel efficiency will lead to 22.47% fall in estimated unaccounted income. A 10% increase in average carrying capacity will result in a 26.65% increase in estimated unaccounted income. In other words, if one incorporates any estimate of overloading of vehicles, the estimates of unaccounted incomes would increase.

Robustness of the Estimates

To check the robustness of our estimates with reference to change in structural composition of the economy and transport intensity of the sectors, first, based on availability of information we have extended our analysis to cover another two years, 2009–10 and 2010–11. This helps to rule out the possibility that the results obtained for 2011–12 are an aberration relevant to a single year. Second, we have estimated the results with reference to two successive I–O tables of 2003–04 and 2007–08 released by CSO (2008, 2012). It is expected that with changes in

Table 9: Comparative Static Results

Parameter (Assumption)	Supply of Road Freight Transport (in BTKM)		Demand for Road Freight Transport (in BTKM)	Unaccounted Income		
	Present	After Change (10%)		Present	After Change	% Change
(A)	(B)	(C)	(D)	(E) = [(B-D)/B]	(F) = [(C-D)/C]	(G) = [(F-E)/E*100]
Average daily distance travel (M&HCVs:151 km; LCVs:55 km) (increase)	1,537.51	1,587.58	1,147	0.25	0.28	9.26
Fuel efficiency (km/litre) (M&HCVs: 3.2; LCVs: 8.5) (decrease)	1,537.51	1,428.24	1,147	0.25	0.20	-22.47
Average carrying capacity (tonne/vehicle) (M&HCVs: 22.05; LCVS: 3.99) (increase)	1,537.51	1,690.96	1,147	0.25	0.32	26.65

Source: Estimated by authors.

Table 10: Estimation of Unaccounted GDP in India

Description	Prices in	2011–12	2010–11	2009–10
Estimated share of unaccounted GDP (% of total GDP)	2003–04	28.85	30.20	34.98
	2007–08	25.40	26.57	30.05

Source: Computed by authors.

Table 8: Alternative Estimates of Black Income of Indian Economy (as percent of GNP or GDP)

Year	Chopra (1982) Estimates		Gupta and Gupta	Gupta and Mehta	Ghosh et al	Rangnekar	NIPFP (1985)	Schneider	Chaudhuri et al	Schneider	Kumar
	Wanchoo Method*	Own Method*	(1982) Estimates*	(1982) Estimates#	(1981) Estimates*	(1982) Estimates*	Estimates	(2005) Estimates	(2006) Estimate	(2004) Estimates	(2013)
1970–71	4.8	5.2	22.3	–	7.6	–	–	–	–	–	
1971–72	5.1	3.2	28.7	–	7.8	–	–	–	–	–	
1972–73	4.0	3.8	31.9	–	7.8	–	–	–	–	–	
1973–74	4.9	8.1	27.1	–	7.4	9.9	–	–	–	–	
1974–75	5.9	12.4	20.9	13.8	8.1	9.3	–	–	–	–	
1975–76	5.6	9.9	25.0	–	8.4	10.0	15–18	–	–	–	
1976–77	5.7	10.2	37.6	–	8.7	11.3	–	–	–	–	
1977–78	–	–	38.4	–	8.7	12.1	–	–	–	–	
1978–79	–	–	48.1	19.8	–	13.5	–	–	–	–	
1979–80	–	–	–	–	–	14.4	–	–	–	–	
1980–81	–	–	–	–	–	–	18–21	–	–	–	
1983–84	–	–	–	–	–	–	19–21	–	–	–	
1990–91	–	–	–	–	–	–	–	20.6	–	–	
1994–95	–	–	–	–	–	–	–	21.8	20.3	–	
1999–2000	–	–	–	–	–	–	–	23.1	–	23.1	
2001–02	–	–	–	–	–	–	–	–	–	24.2	
2002–03	–	–	–	–	–	–	–	–	–	25.2	
2013											50.0

* – Estimates are in percentage of GNP at current market prices. # – Estimates are in percentage of GDP at factor cost and 1770–71 prices. Other estimates are in percentage of GDP.
Source: NIPFP (1985); Government of India (2012); Schneider (2004, 2005); Chaudhuri et al (2006).

the economy as reflected in the I–O tables, the measure of unaccounted incomes too would change. However, if with change in the I–O tables, there is a very dramatic change in the results for any given year, then the methodology and the results would be viewed with a degree of suspicion.

Before going into the estimates for unaccounted supply of road freight transport, it would be worthwhile to check the physical demand and supply of diesel for road freight transport for all three years of our analysis. In Figure 2, we present the estimates of supply and demand for diesel in road freight transport across cumulative stock of goods carriages. Across all estimates, we find that the availability of diesel could meet demand for up to six years cumulative stock of goods carriages.[14] It means that if the actual stock of vehicles in operation is higher, then either the vehicles would be running fewer kilometres per day or there is not enough diesel to run them.

The estimates for various years corresponding to two I–O tables are presented in Table 10 (p 112). It shows that the estimates of unaccounted income (as percentage of total income—accounted and unaccounted) do vary across I–O tables and year of estimation, but the variation is not large. Estimates based on 2003–04 I–O table show that unaccounted incomes vary from 29% (in 2011–12) to 35% (in 2009–10). On the other hand, estimates based on 2007–08 I–O table vary from 25% (in 2011–12) to 30% (in 2009–10). Variation in estimates across I–O tables is only 3% to 5%.

Impact of additional supply of diesel: It is often argued that diesel in the country is adulterated with a number of other products, primarily kerosene. It is therefore interesting to ask what happens to the estimates of unaccounted demand for road freight transport and corresponding unaccounted GDP if the effective supply of diesel was higher, say by 5% (Scenario I) or 10% (Scenario II). Table 11 presents the baseline scenario and two alternative scenarios: Scenario I where the fuel supply for goods carriages is higher by 5%, and Scenario II where additional 10% fuel is available for road freight transport. The estimates show that with additional availability of diesel, unaccounted income increases.

Table 11: Estimation of Unaccounted Supply of Road Freight Transport (I-O Table 2007–08) (as % of total GDP)

Description	2011–12	2010–11	2009–10
Baseline scenario	25.40	26.57	30.05
Scenario I (5% additional diesel supply)	32.38	33.56	36.33
Scenario II (10% additional diesel supply)	38.27	39.34	41.35

Source: Computed by authors.

Conclusions

This paper develops a methodology for estimation of unaccounted GDP based on road freight transport as a universal input. The methodology captures economic activities which are not fully accounted in the official estimate of GDP. The paper estimates the size of the unaccounted GDP (as percentage of total GDP: unaccounted and accounted) in India. However, activities like bribe-taking and kickbacks are transfers and not accounted either in the official estimate of GDP or in our estimation of unaccounted GDP.

To capture the dynamics of the relationship between inputs and outputs and structural changes of the economy, the methodology is tested by using two different I–O tables (2003–04 and 2007–08) and estimating the results for three consecutive years (2009–10 to 2011–12). The results show that for reasonable assumptions, fairly consistent estimates of unaccounted GDP can be derived. The actual level of unaccounted incomes in the country can be calibrated by incorporating estimates of the adulteration in diesel and estimates of overloading in trucks.

It should be mentioned here that the estimate of unaccounted incomes derived here can be interpreted as an estimate of the extent to which GDP estimates of economic activity are under-reported. This interpretation has two limitations: first, these estimates by themselves cannot be related to incomes not reported for purposes of taxes. Second, any incomes which are generated for illegal activities and/or from activities which are not part of value addition in the economy will not be reflected in this approach. For instance, suppression of incomes from capital gains from the sale of real estate property will not be reflected in this estimate since this is considered a transfer in the methodology for measurement of GDP.

NOTES

1 See, for instance, Capasso and Jappelli (2013), Schneider (2005), Bajada and Schneider (2005), Eilat and Zinnes (2002), Caridi and Passerini 2001, Bajada 1999, Bagachwa and Naho (1995), Frey and Pommerehne (1984), Tanzi (1983). For a comprehensive review of literature on unaccounted/shadow economy see OECD (2002).

2 OECD (2002) classifies unrecorded economic activities into underground production, illegal production, informal sector production and production of households for own final use.

3 Global indicator methods, in which unaccounted incomes or non-measured production is modelled in terms of a single variable (usually a physical indicator) with which it is believed to be highly correlated, electricity consumption being the most commonly used.

4 For an extensive review of methodologies for estimation of unaccounted income, see Chapter 12 of OECD (2002).

5 Following Government of India (2010), we assume that average daily distance travel of medium and heavy commercial vehicle (M&HCV) is 151 kilometre and light commercial vehicle (LCV) is 55 km.

6 While some reports claim that life of goods carriage in India is up to 20 years (World Bank 2005; MoRTH 2011a), there are no studies that establish an age for trucks on Indian roads.

7 The assumption on average annual distance travel is based on Government of India (2010) and assumption on capacity of goods carriages is estimated based on category-wise vehicle sales data (see Table A1 in Appendix).

8 Estimated average fuel efficiency for M&HCVs is 3.2 km/litre and for LCVs is 8.5 km/litre (see Table A1 in Appendix).

9 In other words, it is being assumed that the entire demand for road transport services for the goods producing sectors is for freight services alone.

10 As published by Petroleum Policy Analysis Cell (PPAC), http://ppac.org.in/WriteReadData/userfiles/file/PT_Consumption_H.xls (viewed on 8 October 2014).

11 We have compiled data on category-wise number of registered motor vehicles for All India and Delhi from 31 March 1996 (1995–96) to 31 March 2012 (2011–12). The data is published by the Ministry of Road Transport and Highways (MoRTH) and is also available in www.indiastat.com website.

12 Though in a few metros taxis, three wheelers and jeeps are running on alternative fuels (like LPG, CNG), reliable estimates of their percentage share in total stock of vehicles and their average daily consumption of fuels is not available to us. Therefore, we have not attempted to make any guesstimate and reduce the demand for diesel in passenger road transport.

13 We get 1,513 billion tonne km from six years' stock of goods carriages for which entire demand for diesel is met by the available of supply, and another 24.51 billion tonne km from a few goods carriages (having vintage more than six years) for which additional 0.36 billion litre of diesel (over and above meeting the demand for six years' stock of goods carriages) is available.

14 By matching availability and demand for diesel, additional supply of road freight transport of 24.51 and 62.22 billion tonne km is gained

for 2011–12 and 2010–11 (with reference six years' stock of goods carriages). For 2009–10, we have a reduction in supply of road freight transport by 80.26 billion tonne km due to unavailability of diesel to meet six years' stock of goods carriages.

15 These are magazines available online at: http://www.motorindiaonline.in/ and http://www.commercialvehicle.in/

16 The data on truck freight rate (in rupees per tonne km for 16 tonnes vehicle) between four metros (Kolkata, Mumbai, Chennai, and New Delhi), and 26 major cities, is taken from http://www.infobanc.com/logistics/logtruck.htm (viewed on 10 April 2012); and the data on distance between cities (in km) are taken from http://www.distancebetweencities.co.in/

17 This is a simple average of the rates computed for different pairs of destinations within India. Similar rates are reported in a study by TCI and IIMC (2012).

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Appendix I

Estimation of Average Freight Transport Capacity and Fuel Efficiency of M&HCVs and LCVs

First, from the data on the category-wise number of registered vehicles, we estimate the stock of goods carriages (multi-axle/articulated vehicles/trucks and lorries/light motor vehicles (goods)), and passenger carriers (buses, taxis, three-wheelers, passenger cars, vans, etc). The latest data available for statewise, category-wise registered motor vehicles is as on 31 March 2012. Since, average vehicle weight-wise information on stock of goods carriages is not available from the data released by the Ministry of Road Transport and Highways, we have relied on category-wise domestic sales data released by magazines like *Motor India* (May 2011 and May 2012 issues) and *Commercial Vehicle* (May 2012 issue) (Table A2). Since all domestic sales of vehicles required registration, ideally, domestic sales figure should match the number of registrations of vehicles in a year. Second, from available data on category-wise (based on gross vehicle weight) domestic sales of commercial vehicles, we estimate the weighted average maximum weight for light commercial vehicles (LCVs: maximum weight up to 7.5 tonne) and medium and heavy commercial vehicles (M&HCVs). The estimated maximum weight for LCVs is 3.99 tonne, and that of M&HCVs is 22.05 tonne (Table A1).

Third, since data on fuel efficiency across varieties of goods carriages are not available in the public domain, to estimate the fuel efficiency of the vehicles, we depend on company product brochures where, for a few models, we found the fuel efficiency figures. The available information is placed according to their category based on gross vehicle weight (GVW), and we estimate the weighted average fuel efficiency of the vehicles. Average fuel efficiency for LCVs comes to 8.5 km per litre, and that of M&HCVs to 3.2 km per litre. We found that fuel efficiency figures as put up by Government of India (2010) for LCVs (light trucks) and M&HCVs (heavy trucks) are 4.5 km per litre and 3.6 km per litre, respectively. The estimate of average mileage provided by the Transport Corporation of India (TCI) and the Indian Institute of Management Calcutta (IIMC) (2012) for major freight across India is 4.06 km per litre for 2011–12. The estimated average fuel efficiency for M&HCVs is 3.2 km per litre, and for LCVs it is 8.5 km per litre (Table A1), and we have considered these numbers for estimation. The rationale behind the numbers put up by Government of India (2010), and TCI and IIMC (2012) is not clear.

Appendix II

Estimation of Average Tariff for Road Freight Transport

To determine a reliable and representative average tariff of road freight transport per tonne-km, we worked with road freight tariff across Indian cities.[16] We have found that the average tariff across cities varies, and the average tariff per tonne per km of road freight transport is ₹1.75 (minimum ₹1.1 to maximum ₹4.6) for medium and heavy commercial vehicles (M&HCVs).[17] To estimate the average tariff for light commercial vehicles (LCVs), we have relied on informal discussions with a few transporters and local traders, and find that the average tariff for LCVs is higher than for M&HCVs. The reason for this difference is that LCVs mostly operate for shorter distances, and within city limits. Traffic restrictions on the movement of goods carriages within the city, as well as various factors influence the higher average tariff for LCVs. The weighted average of road freight tariff is estimated to be ₹2.275 per tonne-km for 2011–12 (see Table A2).

Table A1: Category-wise Domestic Sales of Commercial Goods Carriers in India—2009–10 to 2011–12

Sl No	Category of Commercial Vehicle (A)	Min. Mass (tonne) (B)	Max Mass (tonne) (C)	Domestic Sales (in Nos) 2009–10 (D)	2010–11 (E)	2011–12 (F)	Gross Vehicle Weight (tonnes) (G)=(C*F)	Weighted Average Vehicle Weight (tonne) (H)=(G/F)	Fuel Efficiency (in km/litre) (I)	Weighted Average Fuel Efficiency (km/litre) (J)
	Light commercial vehicles (LCVs) (goods carrier)									
1	Maximum mass up to 3.5 tonne		3.5	2,12,943	2,72,995	3,61,192	12,64,172		8.5	
2	Maximum mass exceeding 3.5 tonne but not exceeding 7.5 tonne	3.5	7.5	40,421	44,035	50,268	3,77,010			
	Total LCVs (goods carrier) (1 to 2)			2,53,364	3,17,030	4,11,460	16,41,182	3.99		8.5
	Medium and heavy commercial vehicles (M&HCVs) (goods carrier)									
3	Maximum mass exceeding 7.5 tonne but not exceeding 12 tonne	7.5	12	43,679	55,411	67,056	8,04,672		5.1	
4	Maximum mass exceeding 12 tonne but not exceeding 16.2 tonne	12	16.2	48,605	60,686	60,955	9,87,471		3.5	
5	Maximum mass exceeding 16.2 tonne but not exceeding 25 tonne	16.2	25	76,556	85,503	78,185	19,54,625			
6	Maximum mass exceeding 25 tonne		25	14,348	44,471	64,644	16,16,100		2.7	
	Haulage tractor (tractor-semi trailer/trailer)									
7	Maximum mass exceeding 16.2 tonne but not exceeding 26.4 tonne	16.2	26.4				-			
8	Maximum mass exceeding 26.4 tonne but not exceeding 35.2 tonne	26.4	35.2	8,923	12,839	10,871	3,82,659			
9	Maximum mass exceeding 35.2 tonne but not exceeding 40 tonne	35.2	40.0	338	562	1,017	40,680			
10	Maximum mass exceeding 40 tonne but not exceeding 49 tonne	40.0	49.0	7,918	13,165	14,638	7,17,262			
11	Maximum mass exceeding 49 tonne		49	1,494	2,484	1,943	95,207			
	Total M&HCVs (3 to 11)			2,01,861	2,75,121	2,99,309	65,98,676	22.05		3.2

Source: Motor India (May 2011, May 2012), Commercial Vehicle (May 2012), and Planning Commission (2011).

Table A2: Estimation of Average Tariff per Tonne-km—2011–12

Sl No	Alternative Estimate for Demand of Diesel in the Freight Transport Sector	Unit	Amount	Data source
1	Average vehicle weight of medium and heavy commercial vehicle (M&HCV) under full load (capacity)	Tonne	22.05	Estimated (see Table A1)
2	Average vehicle weight of light commercial vehicle (LCV) under full load (capacity)	Tonne	3.99	-do-
3	Average road freight tariff for M&HCV	₹ per tonne-km	1.75	Estimation based on data provided in http://www.infobanc. com/logistics/logtruck.htm
4	Average revenue for light commercial vehicle (LCV)	₹ per tonne-km	7.00	Estimated (4*Av. Rev. for M&HCVs)
	Average monthly distance travelled			
5	M&HCV	km per month	4,592.92	Assumption based on Government of India (2010)
6	LCV	km per month	1,672.92	-do-
	Stock of goods carriages (as on 31March 2012)			
7	No of multi-axle/articulated vehicles/trucks and lorries (age ≤7 years) (M&HCVs)	Nos	13,38,288	Estimated based on state-wise, category-wise vehicle registration data released by the Ministry of Road Transport and Highways, Government of India, New Delhi
8	No of light commercial vehicles (goods carrier) (age ≤7 years) (LCVs)	Nos	22,88,585	-do-
	Average annual road freight transport			
9	M&HCVs [(5*1)]*12 months]	Tonne—km per vehicle	12,15,285.75	Estimated
10	LCVs (6*2)*12 months	Tonne—km per vehicle	80,099.25	-do-
	Average annual road freight transport			
11	M&HCVs [(9*7)/109]	Billion tonne—km	1,626.40	Estimated
12	LCVs [(10*8)/109]	Billion tonne—km	183.31	-do-
13	Total (11+12)	Billion tonne—km	1,809.71	
	Share in total road freight transport			
14	M&HCVs (11/13)		0.90	Estimated
15	LCVs (12/13)		0.10	-do-
16	Weighted average revenue for road freight transport (14*3+15*4)	₹ per tonne—km	2.275	Estimated

Source: Computed based on data sources as shown in last column.