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The direct economic impact of gold

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Contents

Foreword

It is with great pleasure that I am able to introduce The Direct Economic Impact of Gold, a new independent report from PwC, commissioned by the World Gold Council.

This report is both ground-breaking in scope and timely in its analysis. It addresses, for the first time, the direct economic impact of gold on the global economy, and does so in a way which is objective in stance and rigorous in its treatment of complex data. The report is unique in looking at an entire value chain, including gold mining, refining, and fabrication and consumption. It helps us understand the fundamental role that gold plays in advancing economic development and ultimately the needs of society.

The scope of the report has been determined by the availability of data and therefore there are some limitations within the report. It details where additional research would improve understanding of the significant contribution the gold industry makes to households, communities and nations alike. If one were to add in the indirect value created by the gold industry, the value delivered would likely be significantly larger; indeed quantifying this “multiplier effect” would merit its own research report.

This is a time of change for the entire gold industry. The mining sector is facing a barrage of converging challenges; increasing costs, ever higher expectations from a wide range of stakeholders and a gold price which could call in to question the viability of some projects and lead to a contraction in supply. Demand however is increasing, fuelled by; expanding middle classes in Asia, diversification of reserve assets by central banks and a growing desire for physical gold amongst many Western savers.

In the midst of all this, and at a time when the ‘extractive’ industries are being widely scrutinised for their global impact, it is important to be reminded of how gold contributes so broadly to the global economy, ranging from foreign exchange earnings for gold-exporting countries to employment opportunities and tax revenues This study demonstrates this clearly; of particular note is the fact that the economic value generated has a direct and sustained impact on the local economies where gold production or consumption takes place.

I believe that it is only on the basis of a more realistic and better rounded understanding of gold’s true impact on our global community that the gold industry can further develop and sustain effective partnerships with all our stakeholders. I hope that this research will contribute to the quality of this conversation and lead to further research and discussion.

Randall Oliphant, Executive Chairman, New Gold Inc. and Chairman, World Gold Council

Executive summary

Background

As part of its work as the market development organisation for the gold industry, the World Gold Council commissioned PricewaterhouseCoopers LLP (PwC) to analyse the direct economic and fiscal contribution of gold in the world's major gold producing and consuming countries. The key measures used are gross value added (GVA), which measures the contribution to gross domestic product (GDP), employment and taxes paid. This is the first time that the available evidence on the contribution of gold has been collated. As such, the report provides a baseline assessment of gold's direct economic and fiscal contribution.

Key findings

Global gold supply reached 4,477 tonnes in 2012 with approximately two thirds coming from mining and one third from the recycling of gold.

- The 15 largest gold producing countries, which accounted for around three quarters of global output, directly generated US$78.4 billion of gross value added (GVA) in 2012 – approximately equal to the GDP of Ecuador or Azerbaijan or 30% of the estimated GDP of Shanghai.
- Large scale, formal gold mining in the top 15 producing countries directly employed an estimated 527,900 people in 2012.
- Gold mining is a significant source of exports for some countries: in 2012, gold exports were 36% of all Tanzanian exports and 26% of exports in Ghana and Papua New Guinea.
- Limited data are available on the scale of the contribution of gold mining to the public finances: such evidence as exists suggests that mining royalties are only a small proportion of the total fiscal contribution of gold mining companies.
- The estimated GVA of global gold recycling is between US$23.4 billion and US$27.6 billion.
- The GVA per tonne of recycled gold is approximately US$16 million compared with approximately US$36 million for gold produced from mines.

In 2012, investment demand (consisting of bar and coin and gold-backed exchange traded funds (ETFs)) accounted for 35% of global gold demand, central bank gold purchases accounted for 12%, jewellery accounted for 43% and use in technology/manufacturing accounted for around 10% of gold demand.

- The 13 largest gold consuming countries in 2012 accounted for 75% of gold used for fabrication and 81% of gold used for (final) consumption, either in the form of jewellery or investment products such as small bars and coins.
- Their activities directly generate up to USS110 billion of GVA – approximately equal to the GDP of Bangladesh or half the GDP of Hong Kong or Singapore.
- The direct GVA associated with the fabrication of small bar and coin is estimated to be US$13.3 billion across the top 13 consuming countries whilst the direct GVA associated with consumption is estimated to be US$38.3 billion: these estimates are not additional since the estimated GVA based on fabrication will be included in the consumption based estimate.
- The direct GVA attributable to gold jewellery fabrication and consumption across the top 13 gold consuming countries is estimated at US$69.8 billion.
- The direct GVA attributable to gold's use in technology fabrication is estimated at almost US$4 billion (excluding the value generated by the retail component of these goods).

Overall, the GVA associated with the supply of and demand for gold is estimated to be in excess of US$210 billion across those countries in scope of this analysis: this means it is similar to the GDP of the Republic of Ireland or the Czech Republic or Beijing.

Scope of analysis and approach

The report examines the key stages in the value chain for gold from its extraction from the ground through processing to its application in diverse uses. The analysis of the **supply of gold** focuses on mine production and the recycling of gold whilst the **demand side analysis** focuses on gold fabrication (primarily for jewellery and technology) and certain forms of investment (principally bar and coin). The analysis does not examine the economic impact of holding gold on portfolio performance as this is already addressed by other work being led by the World Gold Council[1].

The economic analysis concentrates on the direct economic impacts: none of the indirect, induced or wider economic impacts that might arise is considered systematically. The key metrics are GVA – which measures the economic contribution of those entities engaged in the gold value chain and reflects their contribution to the economies in which they operate – and employment. GVA is used because it measures the value of an activity in a way which lends itself to direct comparison with Gross Domestic Product, which is used worldwide to measure economies' economic output. Its use in this report does, however suffer from practical limitations. Not all the data needed to measure the economic impact are readily available from secondary sources. The resulting gaps are filled by making estimates by linking and extrapolating from available datasets.

The fiscal analysis focuses on the revenues derived by governments from those taxes and other fiscal measures which are peculiar to the extraction and use of gold rather than those which apply to all or most businesses regardless of their sector (e.g. corporation tax). This is largely because of the practical difficulties of assessing the scale of all these taxes on a consistent basis. This means that the estimated tax payments presented later in this report are likely to understate significantly the total fiscal contribution of gold mining companies.

No consideration is given to the social and environmental impacts associated with the supply of and demand for gold.

The report focuses on those countries which are the largest producers and consumers of gold and, together, accounted for at least three quarters of global gold mine production and gold demand. It includes the 15 major gold producing countries and the 13 major gold consuming countries. It covers the year 2012, the most recent year for which there is data.

In all cases, the report summarises the gross economic and fiscal contribution directly attributable to gold. It draws on a range of secondary data sources: no work has been done to assure any of these secondary data nor has any primary data collection been undertaken.

The supply of gold

Global gold supply reached 4,453 tonnes in 2012. Approximately two thirds of new gold supply each year comes from mining with the remaining one third coming from the recycling of gold.

Mine production

The focus of this report is on formal, large scale mining. The impact of artisanal gold production is also considered, although the analysis is limited because reliable and consistent statistics are not available on this form of supply across all the countries within scope.

Global mine production was 2,861 tonnes in 2012. Mines in the top 15 gold producing countries extracted 2,177 tonnes of gold in 2012, 76% of the world total. The six largest producers, China, Australia, the United States, Russia, Peru and South Africa, extracted more than half of the gold mined globally.

The gold mines in the world's top 15 producing countries are estimated to have generated US$78.4 billion of direct GVA in 2012. This is equal to the entire national economic output of Ecuador or Azerbaijan or 30% of the estimated GDP of Shanghai. The direct GVA for each country is shown in Figure 1. This impact excludes the indirect or induced effects of gold mining which arise from spending in the supply chain and by employees on goods and services. If this impact was included, the economic contribution of gold mining would be significantly bigger.

China is estimated to derive the largest economic contribution directly from gold mining at US$12.6 billion in 2012, although this is only a small proportion of the total output of the world's second largest economy (0.2%).

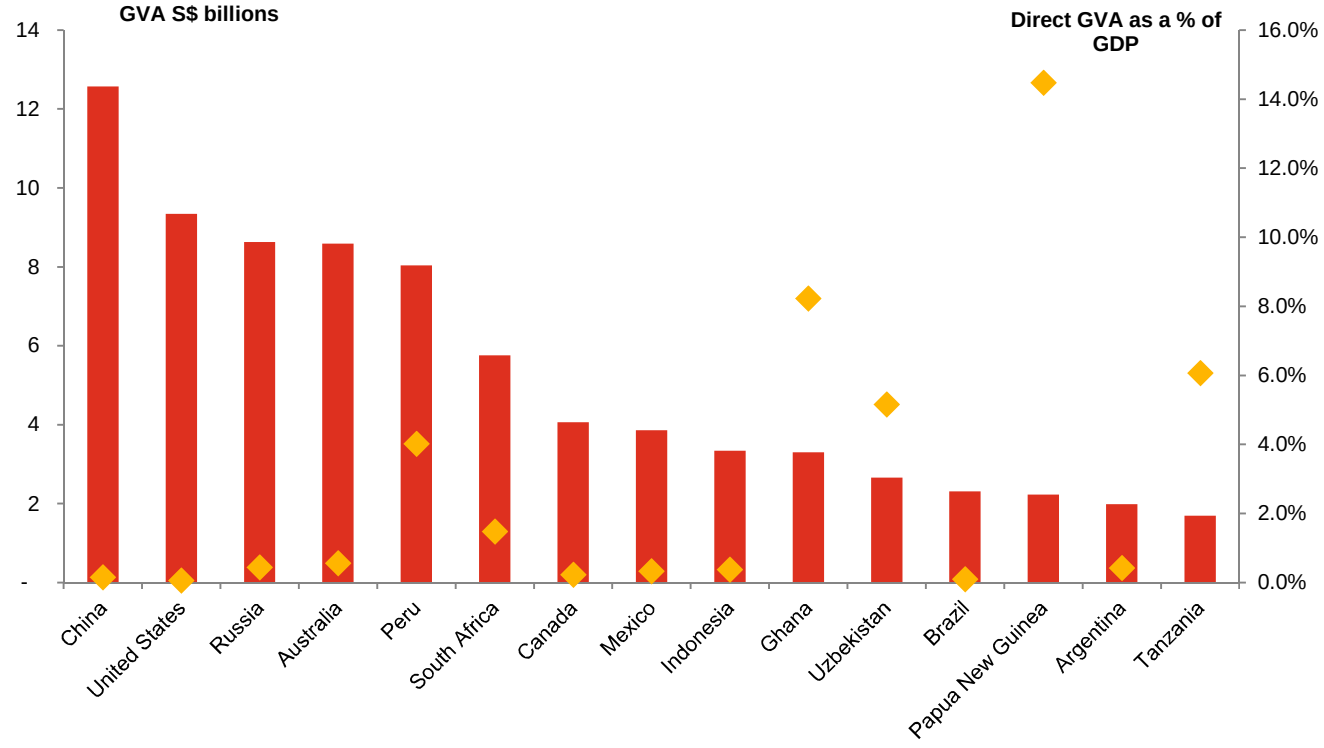
[1] See for example World Gold Council (2012) *Gold as a strategic asset for UK investors: portfolio risk management and capital preservation*, July 2012.

The direct GVA from gold mining is also estimated to be over US$8.0 billion in the US, Australia, Russia and Peru.

The significance of gold mining to national economies varies considerably. It is estimated to be greatest in Papua New Guinea (15% of GDP), followed by Ghana (8% of GDP) and Tanzania (6% of GDP). For these countries, gold mining is one of the most significant sources of wealth creation in the economy.

The average amount of economic value added per ounce of gold is US$1,139 and ranges from US$946 in China to US$1,352 in Peru in 2012. The differences between countries reflect variations in labour costs and productivity.

Figure 1: Direct gross value added by gold mining (2012)



Source: PwC analysis based data from the London Bullion Market Association (LBMA), Thomson Reuters GFMS Mine Economics and Gold Survey 2013, International Monetary Fund

The employment supported by gold mines is an alternative measure of economic contribution. Total direct employment in gold mining across the 15 largest gold mining countries is estimated to be 527,900 in 2012. These estimates understate significant employment in artisanal and small scale production outside the formal sector as well as the indirect and induced employment attributable to gold mining[2].

Three countries stand out: South Africa has an estimated 145,600 gold mining employees[3], Russia 134,000 and China is estimated to have 98,000 employees. Gold mining also employs more than 15,000 people in four other countries: Australia (32,300), Indonesia (18,600), Tanzania (17,000) and Papua New Guinea (16,100). The basis for these estimates is explained in Appendix 2.

Average gold production per head in 2012 was around 124 ounces of gold per worker[4] and the average GVA per worker across the 15 largest producing countries is estimated at US$295,000. The average country level estimate of GVA per worker varies from US$841,800 in the United States to US$39,600 in South Africa.

The scale of capital expenditure (capex) made by gold mining companies is a forward looking indicator of future GVA and employment. It is not, however, additional to GVA as some of the resources used to fund capex (such as retained profits) are already captured in GVA. Moreover, not all gold mines publicly report their capex. In

[2] Various analyses exist which assess the scale of these 'multiplier' effects. Most of the evidence relates to mining as a whole rather than just gold mining.
[3] This reflects its labour intensive, deep level mining.
[4] Including contractors where available.

2012, the level of capex by those companies which do report their capex was US$17.7 billion. About 34% of the capex was spent maintaining existing operations and 66% was spent either expanding current operations or developing new operations. These figures are likely to underestimate significantly the actual level of capex.

The most important destinations for investment received in 2012 were Canada (US$2.6 billion), the United States (US$2.5 billion) and Australia (US$2.3 billion).

For some countries, gold mining is a significant source of exports and, therefore, foreign exchange earnings. In 2012, gold exports were 36% of all Tanzanian merchandise exports, 26% of exports in both Ghana and Papua New Guinea and 21% of Peruvian exports. The United States and China are the two largest exporters although extensive gold trading inflates the volume of gold exports: their export earnings in 2012 were US$33.7 billion and US$22.9 billion respectively.

The report also considers the fiscal contribution of gold mining to public finances. Gold mines bear a number of specific taxes in addition to the taxes on profits and labour borne by all companies. These specific taxes include mining royalties, licence fees and export duties.

Only limited data are available on the overall scale of the contribution of gold mining to the public finances. Estimates have, however, been developed of the scale of mining royalty payments made to government. These suggest that the combined mining royalty payments in 2012 across all 15 countries were US$4.1 billion. Evidence from other case study research – which focuses on either individual companies or countries - suggests that mining royalties are only a small proportion of the total tax contribution made by mining companies.

Recycling of gold

Recycling of gold is the other significant source of gold supply accounting for around 36% of global supply in 2012. The location of gold recycling activity is not tied to mine production and is more likely to be linked to gold consumption.

Data limitations, including the lack of information on the countries in which recovered gold is subsequently refined, mean that the GVA of gold recycling cannot be estimated at the country level. Instead, the analysis is limited to the global level.

The estimated GVA of global gold recycling activity is presented as a range in Table 1. It is based on estimating the value of recycled gold (valued at the relevant market price) and then estimating the proportion which is GVA by applying a GVA/turnover ratio. Two different GVA/turnover ratios are used: the lower bound estimate uses the ratio for the manufacturing sector globally and the upper bound uses the ratio for the recycling sector globally.

Table 1: Estimated turnover and GVA of global gold recycling (US$ millions, 2012)

	Turnover	GVA	
		Lower bound – based on the global manufacturing sector ratio	Upper bound – based on the global recycling sector ratio
World total	**86,718**	**23,429**	**27,576**

Source: PwC analysis using data from World Gold Council, World Input-Output Database (WIOD) and national statistical offices

The GVA estimates for global gold recycling range from US$23.4 billion to US$27.6 billion. The value added per tonne of recycled gold using the average of the lower and upper bound estimates is approximately US$15.8 million. This compares with the GVA per tonne of gold produced from mines of approximately US$36.0 million.

Demand for gold

The uses of gold are wide-ranging reflecting both the physical appearance and properties of gold and its advantages as a store of value.

In 2012, investment demand (consisting of bar and coin and gold-backed Exchange Trades Funds (ETFs)[5]) accounted for 35%, central bank gold purchases accounted for 12%, jewellery accounted for 43% and use in technology/manufacturing accounted for around 10% of gold demand.

[5] ETFs cannot clearly be linked to specific countries and are excluded from the analysis of the direct economic impact.

The 13 largest gold consuming countries in 2012 accounted for 75% of gold used for fabrication[6] and 81% of that used for (final) consumption, either in the form of jewellery or investment products such as small bars and coins. By far, the two largest consuming countries are India and China.

The analysis of the economic impact of gold demand has focused on three segments of the market:

- Bar and coin fabrication and consumption;
- Jewellery fabrication and consumption; and
- Technology/manufacturing (e.g. electronics, decorative uses and dentistry).

In each case, the focus is on providing estimates of the GVA attributable to gold during the fabrication process. In addition, the wholesale/retail GVA is also estimated for jewellery and bar and coin: in the case of manufacturing uses, the complexity of the relevant value chains allied to a lack of data on the consumption of those manufactured goods which use gold as an input, precludes analysis of the GVA of retail activity of these manufactured goods.

Bar and coin

Gold bar and coin is the most important form of investment by volume. Bar and coin demand has surged following the financial crisis and accounted for the largest proportion (82%) of total investment demand in 2012. The focus of this analysis is on the economic impact of fabricating and consuming bar and coin: the economic value that gold has as an investment asset in portfolio diversification strategies is not considered as the World Gold Council is carrying out separate studies in this area[7].

The direct GVA associated with bar and coin fabrication is estimated in two steps. First, the mark-up achieved by fabricators is applied to the value of the purchases of gold to estimate their turnover. Second, the GVA is then estimated by multiplying the estimated turnover by the share of turnover that is GVA. In total, the direct GVA associated with the fabrication of gold bars and coins is estimated to be US$13.3 billion across the top 13 consuming countries, led by India, China and Vietnam.

The direct GVA associated with the consumption of bar and coin is estimated in a similar way. First, the mark-up achieved by sellers of bar and coin over the underlying cost of the gold is estimated to derive turnover. Second, the share of this turnover that is GVA is then estimated. In total, the direct GVA associated with the consumption of gold bar and coin is estimated to be US$38.3 billion across the top 13 consuming countries, led by India, China and Vietnam. This estimate should not be seen as additional to the estimate based on fabrication as – at a global level - the value added by fabrication will be included in the consumption based estimate.

Neither estimate captures the economic value, including GVA, generated by subsequent trading in gold for example, through brokerage firms and banks.

Further details of both methods are in Appendix 2.

Jewellery

Jewellery accounts for the largest proportion of gold fabrication and consumption demand. India and China account for more than half of global gold jewellery fabrication and consumer demand.

Data from national governments do not typically provide the level of granularity required to assess the GVA of the fabrication of gold jewellery directly. Consequently, it is estimated by using the mark-up achieved by fabricators and retailers on purchases of gold to estimate the turnover linked to gold consumption in jewellery. Further details of the method are in Appendix 2.

Since this approach does not allow for the other complementary inputs to the production process (such as labour and capital), it will provide conservative estimates of the GVA associated with gold jewellery.

Overall, the direct GVA attributable to gold jewellery fabrication and consumption across the top 13 gold consuming countries is estimated at US$69.8 billion. Although China fabricates and consumes less gold than India, its total GVA exceeds that of India because it adds more value per ounce of gold.

[6] Fabrication covers "*the first transformation of gold bullion into a semi-finished or finished product*".
[7] See for example World Gold Council (2012) *Gold as a strategic asset for UK investors: portfolio risk management and capital preservation*, July 2012.

Technology

Gold is used in a wide range of technological/manufacturing applications because of its electrical conductivity, malleability and resistance to corrosion. Applications include electronic goods and equipment, telecommunications devices and household appliances. Gold is also used in healthcare services and pharmaceutical products due to its "biocompatibility" and resistance to bacterial colonisation.

Table 2 shows fabrication demand for technology purposes in 2012. Global technology fabrication demand amounted to around 408 tonnes in 2012, with gold destined for the electronics industry accounting for the largest share. The United States is the largest consumer of gold for technology purposes followed by China and Germany.

Table 2: Technology fabrication demand (tonnes, 2012)

	Country	Electronics	Dentistry	Other industrial and decorative	Total technology fabrication demand
1	China	48	-	19	67
2	United States	56	7	3	66
3	Switzerland	5	2	10	17
4	Germany	11	2	3	17
5	Russia	13	2	-	15
6	India	2	-	9	12
7	Thailand	-	-	3	3
Total		**135**	**13**	**46**	**195**
World total		**285**	**39**	**84**	**408**

Source: Thomson Reuters GFMS Gold Survey 2013 and World Gold Council

The approach to estimating the GVA associated with technology fabrication is similar to that used for bar and coin and for jewellery.

On this basis, the direct GVA attributable to gold's use in technology fabrication is estimated at almost US$4 billion in 2012 with the United States accounting for a lion's share of this value (almost 56%).

This estimate does not capture the value generated by the retail component of these goods due to the lack of available data on end-use.

Extending the analysis

As part of the preparation of this report, consideration has also been given to how the analysis might be extended, either to enhance the robustness of the estimates of the direct impacts or to broaden their scope to include the indirect, induced and wider economic and fiscal impacts. The key conclusions are summarised below.

Direct impacts

The analysis of the **direct economic impacts** can potentially be improved and extended in several ways:

- The robustness of the impacts associated with the **supply of mined gold** can potentially be enhanced by gathering mine or country level data from mining companies through primary research.
- Further work could be undertaken to understand better the significance and economic contribution of artisanal gold production.
- The estimates of the economic impact of **gold recycling** can be enhanced by developing a better understanding of where the refining activity takes place and how much value added is associated with this process.
- There is more scope for strengthening the methods and data used to estimate the impacts associated with the **demand** for gold as the nature of the organisations involved and the complexity of the value chains mean that more challenges need to be overcome.

The analysis of the **direct fiscal impacts of gold mining** can potentially be improved and extended in several ways:

- By gathering mine or country level data on **gold specific taxes** and other fiscal measures actually paid by gold mining companies on a country by country basis through primary research.

- By extending the analysis to cover **all taxes** actually borne (or, possibly, collected) by gold mining companies.

In considering these options, it will be important to recognise forthcoming developments in reporting of tax payments in the mining sector.

The analysis of the **direct fiscal impacts** associated with **gold recycling** and **gold demand** can potentially be extended by undertaking primary research with the major gold recyclers and gold consumers to gather data on any gold specific taxes that they bear. This will include import duties paid on gold as a raw material and duties on exports of finished or semi-finished products.

Indirect, induced and wider impacts

The current analysis has focused on the direct economic and fiscal impacts of gold supply and demand. As such, it excludes the indirect, induced and wider impacts that arise. These may be significant, although few existing studies have quantified them to date for gold mining.

Various possible methodologies could be used to estimate the indirect and induced impacts:

- Multiplier analysis;
- Input-output analysis; and
- Dynamic economic modelling (also known as computable general equilibrium modelling).

Each methodology has its strengths and weaknesses, but all are potentially limited by the availability and quality of economic data related to the supply of and demand for gold.

Introduction

Background

As part of its work as the market development organisation for the gold industry, the World Gold Council commissioned PricewaterhouseCoopers LLP (PwC) to analyse the direct economic and fiscal contribution of gold in the world's major gold producing and consuming countries. This is the first time that the available evidence on the economic and fiscal contribution of gold across the value chain has been collated. An important element of the work has involved identifying the available evidence. The report, therefore, provides a baseline assessment of the direct contribution of gold.

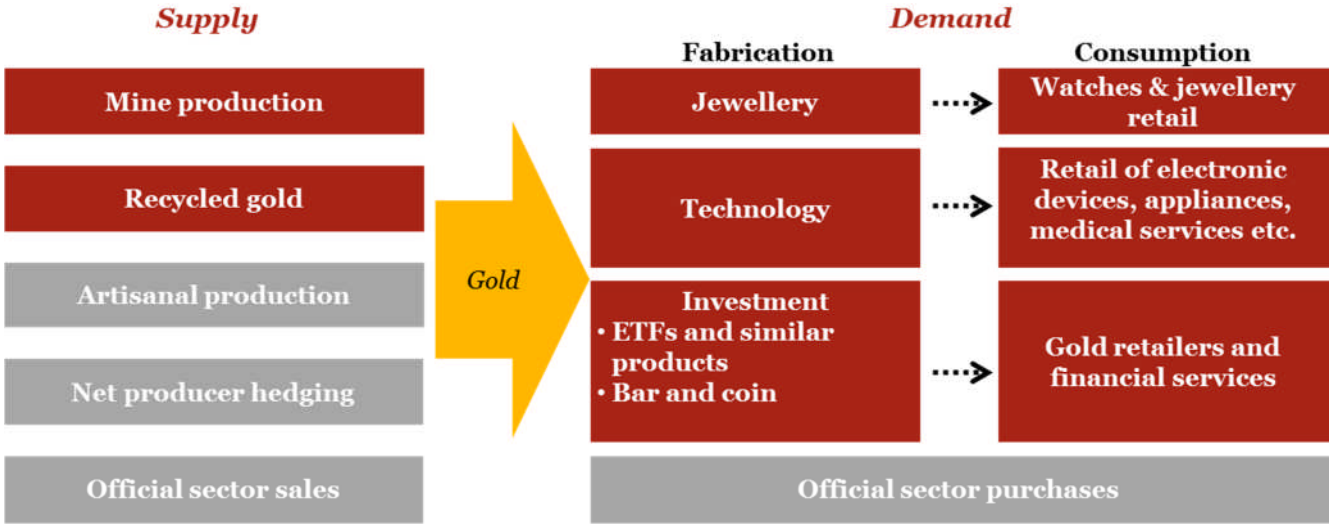
The remainder of this introduction:

- Describes the gold value chain;
- Explains the scope of the analysis;
- Provides an overview of the approach and method that have been used in the analysis; and
- Outlines the structure of this report.

The gold value chain

Figure 2 illustrates the key elements of the value chain for gold and the products which its use supports, for example in jewellery, technology and in bar and coins. The analysis considers the supply of gold separately from the demand for gold. The supply side analysis focuses on mine production and gold recycling. The demand side analysis focuses on the use of gold in fabrication.

Figure 2: The gold value chain



Scope of analysis

Activities

This report examines the direct economic and fiscal impact of each of the key stages in the value chain for gold from its extraction from the ground through processing to its application in diverse uses. The analysis of the supply of gold focuses on mine production and extraction as well as the recycling of gold. The demand side analysis focuses on gold fabrication and, where possible, wholesale and retail of gold products. The analysis does not examine the economic impact of holding gold on portfolio performance as this is already addressed by other work being led by the World Gold Council[8].

[8] See for example World Gold Council (2012) *Gold as a strategic asset for UK investors: portfolio risk management and capital preservation*, July 2012.

Impacts

The focus of the report is on the economic and fiscal impacts of the supply of and demand for gold.

Typically, an economic impact analysis might cover up to four different types of effect:

- The direct impact on the host economy (which is usually measured in terms of contribution to national output or employment);
- The indirect impacts which arise from the spending of suppliers (which can be measured in the same terms);
- The induced impacts on the economy through the spending of employees and suppliers' employees; and
- Any wider economic impacts which accrue to other stakeholders.

The economic analysis in this report, however, concentrates on the direct economic impacts which arise along the value chain for gold. None of the indirect, induced or wider economic impacts that might arise from the supply of gold and its demand is considered systematically here although the analysis provides examples of the activities of gold producers to develop their local supply chains.

In considering the fiscal impacts, the focus is on the impact of those taxes and other fiscal measures which are peculiar to gold rather than those which apply to all or most businesses regardless of their sector (e.g. corporation tax).

At this stage, no consideration is given to the social and environmental impacts associated with the supply of and demand for gold.

Geography

The report focuses on the 15 major gold producing countries and the 13 major gold using countries. Together, these countries accounted for 76% of global gold mine production in 2012 and 81% of gold demand[9].

Time period

The report primarily provides a baseline assessment of gold's direct economic contribution in 2012, the most recent year for which there is data. As such, it has been developed so that it can be updated in the future.

Where year to year volatility in supply and/or demand data is an issue, the report uses averages across time and where data are not available for 2012, earlier data are used: where this occurs, this is made clear in the report.

The report does not provide a historic view of gold's direct economic impact nor does it provide a forward looking assessment of gold's contribution, although some indicators are forward looking (e.g. investment).

Overview of approach and method

Figure 3 provides an overview of the approach to the analysis based on the scope of work described above. It highlights the elements of the gold value chain which are assessed and summarises the measures of the direct economic and fiscal impact which are assessed.

Impact measures

With any impact assessment, an important issue is how best to measure the economic and fiscal impacts in scope. This report defines a set of primary and secondary measures (see Table 3). Gross value added (GVA) is the key measure of gold's contribution to economic output. It measures the value of goods and services produced via the activity of firms engaged in extracting, refining and using gold. Employment is essentially an alternative measure of economic contribution. The revenue derived from taxes and other gold specific fiscal measures is a measure of the contribution to the public finances.

Table 3: Indicators of economic and fiscal impact

	Primary	Secondary
Supply	▪ Gross value added ▪ Employment ▪ Taxes and other gold specific fiscal measures paid	▪ Investment ▪ Exports of gold

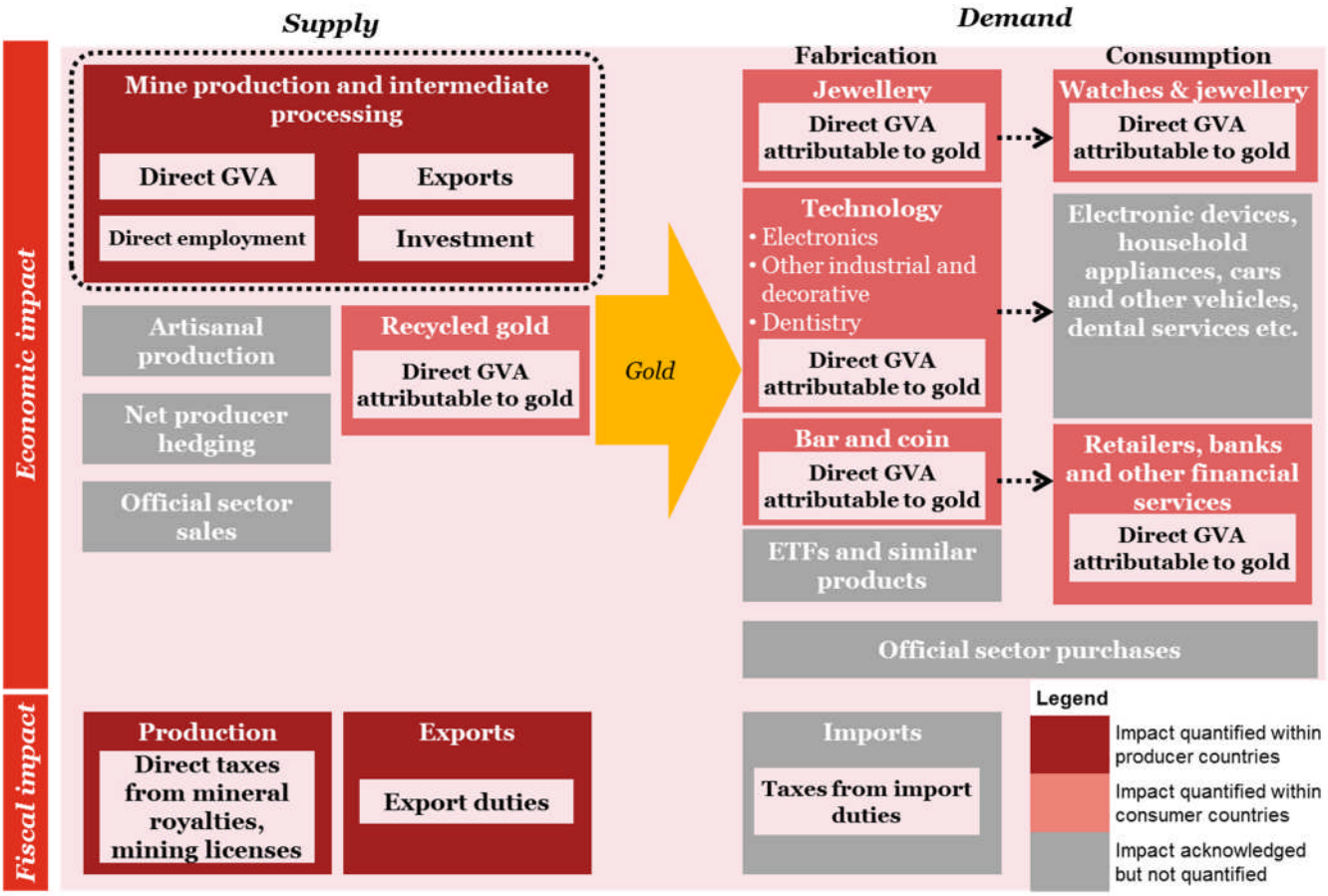
[9] Demand for bar and coin and jewellery.

	Primary	Secondary
Demand	▪ Gross value added ▪ Employment	▪ Purchases of gold ▪ Imports of gold ▪ Exports of products containing gold

Source: PwC

In all cases, the report covers the gross economic and fiscal contribution associated with production and consumption of gold.

Figure 3: Overview of approach and method



All the monetary impacts are expressed in United States dollars. Amounts in local currency units are converted to United States dollars using annual average exchange rates. The report examines both the absolute economic and fiscal contribution of gold related activities and also expresses them relative to metrics covering the primary sector and the economy as a whole.

Data sources

The report draws on a range of secondary sources including:

- Thomson Reuters GFMS Gold Survey 2013;
- Thomson Reuters GFMS Mine Economics;
- World Gold Council publications;
- Official statistics, notably data from national accounts (and other national government statistics);
- Trade associations;
- Company accounts and reports;
- Multilateral organisations such as the International Monetary Fund and UNCTAD; and
- Fiscal data from a number of Extractive Industries Transparency Initiative (EITI) country reports (where they are available).

No primary data collection has been undertaken as part of this analysis.

The quality and accessibility of data vary significantly from source to source and country to country. A key feature of the approach is the establishment and application of an effective hierarchy of sources based on three criteria:

- Consistency – do the data measure the same metric in the same way?
- Timeliness – are the data available up to date (i.e. do they cover 2012)?
- Robustness – are the data sufficiently reliable?

No work has been done to assure any of these secondary data.

In practice, the data needed to apply all the impact measures summarised in Table 3 are not readily available from secondary sources. In these cases, it has been necessary to estimate the potential impacts by linking and extrapolating from project and company level data across economies based on volumes (and other methods). These estimation methods are described in Appendix 2.

Report structure

The report is structured in three further sections as follows:

- **Section 2** examines the supply of gold and summarises the economic impacts directly associated with the mining and recycling of gold;
- **Section 3** analyses the demand for gold which provides our estimates of the economic impacts attributable to the use of gold; and
- **Section 4** summarises the suggested next steps.

Two appendices provide further supporting detail:

- **Appendix 1** contains a glossary of the key technical terms used in this report and explains their meaning; and
- **Appendix 2** describes the methodologies that have been used to measure and estimate the direct economic and fiscal impacts of gold.

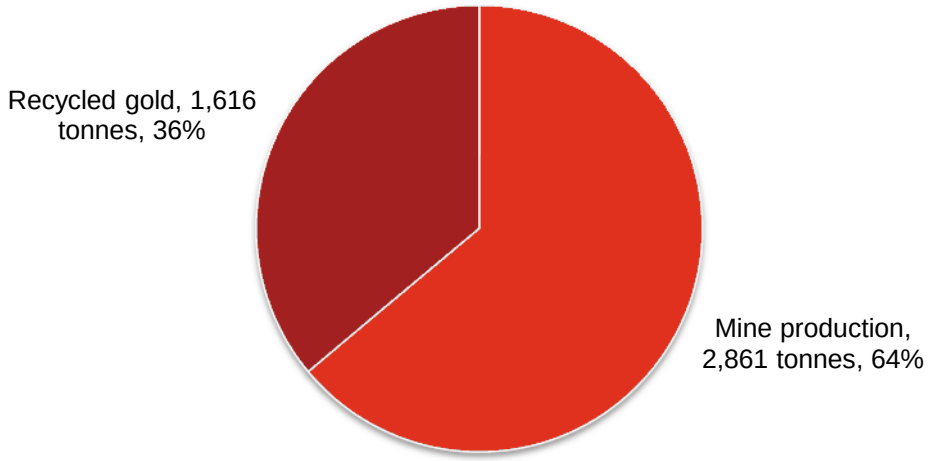
The supply of gold

Introduction

Gold supply comes from three sources: mine production, recycling of gold and net gold hedging[10].

Global gold supply reached 4,477 tonnes in 2012 having increased by 48% from 3,017 tonnes in 2007[11], with most of the growth attributable to recycled gold. Approximately two thirds of gold supply each year comes from mining with the remaining one third coming from the recycling of gold (see Figure 4). The scale of net gold hedging is not significant.

Figure 4: Global gold mine production and supply of recycled gold (tonnes, 2012)[12]



Source: Thomson Reuters GFMS Gold Survey 2013

This section of the report quantifies the principal direct economic and fiscal impacts of the supply of gold, including the economic output and jobs it supports and the taxes it generates. The analysis is split into two parts:

- **Mine production**: this covers the contribution of gold mining to national economies, employment and fiscal receipts in the 15 largest gold producing nations; and
- **Recycling of gold**: this covers the economic impact of gold recycling activities, which are a significant source of gold supply in some countries.

The impact of **artisanal gold production** is considered, although the quantitative analysis is limited because reliable and consistent statistics are not available on this form of supply across all the countries within scope (see page 17).

Mine production

Global mine production increased by 15% from 2,498 tonnes in 2007 to 2,861 tonnes in 2012[13]. New supply has been partly spurred by the sharp increase in the gold price, which more than doubled between 2007 and 2012.

Mines in the top 15 gold producing countries extracted 2,177 tonnes of gold in 2012, 76% of the world total. Table 4 ranks these countries according to the volume of production in 2012. China is by far the largest

[10] This measures the impact in the physical market of mining companies' gold forward sales, loans and options positions. Hedging accelerates the sale of gold, a transaction which releases gold (from existing stocks) to the market. Over time, hedging activity does not generate a net increase in the supply of gold. De-hedging, the process of closing out hedged positions, has the opposite impact and reduces the amount of gold available to the market in any given quarter.
[11] World Gold Council, Gold Demand Trends Full Year 2012.
[12] Total mine supply also includes net producer hedging.
[13] Thomson Reuters GFMS Gold Survey 2013.

producer of mined gold, extracting 413 tonnes in 2012, around 14.5% of the world total. The next five largest producers, Australia, the United States, Russia, Peru and South Africa, account for a further 1,074 tonnes of gold production and, with China, these six countries extract more than half of the gold mined globally.

The key growth areas for mining in recent years include China and Mexico: Chinese gold production increased by almost half (47%) between 2007 and 2012 and Mexican production rose by 118% over the same period. Other countries have seen declines in their production, notably South Africa, where the 2012 mine production figure of 178 tonnes compared to 270 tonnes in 2007.

Table 4: Major gold producing countries (2012)[14]

	Country	Production	Share of global gold production
		Tonnes	*%*
1	China	413	14.4
2	Australia	250	8.7
3	United States	231	8.1
4	Russia	230	8.0
5	Peru	185	6.5
6	South Africa	178	6.2
7	Canada	108	3.8
8	Ghana	96	3.3
9	Mexico	95	3.3
10	Indonesia	89	3.1
11	Uzbekistan	73	2.6
12	Brazil	67	2.4
13	Papua New Guinea	57	2.0
14	Argentina	55	1.9
15	Tanzania	49	1.7
Top 15 total		**2,177**	**76.0**
World total		**2,861**	**100**

Source: Thomson Reuters GFMS Gold Survey 2013, PwC analysis

The contribution of gold mining to the economy

The economic contribution of gold mining is assessed by reference to the GVA. The GVA of gold mining can be estimated using one of two approaches. The first is the income approach which involves calculating the sum of operating profits, depreciation and amortisation and employee costs. The second is the production approach which is derived as the value of sales of gold less the cost of intermediate consumption or the cost of inputs and raw materials directly attributable to that consumption. Both have been used.

Extraction and refining of gold generate a significant economic contribution. It is estimated that gold mining in the world's top 15 producing countries generated US$78.4 billion of direct GVA in 2012. This contribution is significant; it is equal to the entire national economic output of Ecuador or Azerbaijan, countries with populations of 15 million and 9 million people respectively, or 30% of the GDP of Shanghai.

Gold mining directly generated US$78.4 billion of economic output in 2012 – equal to the GDP of Ecuador or Azerbaijan

Economic data from national governments and multilateral institutions do not provide the level of granularity needed to assess gold mining's economic contribution so it is necessary to estimate the direct GVA of gold mining using financial accounting information for large gold mines. Further details of the approach used can be found in Appendix 2. In summary, the key components of the analysis are gold mine production and costs which are used to estimate revenue, operating profits (before tax), depreciation, amortisation and labour costs. These components are combined to estimate GVA.

[14] Note that figures may not sum due to rounding.

This analysis implicitly assumes that the average GVA per ounce of gold is the same across all forms of production in each country. It also does not consider the indirect or induced effects of gold mining which arise from spending in the supply chain and by employees on goods and services. If these effects were included the full economic and fiscal contribution of gold mining would likely increase significantly (see Box 1).

Box 1: Indirect and induced effect of gold mining industry

Although the focus of the current analysis is the direct economic (and fiscal) impact of gold, several studies point to the significant indirect and induced economic impact of gold mining.

For example, a 2009 study of Newmont Ghana Gold's (NGGL) socio-economic impact estimates that overall NGGL's activities supported 48,300 jobs in Ghana[15]: of these, 1,700 jobs were with NGGL and 5,100 were with its direct suppliers. In addition, NGGL's suppliers generated an estimated 28,900 jobs and spending by those employed directly and indirectly supported a further 12,500 jobs.

Similarly, a study by the World Gold Council[16] showed that the four largest gold mines in Peru directly employed 4,500 workers in 2011 and contributed 1.4% of Peru's GDP (in 2010). Using a multiplier of 1.9, which the authors view as conservative, the study estimates that an additional 4,050 jobs were supported indirectly by mining operations. Throughout the supply chain, these four mines were estimated to generate additional salaries of US$240 million.

The estimates of GVA of gold mining, both absolutely and relative to the whole economy, are presented in Figure 5. The ranking closely follows the production ranking in Table 4. This is not surprising as countries mining more gold are likely to generate a greater economic contribution.

China is estimated to estimate the largest economic contribution from gold mining at US$12.6 billion in 2012, although this is only a small proportion of the total output of the world's second largest economy (0.2%). The direct GVA from gold mining is also over US$8.0 billion in the US, Russia, Australia and Peru, at US$9.3 billion, US$8.6 billion, US$8.6 billion and US$8.0 billion respectively.

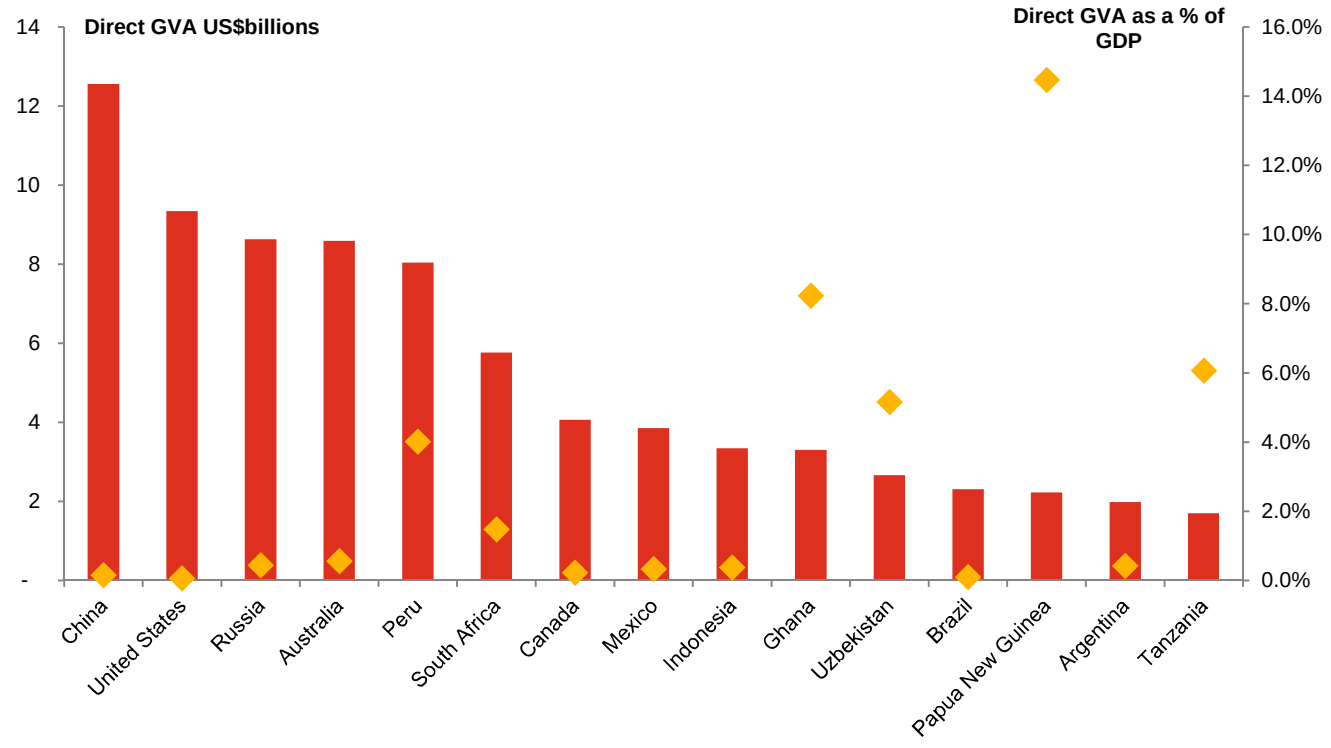
The average amount of economic value added per ounce of gold ranges from US$946 in China to US$1,352 in Peru in 2012. The average level of value added per ounce of gold is US$1,139.

This analysis only captures the value of the GVA generated in the host country. In practice, some of this value will flow abroad if profits are remitted overseas. On the other hand, the development of mining operations may be financed partially from foreign direct investment, which brings additional international capital into the host country. Similarly, some of the value will flow abroad if (any) migrant workers partly remit their salaries.

The significance of gold mining to national economies is also shown in Figure 5. It is estimated to be greatest in Papua New Guinea (15% of GDP), followed by Ghana (8% of GDP) and Tanzania (6% of GDP). For these countries, gold mining is one of the most significant sources of wealth creation in the economy, especially when it is recalled that these estimates do not capture the indirect and induced effects of gold mining.

[15] Kapstein, E. and Kim, R. (2011) *The Socio-Economic Impact of Newmont Ghana Gold Limited*.
[16] World Gold Council (2011) *The economic contribution of large-scale gold mining in Peru*, March 2011.

Figure 5: Direct gross value added (GVA) by gold mining (2012)



Source: PwC analysis based data from the London Bullion Market Association (LBMA), Thomson Reuters GFMS Mine Economics and Gold Survey 2013, International Monetary Fund

Employment in gold mining

The employment supported by gold mining is an alternative measure of its economic contribution to GVA. As with GVA, however, data from national governments and multilateral institutions do not consistently provide sufficiently granular information to identify the number of people directly employed in gold mining, so it is necessary to look to alternative sources or to estimate these figures.

Two different sources are used to estimate national employment (including contractors) in gold mining:

- **National sources of gold mining employment**: these include national chambers of mining, other trade associations and, in the case of the United States, the national statistical office.
- **Company level data**: company level data are used to estimate the average productivity of gold mines (i.e. output per worker) in each producing country so that the implied employment can be inferred from the GVA estimates in Figure 3. In these cases, the estimated output per worker is derived largely from companies engaged in large scale mining whereas the estimated GVA includes all estimated gold production.

The results have been benchmarked against data on the broader mining sector. Often government sources provide employment data on the broader mining sector and these are used to provide an upper bound for gold mining employment as well as a benchmark for mine productivity. Further details of the approach are explained in Appendix 2.

The estimates of employment (including contractors) in gold mining are shown in Table 5 together with the basis of the estimate.

Table 5: Direct employment in gold mining in major gold producing countries (2012)

	Country	Employment *Headcount*	Estimation approach
1	South Africa	145,600	National sources, South African Chamber of Mines (2011 data)
2	Russia	138,000	Company accounts
3	China	98,200	Company accounts

	Country	Employment *Headcount*	Estimation approach
4	Australia	32,300	National sources, Western Australian mining association
5	Indonesia	18,600	Company accounts
6	Tanzania	17,100	Company accounts
7	Papua New Guinea	16,100	Company accounts
8	Mexico	15,700	Company accounts
9	Brazil	14,700	Company accounts
10	Ghana	13,500	National sources, Ghana Chamber of Mines (2011 data)
11	United States	11,100	National sources, United States Census Bureau (2010 data)
12	Peru	9,800	Company accounts
13	Canada	7,200	Company accounts
14	Argentina	5,700	Company accounts
15	Uzbekistan	n/a	n/a
	Total	**527,900**	

Source: PwC analysis based on data from company reports, Thomson Reuters GFMS Mine Economics and Gold Survey 2013, and various national sources – see Appendices 2 and 3 for more detail

The total direct employment in gold mining across the 15 largest gold mining countries is estimated to be 527,900 in 2012. This excludes employment in artisanal and small-scale gold mining.

Three countries stand out: South Africa has an estimated 145,600 gold mining employees, Russia 138,000 and China is estimated to have 98,200 employees. Gold mining also employs more than 15,000 people in four other countries: Australia (32,300), Indonesia (18,600), Tanzania (17,100) and Papua New Guinea (16,100).

The United States, Russia and Peru are estimated to have relatively productive mining sectors as they are ranked as the second, third and fifth countries in terms of the direct GVA impact of gold mining, but are ranked tenth, eleventh and twelfth respectively in terms of employment.

The average GVA per worker across the top 15 producing countries is estimated to be US$295,000 but varies from US$841,800 in the United States to US$39,600 in South Africa, where much of the mining takes place deep underground. Average gold production per head in 2012 was just over 124 ounces of gold per worker[17].

Gold mining in the top 15 producing countries employed an estimated 527,900 people in 2012

There are two reasons why these employment estimates are conservative. First, as noted, they do not separately identify those employed in artisanal gold production where production methods are more labour intensive. Such data as there are suggest that the number of people employed in artisanal production is considerably in excess of those employed in large scale, formal mining. Second, where the estimates are based on data from company accounts, productivity (or output per worker) is calculated for a sample of companies. Due to the challenge of identifying and obtaining these data from small, unlisted companies, there is an inevitable bias towards publicly listed mining companies. These companies may also be the largest gold mining companies which are likely to be best placed to realise economies of scale and, therefore, achieve higher levels of productivity than other, smaller mining companies.

In addition, as with the estimates of GVA, these estimates exclude any indirect or induced employment attributable to gold mining. Employment multipliers would estimate the jobs supported in the supply chain and from consumer spending by employees.

[17] Including contractors where available.

Artisanal and small-scale mining (ASM)

ASM covers a broad spectrum of activities but it is principally characterised by mining operations which exploit marginal or small gold deposits, tend to lack capital, are labour intensive and have poor access to markets and support services[18].

Although the analysis in this section of the report does not capture all the economic impacts of ASM activities due to the lack of comprehensive data on the sector, the importance of ASM activities, particularly in low income and Highly Indebted Poor Countries (HIPCs) is significant. ASM is an important source of livelihoods for millions. The International Labour Organisation (ILO) estimates that around 13 million people worked in ASM in 1999 across metal and non-metallic resources. The increase in demand for minerals and metals from a booming electronics industry and soaring commodity prices have contributed to increased employment in the sector. Recent ASM employment estimates suggest that the number of artisanal miners is between 20 to 30 million globally[19].

ASM is estimated to produce around 330 tonnes of gold each year[20] and around 12% of global mine supply. The level of employment in gold-specific ASM operations is hard to measure but some estimates suggest those employed in ASM mining operations as a whole may be as many as 10 times the number employed in large-scale mining operations[21]. If the same factor were to be applied to gold-specific ASM operations then this would imply employment of more than 5 million worldwide in gold-specific ASM operations.

Some studies have estimated that ASM gold miners typically earn between US$5 and $15 a day[22] - much higher than the national average for poorer nations. If we assume that such workers are paid US$10 a day on average, the total value of earnings of workers in the gold ASM sector could amount to approximately US$12.5 billion annually[23].

ASM is important for the economically vulnerable and is likely to continue to provide livelihoods for millions worldwide. The sector faces some key challenges, including weak controls and regulations, poor social and environmental practices, the use of child labour and smuggling of gold involving criminal networks. Much remains to be done in order to formalise ASM and to improve labour conditions and environmental protection in the sector, as well as to understand the true scale, nature and contribution of ASM activities.

Investment in gold mining

Another measure of the economic contribution of gold mining is the level of capital investment (capex) made by companies operating in the sector. It can be seen as a forward looking indicator of GVA. It should not, however, be seen as additional to GVA as some of the resources used to fund capex (notably retained profits) are already captured in the calculation of GVA.

Table 6 shows the amount of capex recorded by those mines operating in each of the top 15 gold producing countries for which capex data are reported. The estimates distinguish between *ongoing capex* – spending to maintain existing operations - and *expansion capex* – spending used to expand current operations or develop new operations.

In 2012, investment by the subset of gold mines reporting their capex was US$17.7 billion. This amount will understate total capex in gold mining as not all mines report their capex[24]. In particular, the coverage of capex by gold mines in China is very limited. Despite high production levels, investment reported by mining companies operating in China is small in both 2012 and preceding years.

The countries with the largest reported gold mining capex in 2012 are Canada (US$2.6 billion), the United States (US$2.5 billion) and Australia (US$2.3 billion). The level of investment is broadly spread across countries, with all except China and Tanzania recording capital expenditure of greater than US$500m in 2012.

[18] IIED (2002) *Artisanal and small-scale mining*, Chapter 13 in *Breaking New Ground: Mining, Minerals and Sustainable Development*, International Institute for Environment and Development.
[19] Hruschka, F. and Echavarria, C. (2011) Rock solid chances for responsible artisanal mining, ARM Series on Responsible ASM No. 3, Alliance for Responsible Mining, January 2011.
[20] http://artisanalgold.blogspot.co.uk/2011/06/world-artisanal-gold-production.html.
[21] Siegel, S. and Viega, M.M. (2010) *The myth of alternative livelihoods: artisanal mining, gold and poverty,* International Journal of Environment and Pollution 41(3/4): 272–288.
[22] *ibid*
[23] Assuming 250 working days a year.
[24] This differs from the mine production figures sourced from the same database which appears to be comprehensive, based on comparison with alternative sources, such as the US Geological Survey.

Total capex by those companies reporting this information has risen by 83% since 2007 across the top 15 gold producing countries.

Table 6: Investment in gold production in major gold producing countries (US$ millions, 2012)[25]

Country		Ongoing capital expenditure	Expansionary capital expenditure	Total capital investment
1	Canada	395	2,230	2,624
2	United States	1,232	1,265	2,498
3	Australia	855	1,458	2,313
4	South Africa	1,035	759	1,795
5	Russia	250	1,521	1,771
6	Ghana	428	951	1,379
7	Brazil	196	815	1,010
8	Argentina	144	648	791
9	Mexico	189	583	773
10	Indonesia	669	103	772
11	Peru	201	560	760
12	Papua New Guinea	312	417	729
13	Tanzania	187	202	389
14	China	29	103	132
15	Uzbekistan	n/a	n/a	n/a
Total		**6,122**	**11,615**	**17,737**

Source: Thomson Reuters GFMS Mine Economics

Exports of gold

For some countries, gold mining is a significant source of exports and, therefore, foreign exchange earnings. Table 7 shows the value of gold exports from each of the top 15 gold producing countries in 2012. The largest exporters are at the top of the list.

In 2012, gold accounted for 36% of all Tanzanian merchandise exports, 26% of exports in both Ghana and Papua New Guinea and 21% of Peruvian exports

The value of exports is reported in Table 7. These figures are taken from UNCTAD's Trademap database and have been compared with those reported by the national statistical agencies to ensure they are consistent. They do, however, need to be interpreted with care. Gold is a highly-traded commodity, and many countries import and export large quantities of gold at different stages of the fabrication process, independently of mining it. This means that data on export volumes and values do not always reflect mine production for some countries.

Table 7: Exports of gold by major gold producing countries (2012)[26]

Country		Exports	Share of value of national merchandise exports
		US$ millions	*%*
1	United States	33,730	2.2
2	China[27]	22,890	1.1
3	Australia	16,000	6.1
4	Canada	15,340	3.4
5	Peru	9,620	21.4
6	South Africa	8,700	9.9
7	Mexico	7,990	2.2

[25] The figures shown are the sum of ongoing capital expenditure and expansion capital expenditure.
[26] Data for Indonesia, Ghana, Uzbekistan, Papua New Guinea, Argentina and Tanzania refer to 2011.
[27] Data on total China's merchandise exports are sourced from the National Statistical Agency as figures from UNCTAD were not available.

Country		Exports	Share of value of national merchandise exports
		US$ millions	*%*
8	Russia	5,130	1.0
9	Ghana	4,840	26.3
10	Brazil	2,660	1.1
11	Argentina	2,330	2.8
12	Indonesia	2,220	1.1
13	Papua New Guinea	2,180	26.2
14	Tanzania	1,718	36.3
15	Uzbekistan	149	2.5
Total		**135,497**	

Source: UNCTAD Trademap, PwC analysis

The United States and China are the two largest exporters, with export earnings in 2012 of US$33.7 billion and US$22.9 billion respectively, although these figures are inflated by trading. For a number of the other countries, gold represents a large share of total merchandise exports: in 2012, gold exports were 36% of all Tanzanian exports, 26% of exports in both Ghana and Papua New Guinea and 21% of Peruvian exports.

Some care is needed in interpreting the export data as several apparent discrepancies were noted when reviewing the trade data collated by UNCTAD. For example, comparing data on the value and volume of gold exports allows an implied unit value to be derived. In Mexico, Argentina and Peru, this implied unit value of gold is significantly less than the world gold price in the same year[28] (in the other leading producing countries, the implied value is close to the world gold price). Furthermore, the lower unit value of exports in these three countries is not consistent with the selling price by a sample of producers in the countries which show sales values close to the world price of gold. These apparent discrepancies may reflect several factors:

- Data integrity issues: for example, it has been suggested that since gold is often traded alongside silver it may have been coded and valued so as to reflect the combination of gold and silver;
- The influence of artisanal gold production; and
- The impact of foreign exchange controls.

Fiscal impacts

As part of a large sector of the economy that generates substantial economic output and employment, gold mining companies also provide government revenues in the countries where they operate. Gold mining bears a number of additional taxes and royalties as well as the taxes paid on employment and profits which are common to most sectors in the economy. This part of the section focuses on these specific royalties and taxes.

Following consultations with PwC mining tax experts in each of the 15 gold producing countries, the types and levels of specific taxes levied on the gold mining sector have been identified. They are summarised in Table 8. The table includes only those taxes that are specific to gold mining; other taxes, such as corporate income taxes and employment taxes are not included. The table shows that the most commonly applied specific tax is mining royalty which is typically levied as a percentage of turnover to reflect resource use. The other common tax is the licence fees required for exploration or when setting up a mine.

Table 8: Summary of mining royalties and other mining taxes in the top 15 gold producing countries

	Mining tax[29]	Export tax	Other mining based taxes[30]	Other fees
Argentina	Mining royalty Provincial 3% Mine-head value	5.0% on ore 5.0% -10.0% on refined metal	No	Licence fee
Australia	Mining royalty	No	No	Licence fee

[28] London Bullion Market Association, London PM fix.
[29] Data are provided in the following order: name of tax, level of tax (federal, state and provincial), tax rate, tax base.
[30] Other taxes refer to other significant product based taxes on mineral extraction other than royalties or fees, such as sales taxes and taxes that are not mining taxes per se but constitute significant tax payments for mining companies.

	Mining tax[29]			Export tax	Other mining based taxes[30]	Other fees
	State 0%-5.3% Volume of mineral extracted					
Brazil	Compensation for the exploitation of mineral resources Federal 1.0% Adjusted revenue			No	ICMS[31] PIS/COFINS[32]	License fee
Canada	Mining taxes Province 2.0% to 16.0% depending on province Adjusted PBT			No	No	License fee
China	Resource tax Federal RMB 1.5 – RMB 7 per tonne Weight	Compensation for mineral resource Federal 0.5% - 4.0% Revenues	Royalty fee for exploration right Federal Depends[33] Area	No universal export duty, but could be charged based on Harmonised System Code	VAT on sales at 17% Local surcharges on VAT at 4.0% to 12.0%	Licence fee
Ghana	Mineral royalty Federal 5.0% Turnover			No	No	Licence fees Deadrent Dividends to government Ground rent Annual Mineral Rights fee
Indonesia	Government royalty Federal 3.8% Revenue			No	No	Licence fees Deadrent Land and building tax
Mexico	No			No	Flat tax. Federal. 17.5%. Income less cost	Licence fees
Papua New Guinea	Mining royalty Federal 2% Revenue less direct costs of sales	Mineral resources authority level Federal 0.25% Turnover		No	No	Application fee for licences Sundry other fees
Peru	Mining royalty Regional 1.0%-12.0% Profit before tax	Special mining tax Federal 2.0% - 8.4% Profit before tax	Special mining contribution Federal 4.0% - 13.12% Profit before tax	No	No	Licence fees
Russia	Mineral resources extraction tax			Tax applied on	No	Licence fees

[31] ICMS is an indirect tax similar to VAT which is applied at State level. The rates vary according to where the product/good/mine is being sold depending on the specific state legislation. It is levied on domestic sales and charged on the price of the mineral.

[32] PIS and COFINS are Federal social contribution taxes due by all entities in Brazil on domestic sales (i.e. not restricted to mining companies) and calculated based on gross revenues. There are two different regimes applicable for PIS and COFINS: the non-cumulative and the cumulative regime. Under the first one, the tax rate 9.25% (1.65% PIS and 7.6% COFINS), but taxpayers may calculate credits upon some inputs and expenses allowed in tax legislation; Under the cumulative regime, no tax credits are allowed, but the rate is inferior, 3.65% (0.65% PIS and 3% COFINS).

[33] The Royalty Fee for Exploration Right is RMB 100/annum/km² for the first three years and an additional RMB100/annum/km² from the fourth year, with a ceiling of RMB500/annum/km². There are incentives for Foreign Invested Enterprises exploring mineral resources in Western China region: a 1-year exemption followed by a 2-year 50% reduction for Sino-Foreign joint projects. The Royalty Fee for Exploitation Right is RMB 1,000/annum/km². There are incentives for Foreign Invested Enterprises exploiting mineral resources in Western China region: a 1-year exemption followed by a 2-year 50% reduction for Sino-Foreign joint projects. A further 4-year 25% reduction on projects is available where advanced/new technology is deployed to enhance the utilisation rate.

	Mining tax[29]		Export tax	Other mining based taxes[30]	Other fees
	Federal 6.0% Value of extracted mineral resource		ores		
South Africa	Mining and petroleum resources royalty Federal 0.5% - 5.0% Adjusted revenues		No	No	Licence fees
Tanzania	Government mining royalty Federal 4.0% Market value		No	No	Licence fees Deadrent Service levy
United States	Nevada net proceeds tax State 2.0% - 5.0% Adjusted profit before tax	Other state severance taxes State 2.0% - 5.0% Adjusted profit before tax	No	No	No
Uzbekistan	Royalty Federal 5.0% Units produced at weighted average sales price		No	No	Signing bonus Commercial discovery bonus

Source: PwC (2012) Corporate income taxes, mining royalties and other mining taxes: a summary of rates and rules in selected countries, June 2012

Although Table 8 shows the type and range of specific taxes faced by gold mining companies, it does not provide the value of the actual payments made by them to governments. Research in each of the 15 gold producing countries to establish the availability of official statistics on specific tax payments made by gold mining companies indicates that such data are publicly available only in Russia, Brazil and South Africa. Moreover, in these countries, the data only include mining royalties. To the extent that other data are available, they cover the broader mining sector, not just gold mining.

In the absence of specific data for gold mining in most countries, estimates of the mining royalties for which gold producers are potentially liable are shown in Table 9. These values are calculated using information from PwC tax experts and the royalty rates reported by Thomson Reuters GFMS Mine Economics and the total production estimates presented in Table 4. To the extent that gold producers do not pay all their liabilities, these estimates will overstate the actual payments made to governments.

Based on these figures, the greatest liability for mining royalties occurs in China and Russia, at US$1,398 million and US$797 million respectively. Both countries have relatively high royalty rates, on a per ounce basis, and high levels of gold production. It is estimated that the combined mining royalty liabilities in 2012 across all 15 countries was US$4.1 billion.

These estimates can be compared to the government royalty data for Russia, Brazil and South Africa to test the appropriateness of the approach taken. The Russian tax authorities reported that gold mining royalties paid were US$681 million in 2012[34], below the estimate of US$797 million. In South Africa, the reported revenue of US$111 million[35] is close to the estimated liabilities of US$118 million. The government data are on a fiscal year basis so are not completely comparable to the calendar year estimates in Table 9. There is, however, a bigger proportionate discrepancy in Brazil. Official statistics report gold mining royalties of US$17 million in 2012[36] which is less than half the estimated liability of US$49 million. These results suggest that the individual country tax estimates should be treated as indicative only.

[34] Russian Federal Tax Service, http://www.nalog.ru/nal_statistik/forms_stat/.
[35] South Africa National Treasury and South African Revenue Service, 2012 Tax Statistics.
[36] Brazilian Ministry for Mineral Production, https://sistemas.dnpm.gov.br/arrecadacao/extra/Relatorios/arrecadacao_cfem_substancia.aspx.

Table 9: Estimated liability for mining royalties by country (2012)

	Country	Royalty rate (US$/oz)	Total royalty liability (US$ million)
1	China	105.2	1,398
2	Russia	107.8	797
3	Australia	48.0	386
4	United States	35.8	266
5	Ghana	76.0	234
6	Peru	38.0	226
7	Argentina	114.5	201
8	Indonesia	43.2	124
9	South Africa	20.6	118
10	Tanzania	67.0	106
11	Mexico	22.3	68
12	Papua New Guinea	33.4	61
13	Brazil	22.5	49
14	Canada	8.6	30
-	Uzbekistan	-	-
	Total		**4,063**

Source: Thomson Reuters GFMS Mine Economics and Gold Survey 2013, PwC estimates

The work to date has highlighted a lack of consistent official statistics on the contribution of gold mining companies to the public finances in the countries in which they operate. Whilst the liability for mining royalties can be estimated as shown above, other mining specific taxes and payments are much harder to estimate. In many cases gold mining related fees are determined on a case-by-case basis and, therefore, cannot be generally estimated.

Moreover the taxes paid by a mining operation will vary significantly across its lifetime. Thus, during exploration, permitting and project development stages lasting up to seven to ten years, there will be a significant outflow of investment funds and tax liabilities will be limited. Once the mine begins production, it will be liable for royalty payments and excise duties but it will need to have recovered its initial investment before it becomes liable to corporate income taxes after which its fiscal contribution will tend to escalate.

As noted, gold mining companies are also liable to other taxes, such as corporate income taxes. These often have complicated rules for calculation which depend on the specific circumstances of each mining company. Again, this makes reliable estimation difficult. Nonetheless, some sense of the overall scale of the contribution of gold mining companies to the public finances can be gained from several sources:

- Data published by two of the largest gold mining companies (see Box 2);
- Data from EITI reports for Tanzania and Ghana (see Box 3): Indonesia and Peru are also EITI members; and
- A PwC survey of the total tax contribution of the mining industry in 2009 (see Box 4).

These sources indicate that, for the two companies considered, royalties are only a relatively small proportion of the taxes paid. Likewise, in the case of Tanzania and Ghana, the evidence shows the importance of the gold mining sector's fiscal contribution is significant.

Box 2: Company case studies - tax payments by Newmont and Goldcorp

Newmont Mining Corporation is one of the largest gold mining companies in the world with gold mines in the United States, Ghana, Peru, Indonesia, Australia and New Zealand. It has published on its website details of the amount of total taxes that it pays per ounce of gold produced for the year ended 31 December 2011. Also shown is the amount of gold produced in each country where it operates. Newmont does not identify the taxes included in the total tax per ounce calculation, but these are likely to include some or all of the taxes shown in Table 10. As the table shows, the total tax per ounce is several times greater in all countries than the royalty per ounce.

Table 10: Newmont Mining Corporation's estimated tax payments

Country	Gold produced[37] *Tonnes*	Total tax *US$/oz*	Total tax *US$ millions*	Share of country production[38] *%*	Royalty *US$/oz*	Taxes
Australia	57.4	198.4	366	25.5	48.0	Licence fees, royalties, resource rents, corporate income tax, employment taxes, fuel excise duty, GST, council rates, mining taxes, withholding taxes
Ghana	17.6	281.3	159	19.3	75.9	Licence fees, royalties, resource rents, corporate income tax, employment taxes, social security, fuel duties, customs duties, business rates, withholding taxes, sales taxes
Peru	40.2	145.3	188	21.4	38.0	Licence fees, royalties, resource rents, corporate income tax, social security, sales tax, withholding taxes, employment taxes
United States	54.2	251.7	438	23.3	35.8	Licence fees, federal and state corporate income taxes, social security, employment taxes, sales taxes, property taxes, severance taxes

Source: PwC analysis

Goldcorp is one of the world's largest gold producers with operations and development projects located throughout the Americas. While its main product is gold, it also produces silver, copper and lead. From the 15 gold producing countries in scope, Goldcorp has mines in Canada, the United States and Mexico. Goldcorp published its total tax contribution for 2011 by country as shown in Table 11. Although Goldcorp does not publish the name of the taxes included in its total tax contribution, the table suggests the taxes expected to be paid by a mining company in the relevant countries.

Table 11: Goldcorp's total tax contribution

Country	Gold produced[39] *Tonnes*	Total tax *US$/oz*	Total tax *US$ millions*	Share of country production[40] *%*	Royalty *US$/oz*	Taxes
Canada	35.4	170	225	32.9	8.6	Licence fees, federal and state corporate income taxes, social security, employment taxes, sales taxes, property taxes, severance taxes
United States	5.3	113	25	2.3	35.8	Mining taxes, provincial profit taxes, employment taxes, social security, sales taxes, property taxes, business rates, fuel excise duty, withholding taxes
Mexico[41]	21.5	639	442	24.3	22.3	License fees, resource rents, Corporate income taxes, employment taxes, social security, property taxes, sales taxes, aggregates levy, excise duties, withholding taxes.

Source: PwC analysis

[37] http://www.beyondthemine.com/2012/.
[38] Thomson Reuters GFMS Gold Survey 2013.
[39] http://csr.goldcorp.com/2011/3_contributions.php.
[40] Thomson Reuters GFMS Gold Survey 2013.
[41] These figures include a mine sold by Goldcorp and also activities in Guatemala.

Box 3: Country case studies – Tanzania and Ghana

The Government of **Tanzania** does not publish data on the revenues it derives from the mining industry, or from gold mining specifically.

Two of the largest gold mining groups operating in Tanzania do however publish their total tax contribution. This gives an indication of the total fiscal contribution to the Tanzanian public finances by the gold mining sector. These figures are shown in Table 12 for 2011.

Table 12: Total tax contribution of largest Tanzanian gold miners (2011)

Group	Gold production *Tonnes*	Share of country production[42] *%*	Total tax *(US$ millions)*
African Barrick Gold	21.4	43.2	135.5
AngloGold Ashanti	15.4	30.1	101.1

Source: http://www.anglogold.com/NR/rdonlyres/B40A0B49-FFF9-43B6-820B-C196B1AF41C1/0/Tanzania.pdf, African Barrick Gold Annual Report 2011

African Barrick Gold and AngloGold Ashanti between them paid US$236.6m in taxes and other payments to government in 2011 and accounted for 73.3% of gold produced in Tanzania. This compares with the estimated liability for mining royalty of US$102.5m shown in Table 9.

Tanzania is a member of the EITI. The EITI data for Tanzania cover 19 taxes[43]. The companies' total tax contribution may, however, include other taxes.

The most recent EITI report for Tanzania, which covers the year to 30 June 2010, shows that gold mining companies made payments to government of US$194m. While not covering the same period as the company data in Table 9, this suggests that the TTC is larger than the company taxes covered by the EITI.

According to a report published by the Ghana Chamber of Mines based on data from the Ghana Revenue Authority, the mining sector contributed around US$646 million in taxes, equivalent to 28% of total tax revenues and 38% of total company taxes[44] in 2011. Moreover, revenues from gold mining also accounted for the overwhelming share of total mineral revenues in 2011 (97% or US$4.6 billion).

EITI reports for Ghana are available for the years 2010 and 2011[45]. They include only certain payments, namely payments for mineral rights licences, ground rent, property rates, mineral royalties, corporate tax and dividends paid to government. As for Tanzania, there are other taxes that will be paid by mining companies that are not covered by the EITI.

Of the 11 companies covered by the EITI in Ghana, nine are gold mining companies. Between them these nine companies paid US$182 million in 2010 and US$439 million in 2011. The majority of the increase appears to come from corporate income taxes. The EITI report suggests that this may be due to the end of the initial investment recovery periods for major producers as well as higher prices.

Box 4: Total tax contribution of mining industry

A PwC Total Tax Contribution survey of the mining industry in 2009 showed that for the participating companies, royalties, licence fees and resource rents together made up 16% of the Total Tax Contribution on average, while mining specific taxes made up just 5%. The rest of the tax contribution was made up from a range of taxes including taxes on property, employment, sales, customs duties and corporate income taxes. Although this study looked at all mining companies, not just gold producers, this suggests that the contribution of mining companies to public finances is considerably greater than just mining royalties.

[42] Thomson Reuters GFMS Gold Survey 2013.
[43] http://eiti.org/files/Tanzania-2010-EITI-Report.pdf.
[44] Includes corporate income tax, withholding tax and levies.
[45] http://eiti.org/report/ghana/2011.

Recycling of gold

Recycled gold refers to gold sourced from previously fabricated products that is subsequently refined back into bars.

The list in Table 13 shows the top source countries of recycled gold. The United States and Italy are the top two sources of recycled gold followed by China and India. The recovery of gold from previously fabricated products destined for recycling is more likely to occur in countries with high gold consumption as this provides a ready source of material and, as a result, gold recovery activity is not tied to geological conditions in the same way as mine production.

Table 13: Supply of gold for recycling (tonnes, 2012)

	Country	Recycled gold supply
1	United States	129
2	Italy	123
3	China	120
4	India	113
5	United Arab Emirates	73
6	Turkey	72
7	United Kingdom	69
8	Mexico	63
9	Egypt	54
10	Indonesia	49
Total		**864**
World		**1,616**

Source: Thomson Reuters GFMS Gold Survey 2013

Recycled gold is a significant source of gold supply. It generated 1,616 tonnes of gold supply in 2012, or 37% of the global supply of gold. The output of recycled gold has increased by 60% since 2007, when the global total was 1,005 tonnes. This supply response has been far more significant than in mine production, where development lead times and other barriers limit rapid responses.

The supply of gold from recycling has increased by 60% since 2007: production has increased from 1,005 tonnes in 2004 to 1,616 tonnes in 2012

Data limitations mean that the value added by gold recycling cannot be estimated as easily and with the same degree of confidence as that associated with gold mining. There are two key uncertainties. First, whilst the data in Table 14 show where recycled gold is recovered from previously fabricated products, it does not provide an indication of where the subsequent refining of recycled gold takes place. This is where most of the value added of gold recycling is generated. The lack of data on where recycled gold is refined rules out further analysis at a country level.

The potential value added by global recycling is, therefore, analysed at the global level. This is done by estimating the market value of gold produced by recycling (effectively turnover) and then estimating the proportion of this turnover which is value added using data from the World Input-Output Database.

The second uncertainty concerns the proportion of recycling turnover which is GVA. There is no specific turnover/GVA ratio for gold recycling available for any country, much less at the global level, so the global average ratio for recycling in general is used instead. This estimate is indicative as it is not known whether this ratio is an accurate representation of gold recycling activities. It is also recognised that gold recycling would involve some component of fabrication. To reflect this uncertainty, the turnover/GVA ratio for the global manufacturing sector is also used to estimate GVA.

The estimated GVA of global gold recycling activity is presented as a range in Table 14. The lower bound is estimated using the turnover/GVA ratio for the manufacturing sector globally. The upper bound is estimated using the turnover/GVA ratio for the recycling sector globally.

Table 14: Estimated turnover and GVA of global gold recycling (US$ million, 2012)

	Turnover	GVA	
		Lower bound – based on the global manufacturing sector ratio	Upper bound – based on the global recycling sector ratio
World	**86,718**	**23,429**	**27,576**

Source: PwC analysis using data from Thomson Reuters GFMS Gold Survey 2013, the World Gold Council, World Input-Output Database (WIOD) and national statistical offices

The GVA estimates for global gold recycling ranges from US$23.4 billion to US$27.6 billion. The value added per tonne of recycled gold using the average of the lower and upper bound estimates is approximately US$15.8 million. This is in contrast to the value added per tonne of gold produced from mines, which is approximately US$36.0 million. This implies that more economic value per ounce is added by mining gold than by recycling it.

Demand for gold

Introduction

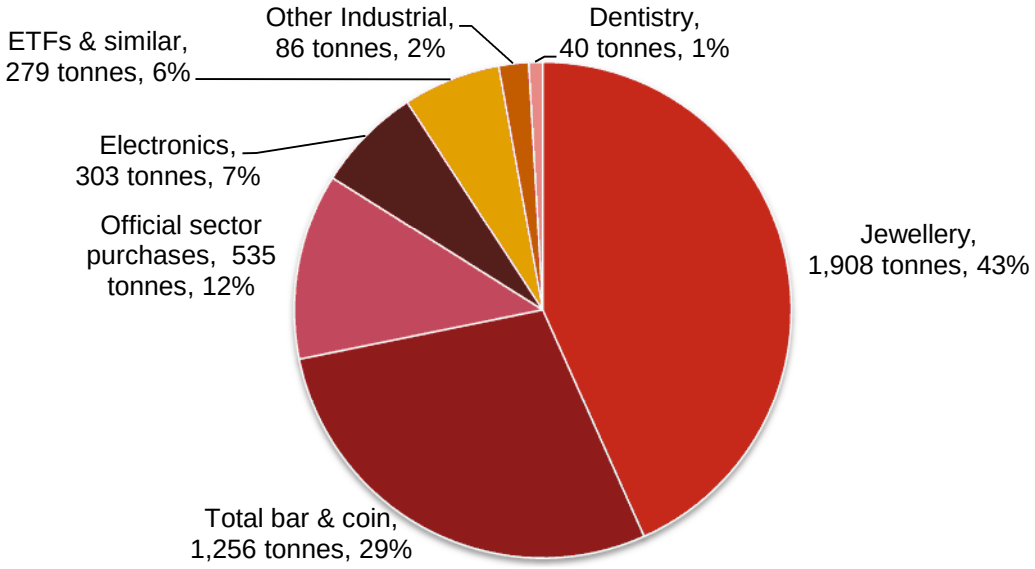
The uses of gold are wide-ranging and well-documented. In addition to its value as an investment, the physical appearance and properties of gold lend themselves to its use in jewellery and for various technological/manufacturing uses. For example, in many developing countries, gold jewellery is not only perceived as an adornment but also as an effective savings vehicle. Its unique properties make it a key input in the manufacture of electronic goods and telecommunications devices, health care and dental equipment, nanotechnology and high-tech engineering.

Global gold demand rose by around 42% between 2007 and 2012, peaking in 2011 at 4,582 tonnes. The breakdown of global gold demand in 2012, which is shown in Figure 6, contains four key elements:

- Central bank purchases which account for 12% of demand;
- Investment demand (which consists of total bar and coin and gold-backed ETFs and similar products[46]);
- Jewellery which accounts for the largest proportion of gold demand; and
- Technology/manufacturing, which includes uses such as in electronics and dentistry, accounts for around 10% of gold demand.

The rest of this section considers each of these uses in turn.

Figure 6: Global gold demand[47] (tonnes, 2012)



Source: World Gold Council

Central bank purchases of gold

Gold is an important reserve asset for central banks and investors. Gold accounts for around 12% of the value of total reserves in 2012 globally on average[48]. Central banks around the world are, therefore, important sources of demand for gold: net official sector purchases[49] amounted to 535 tonnes of gold or 12% of global demand.

The value of gold is resilient to inflation, and allows central banks to hedge effectively against currency fluctuations caused by economic and monetary policies. A recent study by the World Gold Council also

[46] A final component of investment demand consists of OTC investment and stock flows which is partly a statistical residual. These largely reflect demand in the opaque over-the-counter (OTC) market, with an additional contribution occasionally from changes to fabrication inventories.
[47] Refers to gold consumption, not fabrication.
[48] World Gold Council, 13 March 2013.
[49] Central bank net purchases are gross purchase of gold less gross sales by central banks and other official institutions. They exclude swaps and the effects of delta hedging.

concluded that gold is an attractive alternative in the strategies of central banks to diversify their reserve assets[50].

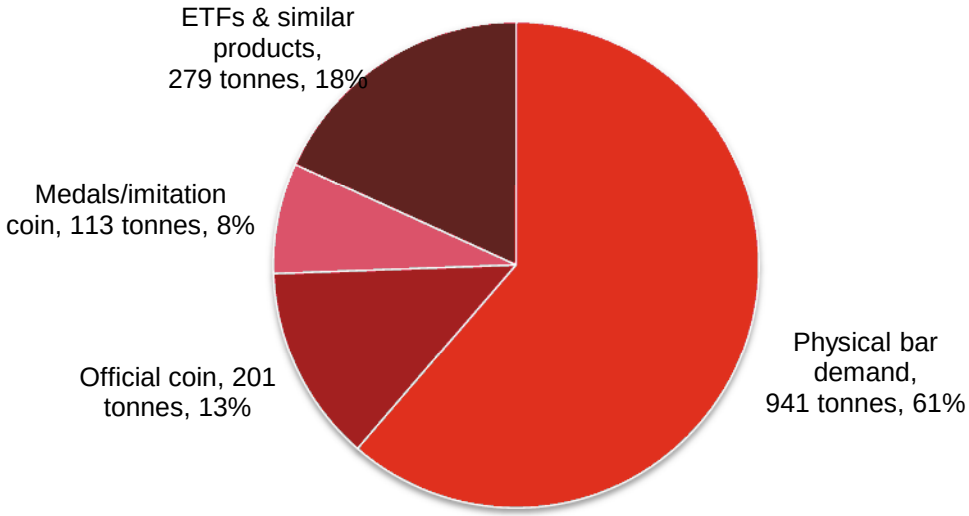
Whilst the economic significance of these purchases is not considered further as part of this study, it is acknowledged that gold is valuable to central banks and investors, not only because it plays a key role in portfolio diversification, but also because its value is resilient to macroeconomic shocks that would otherwise undermine the value of currency reserves. It can be effectively deployed to maintain liquidity during periods of economic turbulence. The low correlation between gold and movements in key currencies and its strong inverse correlation with the US dollar[51] make it an ideal investment for hedging against risk.

Investment

Gold is an important investment asset and savings vehicle for many. In 2012, demand for gold for investment purposes represented over one third of global demand. It includes demand for physical bars and coins, gold-backed ETFs and similar products and over the counter (OTC) investment and stock flows. Figure 7 shows the breakdown of gold investment demand for 2012. While it is acknowledged that gold plays an important role as an investment asset and in portfolio diversification strategies, the economic value of this role is not discussed further here as the World Gold Council is carrying out separate studies in this area[52].

The focus of the rest of this report is on the economic impact of fabricating (and consuming) small bar and coin and other uses of gold.

Figure 7: Breakdown of demand for gold for investment purposes (2012)



Source: World Gold Council

[50] World Gold Council (2013) *Central bank diversification strategies, rebalancing from the dollar and euro*, February 2013.
[51] O' Connor, F. and Lucey, B. (2012) *Gold's Currency Characteristics and its negative relationship with the US Dollar*, Alchemist Issue 66.
[52] See for example World Gold Council (2012) *Gold as a strategic asset for UK investors: portfolio risk management and capital preservation*, July 2012.

Gold fabrication and consumption

Table 15 shows the top 13 gold consuming countries in 2012. An important distinction can be drawn between demand for gold for fabrication and for (final) consumption. Fabrication covers "*the first transformation of gold bullion into a semi-finished or finished product*"[53] whereas consumption refers to the end use of gold (whether in the form of jewellery or investment products such as bars and coins) by the final consumer.

Table 15: Major gold consuming countries (tonnes, 2012)

Country		Fabrication demand *(Jewellery, bar and coin and technology)*	Consumption demand *(Jewellery and bar and coin only)*
1	India	942	864
2	China	840	784
3	United States	147[54]	162
4	Turkey	113	110
5	Thailand	95	81
6	Vietnam	76	77
7	Russia	70	70
8	Indonesia	58	52
9	Saudi Arabia & Yemen	49[55]	62[56]
10	Switzerland	45[57]	81
11	Egypt	38	48
12	Germany	37[58]	110
13	United Arab Emirates	35	59
Total		**2,544**	**2,560**
World		**3,611**	**3,164**

Source: World Gold Council, Thomson Reuters GFMS Gold Survey 2013

The current analysis captures the value attributable to gold during both the fabrication process and subsequent retail activity, particularly for jewellery. The complexity of the value chains into which gold is an input allied to a lack of data on the consumption of those manufactured goods which use gold as an input precludes further analysis on the GVA of the retail activity of these manufactured goods. Although some sector-level GVA estimates in national accounts express the value added of retail activity for specialist stores such as electronic goods stores, these estimates do not capture the value of goods which are sold in non-specialised stores such as department stores and other general retailers. In addition, gold is used in many cases as an intermediate input in other manufactured goods. For instance, gold is used in the manufacture of electronic components such as chips and semi-conductors which form the inputs to goods further down the value chain, including electronic appliances, telecommunications devices and others.

Similarly, for employment, labour force surveys do not typically distinguish employment by the types of goods sold at different points of sale. Given the complexity in tracking and capturing the value attributable to gold throughout the value chain and the lack of available detailed data, employment is excluded from this analysis.

Bar and coin

Total bar and coin demand comprises individuals' purchases of coins and bars (defined according to the standard adopted by the European Union for investment gold). It includes demand for coins and small bars (of 1kg or less). In addition to bullion bars and coins, medallions of at least 99% purity (which are prevalent in the Indian market) are also included. In practice, this includes the initial sale of many coins which are held for their numismatic value (i.e. coins collected for the purposes of studies or collecting) as well as for their intrinsic value. It excludes second-hand coins and is measured as net purchases.

Bar and coin demand has surged following the financial crisis: it has grown by 188% since 2007, and accounts for the largest proportion of total investment demand (82%). This reflects the value of physical bars and coins

[53] World Gold Council (2013) *Gold Demand Trends: Full Year 2012*, February 2013.
[54] Data does not include bar and coin fabrication as US not reported separately.
[55] Data for gold fabrication presented together for Saudi Arabia and Yemen.
[56] Data for Saudi Arabia only.
[57] Data does not include bar and coin fabrication as Switzerland not reported separately.
[58] Data does not include bar and coin fabrication as Germany not reported separately.

of gold as a key investment asset for many. Gold is a liquid and widely-accepted form of exchange, and is frequently used as an alternative asset in countries where saving facilities are limited or inaccessible. In addition, gold offers protection against weak currencies and high domestic inflation – which tend to be more prevalent in low income countries – that would otherwise erode the value of cash savings.

Direct GVA associated with the fabrication and sale of gold bars and coins amounts to US$13.3 billion in the top 13 consuming countries

As data from national governments and international institutions do not typically provide the level of granularity required to assess the GVA of the fabrication and consumption of gold bar and coin directly, each is considered separately.

The direct GVA associated with bar and coin fabrication is estimated in two steps. First, the mark-up achieved by fabricators is applied to the value of the purchases of gold to estimate their turnover. The mark-ups used in assessing the GVA of bar and coin fabrication are obtained from the financial reports of various government mints and major gold refiners. Second, the GVA is then estimated by multiplying the estimated turnover by the share of turnover that is GVA. Turnover/GVA ratios for the manufacturing sector are obtained from national input-output tables and various industry surveys, which are then applied to turnover to obtain GVA attributable to gold. In total, the direct GVA associated with the fabrication of gold bars and coins is estimated to be US$13.3 billion across the top 13 consuming countries, led by India, China and Vietnam. Further details on the approach used can be found in Appendix 2.

The estimates of the GVA derived from gold bar and coin fabrication are shown in Table 16 which covers the top 13 gold consuming countries involved in fabrication of bar and coin. No data on bar and coin fabrication demand are reported for Egypt and Switzerland (although fabrication is known to occur, especially in Switzerland). Direct GVA associated with the fabrication and sale of gold bars and coins amounts to US$13.3 billion in the top 13 consuming countries for which we have data, led by China, India and Vietnam (but excluding Switzerland and Egypt).

Table 16: Direct GVA attributable to gold from the fabrication of gold bar and coin (2012)

	Country	Fabrication demand *Tonnes*	Turnover *US$ millions*	Direct GVA *US$ millions*
1	China	274	19,328	3,985
2	India	312	22,006	3,879
3	Thailand	78	5,491	1,322
4	Vietnam	65	4,610	1,095
5	Turkey	40	3,821	686
6	United States	28[59]	1,560	651
7	Saudi Arabia & Yemen	16	1,577	623
8	Indonesia	22	1,558	579
9	United Arab Emirates	10	958	316
10	Russia	7	364	108
11	Germany	6	303	79
	Total	**858**	**61,575**	**13,324**

Source: PwC analysis based on data from the London Bullion Market Association (LBMA), various financial accounts, various national accounts, World Input-Output Database (WIOD), Thomson Reuters GFMS Gold Survey 2013

An alternative way of estimating the GVA associated with the use of gold in bar and coin involves considering consumption demand (i.e. by looking at the point where the product is sold to the investor). Again, national governments and international institutions do not typically provide data at the level of granularity required to assess the GVA of the consumption of gold bars and coins directly. Instead, the value of sales of bar and coin (i.e. turnover) is estimated by deriving the average mark-up on the underlying value of the gold achieved for different bar and coin products. Then, relevant turnover/GVA ratios for the retail sector (which are obtained

[59] This figure does not include bar fabrication as US-specific data is not reported.

from national input-output tables and various industry surveys) are applied to turnover to obtain the GVA attributable to gold. Further details on the approach used can also be found in Appendix 2.

Direct GVA associated with the consumption of gold bars and coins amounts to US$38.3 billion in the top 13 consuming countries

The estimates of the GVA derived from consumption of gold bar and coin are shown in Table 17 which covers the top gold consuming countries. Of the top 13 gold consuming countries, no data on bar and coin consumption demand are reported for Russia. Direct GVA associated with the consumption of gold bars and coins amounts to US$38.3 billion in the top 13 consuming countries, led by India, China and Vietnam (but excluding Russia and Egypt).

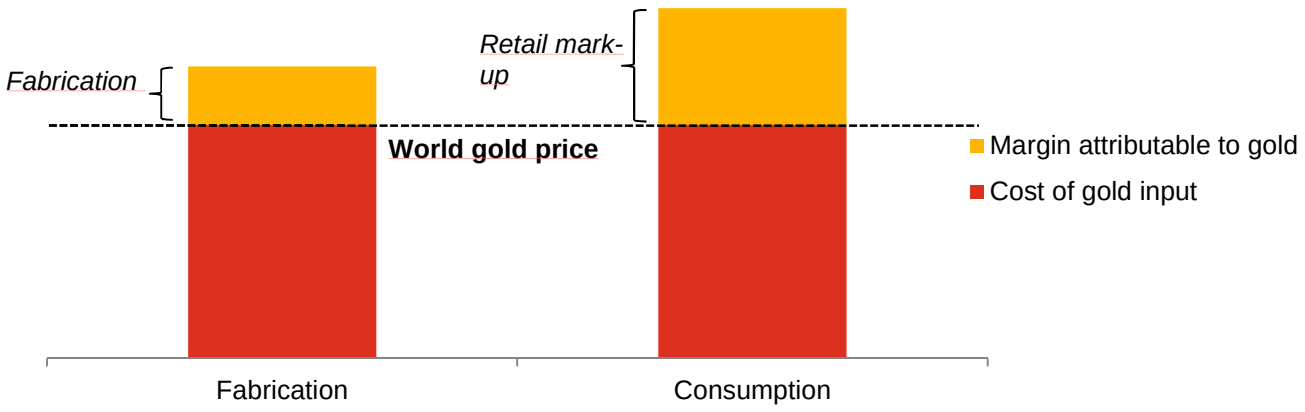
Table 17: Direct GVA attributable to gold from the consumption of gold bars and coins (2012)

	Country	Consumption demand *Tonnes*	Turnover *US$ millions*	Direct GVA *US$ millions*
1	India	312	19,712	17,641
2	China	266	15,291	9,192
3	Vietnam	66	3,777	2,238
4	United States	53	3,101	2,211
5	Turkey	48	2,786	2,058
6	Germany	110	6,238	1,270
7	Switzerland	81	4,635	1,127
8	Thailand	78	4,495	1,035
9	Indonesia	22	1,238	734
10	United Arab Emirates	10	547	416
11	Saudi Arabia	15	875	304
	Total	**1,062**	**62,813**	**38,266**

Source: PwC analysis based on data from the London Bullion Market Association (LBMA), various national accounts, various gold coin and bullion dealers, World Input-Output Database (WIOD), Thomson Reuters GFMS Gold Survey 2013

The two estimates of the GVA attributable to gold bar and coin should not be added together. Both approaches are based on estimating the mark-up on the value of gold in the bar and coin product associated with key activities in the value chain. The fabrication mark-up, however, is akin to a manufacturing/wholesale mark-up whereas the consumption mark-up includes the value achieved at the point of sale to the purchaser (the investor). As Figure 8 illustrates, the fabrication mark-up will be part of the consumption mark-up. The analysis does not capture the value added attributable to any subsequent transactions in the bar and coin supply chain.

Figure 8: Relationship between fabrication and consumption based estimates of GVA



Source: PwC analysis

Jewellery

Jewellery accounts for the largest proportion of gold fabrication and consumption demand. Jewellery demand covers all newly-made carat jewellery and gold watches, whether plain gold or combined with other materials. It excludes second-hand jewellery, other metals plated with gold, bars and coins used as jewellery and purchases funded by trading in existing jewellery.

The direct GVA attributable to gold jewellery fabrication and consumption for the top 13 gold consuming countries is estimated at US$69.8 billion

Table 18 shows the top 13 gold consuming countries by fabrication and consumption demand for 2012. India is the top fabricator and consumer of gold jewellery, accounting for nearly one third of global fabrication and consumer demand. China is the second largest fabricator and consumer of gold. Together, these two countries account for more than half of global gold jewellery fabrication and consumption demand. Although the physical volume of gold jewellery consumed has declined by more than 20% since 2007, the value of demand in these markets has remained relatively resilient compared to other markets in the Middle East and Europe.

Table 18: Gold jewellery fabrication and consumption by country (tonnes, 2012)

	Country	Fabrication	Consumption
1	India	618	552
2	China	498	519
3	United States	54	108
4	Russia	49	70
5	Turkey	74	62
6	United Arab Emirates	25	50
7	Saudi Arabia & Yemen	33[60]	47[61]
8	Egypt	38	46
9	Indonesia	36	31
10	Vietnam	11	11
11	Thailand	14	3
12	Germany	15	-
13	Switzerland	29	-
	Total	**1,494**	**1,498**
	Global	**1,893**	**1,908**

Source: World Gold Council and Thomson Reuters GFMS Gold Survey 2013

As data from national governments and international institutions do not typically provide the level of granularity required to assess the GVA of the fabrication of gold jewellery directly[62], an alternative approach is used. First, the cost of gold inputs is estimated for each country using available data on fabrication demand. Next, mark-ups are applied to these costs in order to derive estimates of the turnover attributable to gold. The mark-ups used in this analysis are obtained from various industry and market analysis reports. Turnover/GVA ratios for the jewellery manufacturing sector are then obtained from national input-output tables and various industry surveys before being applied to turnover in order to obtain the GVA attributable to gold. Where jewellery-specific manufacturing data are not available, the turnover/GVA ratio for the manufacturing sector is applied instead. Further details of the approach used can be found in Appendix 2.

A similar approach is used to estimate the GVA of the retailing of gold jewellery. Rather than using the mark-ups and turnover/GVA ratios associated with jewellery fabrication, however, the corresponding figures for jewellery retail sector are used instead.

[60] Data for gold fabrication presented together for Saudi Arabia and Yemen.
[61] Data for Saudi Arabia only.
[62] GVA estimates using international industrial classifications such as NACE Rev. 2 do not disaggregate the manufacture of jewellery by material type, e.g. platinum, gold, silver etc. In addition, data on GVA are not typically provided on a consistent basis and can vary in levels of disaggregation across countries.

In summary, the key components of the analysis include:

- The fabrication and consumption demand for gold jewellery which provided an indication of the cost of gold inputs;
- The manufacturing and retail industry mark-ups which allowed the estimation of turnover attributable to gold; and
- Turnover/GVA ratios which are used to convert turnover to estimates of GVA attributable to gold.

Table 19 shows the direct GVA attributable to gold jewellery fabrication and consumption for the top 13 gold consuming countries. The total GVA associated with gold jewellery fabrication and consumption is estimated at US$69.8 billion. Although China fabricates and consumes less gold than India, its total GVA (the sum of GVA from jewellery fabrication and consumption) exceeds that of India, primarily due to the lower turnover/GVA ratio associated with the retail sector (i.e. the lower the ratio, the higher the GVA impact of expenditure).

It should be noted that the fabrication process requires some amount of labour and capital input in order to transform refined gold into jewellery for sale. Due to the lack of sufficiently granular data on the other cost components of jewellery fabrication (e.g. labour costs and other capital costs), however, this analysis does not include the additional value generated by these components that are nevertheless attributable to gold jewellery fabrication. This value is potentially significant so the estimates presented in Table 19 will be conservative estimates of the GVA associated with gold jewellery.

Table 19: Direct GVA attributable to gold jewellery fabrication and consumption (US$ millions, 2012)

	Country	Fabrication GVA	Consumption GVA	Total GVA
1	China	5,738	23,261	28,999
2	India	8,003	4,845	12,848
3	United States	1,722	7,585	9,307
4	Russia	893	6,336	7,229
5	United Arab Emirates	457	2,500	2,957
6	Egypt	867	1,066	1,933
7	Indonesia	737	1,126	1,863
8	Saudi Arabia & Yemen	751	1,090	1,841
9	Turkey	349	487	836
10	Vietnam	265	431	696
11	Germany	343	-	343
12	Thailand	246	40	286
13	Switzerland	648	-	648
	Total	**21,018**	**48,767**	**69,786**

Source: PwC analysis based data from the London Bullion Market Association (LBMA), various financial accounts, various national accounts, World Input-Output Database (WIOD), S&P Capital IQ, World Gold Council, Thomson Reuters GFMS Gold Survey 2013

Technology

Gold makes an important contribution to many technological/manufacturing applications. Its electrical conductivity, malleability and resistance to corrosion make it a valuable component in most electronic goods and equipment. The use of alternative metals such as copper and silver is gaining ground in some areas (notably in bonding wire) in response to the relatively high cost of gold inputs. Though these alternatives share similar characteristics to gold, they are imperfect substitutes; often the cost of implementing the required technology to overcome their shortcomings (particularly regarding corrosion resistance) can limit the cost savings gained from switching away from gold. The use of gold in electronics has declined from its peak in 2010, mainly due to price pressures. Nonetheless, gold is not expected to be displaced as the material of choice in many areas. Gold continues to account for the largest share of bonding wire manufactured on a per metre basis[63], and it is a valuable element in high-end applications and safety-critical products such as automotive braking systems and in medical equipment.

The electronics sector is the largest user of gold for technological/manufacturing purposes by far (accounting for around 70% of gold in technological/manufacturing fabrications), but gold also plays an important role in healthcare services and pharmaceutical products due to its "biocompatibility" and resistance to bacterial

[63] *Global Semiconductor Packaging Materials Outlook*, SEMI, November 2011.

colonisation. New areas of research are exploring the use of gold in cancer treatment and in other biomedical applications. Gold is also valued for its use in medical diagnostics tools. For example, in 2012, 160 million malaria testing kits were distributed worldwide, each containing nanoparticles of gold which enable the accurate and cost-effective diagnosis and treatment of the disease[64].

Finally, gold is increasingly used in green technologies including in clean energy generation, pollution control and as catalysts for chemical processes. For example, in the automotive sector, gold is certified for use in vehicle catalytic converters that catalyse the oxidation of harmful by-products in engine exhausts to reduce the emission of noxious chemicals into the atmosphere[65]. The use of gold in these industries could become increasingly significant if future price fluctuations in materials such as platinum and palladium are observed.

While the volume of gold used in new technologies is small, its strategic role in the development of these technologies is critical and not easily displaced; and any future value added to nascent markets is potentially significant.

The technological/manufacturing component of demand as defined by the World Gold Council includes "*all gold used in the fabrication of electronics, dental, medical, industrial, decorative and other technological applications … including gold destined for plating jewellery*"[66].

Technology fabrication demand generates a total of around US$4.0 billion in direct GVA attributable to the seven countries covered

Table 20 shows fabrication demand for technological/manufacturing purposes by country for 2012. Global fabrication demand amounted to more than 400 tonnes in 2012, with gold destined for the electronics industry accounting for the largest share. China is the largest consumer of gold for technological/manufacturing purposes within the top 13 gold consuming countries listed in Table 15[67] at around 67 tonnes in 2012. This is followed by the United States with 66 tonnes and Germany and Switzerland both with 17 tonnes. Together, the countries listed in Table 20 account for around 48% of global technology fabrication demand in 2012[68].

Table 20: Technology fabrication demand by country (tonnes, 2012)

	Country	Electronics	Other industrial and decorative	Dentistry	Total technology fabrication demand
1	China	48	-	19	67
2	United States	56	7	3	66
3	Switzerland	5	2	10	17
4	Germany	11	2	3	17
5	Russia	13	2	-	15
6	India	2	-	9	12
7	Thailand	-	-	3	3
	Total	**135**	**13**	**46**	**195**
	World total	**285**	**39**	**84**	**408**

Source: Thomson Reuters GFMS Gold Survey 2013 and World Gold Council

As before, the approach used in assessing the direct GVA of jewellery and bar and coin fabrication is applied to technology fabrication demand. The estimated mark-ups are obtained from various industry and market analysis reports on the manufacture of electronic goods, healthcare equipment and other technological/manufacturing products. The ratio of turnover to GVA for these sectors is obtained from national input-output tables and various industry surveys. These are then applied to turnover to estimate the GVA attributable to gold.

[64] *World Malaria Report 2012*, World Health Organisation, pp37.
[65] *Catalysis: The accelerator*. Nature Volume: 495, pp. S10–S11, March 2013.
[66] World Gold Council, Gold Demand Trends, Full year 2012.
[67] Japan is the world's largest consumer of gold for technology purposes but is not included in this analysis as its total gold demand does not place it within the top 13 gold-consuming countries. Other significant gold consumers excluded from the analysis include Singapore, Taiwan and South Korea.
[68] The remaining top 13 gold-consuming countries such as Egypt, Indonesia, Saudi Arabia and Yemen, Turkey, the United Arab Emirates and Vietnam have not been included in Table 21 as they do not have significant technology fabrication demand to be captured statistically.

Table 21 shows the direct GVA attributable to gold from technology fabrication by country. Technology fabrication demand generates a total of around US$4.0 billion in direct GVA attributable to gold for the seven countries where gold is used, with the United States accounting for around 56%.

Table 21: Direct GVA attributable to gold from technology fabrication (US$ millions, 2012)

	Country	Electronics	Other industrial and decorative	Dentistry	Total technology fabrication
1	United States	62	1,889	308	2,259
2	China	220	423	-	644
3	Switzerland	194	116	40	349
4	Germany	45	223	59	327
5	Russia	-	255	39	294
6	India	89	26	-	115
7	Thailand	35	-	-	35
	Total	**646**	**2,932**	**445**	**4,023**

Source: PwC analysis based on data from the London Bullion Market Association (LBMA), various financial accounts, various national accounts, World Input-Output Database (WIOD), S&P Capital IQ, Thomson Reuters GFMS Gold Survey 2013

The current report only considers the economic contribution of gold used in the fabrication of technological/manufacturing and other goods. It does not capture the value generated by the retail activities associated with these goods due to the lack of available data on end-use. The retail of electronic goods, healthcare equipment and other products also potentially generate significant levels of direct GVA. As discussed earlier, the fact that gold is often an intermediate input to other manufactured goods makes it extremely difficult to track and capture the value attributable to gold throughout the value chain.

Extending the analysis

As part of the preparation of this report, consideration has also been given to how the analysis might be extended, either to enhance the robustness of the estimates of the direct impacts or to broaden their scope to include the indirect, induced and wider economic and fiscal impacts. The key conclusions are summarised below.

Direct impacts

The analysis of the **direct economic impacts** can potentially be improved and extended in several ways:

- The robustness of the impacts associated with the **supply of mined gold** can potentially be enhanced by gathering mine or country level data from mining companies through primary research. Such work would be especially valuable in improving the quality of the estimates of the impacts on employment and investment.
- Further work could be undertaken to understand better the significance of artisanal gold production.
- The estimates of the economic impact of **gold recycling** can be enhanced by developing a better understanding of where the refining activity takes place and how much value added is associated with this process.
- There is more scope for strengthening the methods and data used to estimate the impacts associated with the **demand** for gold as the nature of the organisations involved and the complexity of the value chains mean that more challenges need to be overcome. These challenges can potentially be met in several (complementary) ways:

  – By undertaking an exercise to identify and analyse the published accounts of companies actively involved in the different parts of the value chain in the 13 countries which are in scope. Depending on the scope of the activities covered by these accounts, and the basis upon which they have been prepared, this could enable better data to be obtained on the value added by these companies.
  – By undertaking primary research to gather data from samples of producers in each part of the value chain. Besides covering the elements of value added, such research could also be used to capture data on employment, investment and exports.

  Both these approaches would also enable to scope of the impact measures covered by the analysis to be extended beyond GVA.

The analysis of the **direct fiscal impacts of gold mining** can potentially be improved and extended in several ways:

- By gathering mine or country level data on **gold specific taxes** and other fiscal measures actually paid by gold mining companies on a country by country basis through primary research. Such work would be especially valuable in improving the quality of the estimates of the direct fiscal impacts.
- By extending the analysis to cover **all taxes** actually borne (or, possibly, collected) by gold mining companies. In many cases gold mining related fees are determined on a case by case basis and therefore cannot be generally estimated. Many other taxes, such as corporate income taxes, have complicated rules for calculation based on the specific circumstances of each mining company. Again, this makes reliable estimation impracticable.

In considering these options, it will be important to recognise forthcoming developments in the reporting of tax payments in the mining sector, notably:

- Section 1504 of the Dodd Frank Act in the United States which requires companies registered with the Securities and Exchange Commission (SEC) to publicly report how much they pay governments for access to oil, gas and minerals; and
- Proposals recently agreed by European Union Member States and the European Parliament as part of the revised European Accounting and Transparency Directives which will require all EU listed or large privately owned extractive businesses to publish all payments over €100,000 to every country where they operate and for each extractive project.

The analysis of the **direct fiscal impacts** of **gold recycling** can potentially be extended by undertaking primary research with the major gold recyclers to gather data on any gold specific taxes that they bear. This would enable estimates to be generated of the fiscal contribution of gold recycling.

Similarly, the analysis of the **direct fiscal impacts** associated with **gold demand** can potentially be extended by undertaking primary research with the major gold consumers to gather data on any gold specific taxes that they bear. This will include import duties paid on gold as a raw material and duties on exports of finished or semi-finished products.

Indirect, induced and wider impacts

The current analysis has focused on the direct economic and fiscal impacts of gold supply and demand. As such, it excludes the indirect, induced and wider economic and fiscal impacts that arise. These may be significant, although few existing studies have quantified them to date for gold mining.

Various possible methodologies could be used to estimate the indirect and induced impacts:

- Multiplier analysis;
- Input-output analysis; and
- Dynamic economic modelling (also known as computable general equilibrium modelling).

Each methodology has its strengths and weaknesses, but all are potentially limited by the availability and quality of economic data related to the supply of and demand for gold (see Table 22).

Table 22: Features of alternative approaches to assessing indirect and induced economic impacts

	Multiplier analysis	Input-output analysis	CGE modelling
Is the data available?	Various sets of social accounting matrices and input-output tables exist to allow multiplier analysis, input output and CGE modelling to be carried out but none isolates the gold related sectors		
Who else uses this type of model?	Widely used in various forms although analysis tends to be specific to a particular situation and, therefore, not flexible	Increasingly being superseded by CGE models	Used widely by the International Monetary Fund and World Bank, especially for fiscal analysis
How useful is the method?	Relies on a static view of the economy so does not easily capture feedback effects	Generally do not include price data so do not link key prices in the economy like gold or wages	Most valuable when projecting future impacts - extensive sensitivity analysis generates richer insights into economic and fiscal impacts

Appendix 1 – Glossary

Central bank net purchases

Gross purchase less gross sales by central banks and other official institutions. Swaps and the effects of delta hedging are excluded.

Consumer demand

The sum of jewellery and total bar and coin purchases for a country (i.e. the amount of gold acquired directly by individuals).

Dental

The first transformation of raw gold into intermediate or final products destined for dental applications such as dental alloys.

Exchange Traded Funds (ETFs) and similar products

Exchange Traded Funds and similar products including: Gold Bullion Securities (London), Gold Bullion Securities (Australia), SPDR® Gold Shares (formerly streetTRACKS Gold Shares), NewGold Gold Debentures, iShares Comex Gold Trust, ZKB Gold ETF, GOLDIST, ETF Securities Physical Gold, ETF Securities (Tokyo), ETF Securities (NYSE), XETRA-GOLD, Julius Baer Physical Gold, Central Fund of Canada and Central Gold Trust, Swiss Gold, iShares Gold Bullion Fund (formerly Claymore Gold Bullion ETF), Sprott Physical Gold Trust, ETF Securities Glitter, Mitsubishi Physical Gold ETF, CS ETF II (formerly Credit Suisse Xmtch II) and Dubai Gold Securities.

Fabrication

Fabrication is the first transformation of gold bullion into a semi-finished or finished product.

Jewellery

All newly-made carat jewellery and gold watches, whether plain gold or combined with other materials. It excludes second-hand jewellery, other metals plated with gold, coins and bars used as jewellery and purchases funded by the trading in of existing jewellery.

London PM fix

Unless described otherwise, gold price values are based on the London PM fix.

Mine production

Output from large scale, regulated gold mines (i.e. excluding informal or artisanal production).

Net producer hedging

This measures the impact in the physical market of mining companies' gold forward sales, loans and options positions. Hedging accelerates the sale of gold, a transaction which releases gold (from existing stocks) to the market. Over time, hedging activity does not generate a net increase in the supply of gold. De-hedging, the process of closing out hedged positions, has the opposite impact and reduces the amount of gold available to the market in any given quarter.

OTC investment and stock flows

Partly a statistical residual, these largely reflect demand in the opaque over-the-counter (OTC) market, with an additional contribution occasionally from changes to fabrication inventories.

Physical bar demand

Global investment in physical gold in bar form.

Recycled gold

Gold sourced from previously fabricated products which has been recovered and refined back into bars.

Technology

This captures all gold used in the fabrication of electronics, dental, medical, industrial, decorative and other technological applications, with electronics representing the largest component of this category. This includes gold destined for plating jewellery.

Tonne

1,000 kg or 32,151 troy ounces of fine gold.

Total bar and coin demand

This comprises individuals' purchases of coins and bars, defined according to the standard adopted by the European Union for investment gold, but includes demand for coins and bars in both the western and non-western markets. Medallions of at least 99% purity, wires and lumps sold in small quantities are also included. In practice this includes the initial sale of many coins destined ultimately to be considered as numismatic rather than bullion. It excludes second-hand coins and is measured as net purchases.

Total investment

Represents the amalgamation of all components of investment demand, including all demand for physical bars and coins, demand for ETFs and similar products, and OTC investment and stock flows.

Appendix 2 – Methodology

Introduction

This Appendix explains the basis for the analysis of the direct economic and fiscal impacts presented in this report. It describes the data sources which have been used as well as the estimation methods which have been applied. The first part of the Appendix covers the supply of gold and the second part addresses gold fabrication and consumption demand.

Supply of gold

Mine production

The direct economic and fiscal impacts of gold mining have been estimated at country level for each of the 15 largest producing countries.

Direct gross value added (GVA)

The GVA of gold mining is a measure of the value added through the economic activity of gold mining companies. It can be calculated using one of two approaches:

- The income approach, which calculates the sum of (gross) operating profit, employee costs and amortisation and depreciation; and
- The production approach, whereby GVA is the revenue from gold mine production less intermediate consumption (i.e. the cost of inputs and raw materials directly purchased).

The estimates of value added of gold mine production in this report using the income approach are generated as follows:

$$Direct\ GVA = Gross\ operating\ profits + Employee\ costs + Amortisation + Depreciation$$

Where:

$$Gross\ operating\ profits = Revenues - Operating\ costs$$

$$Employee\ costs = Labour\ costs\ (as\ \%\ of\ production\ costs)\ x\ Operating\ costs$$

$$Depreciation + Amortisation = Depreciation\ and\ amortisation\ (as\ \%\ of\ production\ costs)\ x\ Operating\ costs$$

The revenue estimates are generated by multiplying mine production (taken from Thomson Reuters GFMS Gold Survey 2013) by the world price for gold, based on the London Bullion Market Association's PM fix gold price. Data from Thomson Reuters GFMS Mine Economics on mine production costs, employee costs, and depreciation and amortisation are provided on the basis of US dollars per ounce of gold produced. These are multiplied by mine production of gold for each country to estimate employee costs and depreciation and amortisation.

Employment

The employment supported by gold mines is an alternative measure of economic contribution to GVA. As with GVA, data from national governments and multilateral institutions do not provide sufficiently granular information to identify the number of people employed in gold mining, so it is necessary to estimate the figures.

Two different sources are used to estimate national employment (including contractors) in gold mining:

- **National sources of gold mining employment**: these include national chambers of mining, other trade associations and national statistical offices; and
- **Company level data**: company level data are used to estimate the average productivity of gold mines in each producing country.

Data on the broader mining sector are often available from government sources. These include employment data for the broader mining sector which are used to provide an upper bound for gold mining employment as well as the basis for a benchmark for mine productivity.

In most cases, company level data are used to generate employment estimates. Estimates of company-level GVA per worker are then combined with national GVA estimates for gold to generate country-level employment

estimates. Where available, contractors are also included in these estimates. Table 23 provides more details on the approach used for each country.

Table 23: Source of employment estimates

Country	Estimation approach	Sources	Note
South Africa	National sources	South Africa Chamber of Mines	Data from 2011 on gold mining employment.
Russia	Company accounts	Polymetal International plc Annual Report 2011, Polyus Gold International Annual Report 2011	Financial and employment data from three companies covering 11 mines produce 25% of national production are used to estimate company-level GVA per worker.
China	Company accounts	Zhong Jin Gold Mining Group Annual Report 2011	Production and employment are obtained for Zhong Jin which accounts for 28% of Chinese mine production.
Australia	National sources	Department of Mines and Petroleum (Government of Western Australia), Australian Bureau of Agricultural and Resource Economics and Sciences	Data on employment by gold mining companies in Western Australia (which accounts for 60% of national production) are obtained. Productivity estimates are derived using regional gold production estimates from the Australian Bureau of Agricultural and Resource Economics and Sciences. The upper bound is 49,000 in metal ore mining in June 2011 from the Australian Bureau of Statistics.
Papua New Guinea	Company accounts	Newcrest Mining Ltd Annual Report 2012 and sustainability report 2012, Ok Tedi Annual Report 2011, Allied Gold Annual Report 2011	Financial and employment data from three companies on four mines covering 62% of national production are used to estimate company-level GVA per worker.
Brazil	Company accounts	Luna Gold Annual Report 2012, Jaguar Mining Annual Report 2012, Yamana Gold Annual Report 2012 and CSR report 2011, Aura Minerals Annual Report 2012	Financial and employment data from four companies on nine mines covering 26% of national production are used to estimate company-level GVA per worker. The upper bound is 175,000 in 2011 based on data from the Brazilian Mineral Institute (IBRAM).
Tanzania	Company accounts	African Barrick Gold	Financial and employment data from one company on four mines covering 43% of national production are used to estimate company-level GVA per worker.
Indonesia	Company accounts	Freeport Mc-MoRan Annual Report 2011, Newcrest Mining Ltd Annual Report 2012 and sustainability report 2012, Newmont Annual Report 2012, Social Impact Assessment Report 2012 for Batu Hijau	Financial and employment data from two companies on two mines covering 58% of national production are used to estimate company-level GVA per worker.
Ghana	National sources	Ghana Chamber of Mines	Data for 2011 on gold mining employment.
United States	National sources	United States Census Bureau	Data on employment for gold ore mining from the United States Census Bureau for 2010. These data may exclude employment in gold processing activities so this may understate the figure.
Peru	Company accounts	Goldfields Annual Report 2011, Compania de Minas Buenaventura SEC report 2012	Data on employment for the four largest mines in Peru covering 52% of national production are obtained from a World Gold Council report for Peru[69]. Production per head is estimated and scaled up to national levels using national production data.
Mexico	Company accounts	New Gold Annual Report 2011, Cerro San Pedro and Mesquite sustainability report 2011, Goldcorp website, Alamos Gold Annual Report 2012, Agnico Eagle Annual Report 2011	Financial and employment data from four companies on five mines covering 60% of national production are used to estimate company-level GVA per worker.
Canada	Company accounts	Agnico Eagle Annual Report 2011, Goldcorp website	Financial and employment data from two companies on six mines covering 51% of national production are used to estimate company-level GVA per worker. The upper bound is 31,631 in metal mining 2012 from Statistics Canada.
Argentina	Company accounts	Yamana Gold Annual Report 2012, Troy Resources Annual Report 2012	Financial and employment data from two companies on three mines covering 16% of national production are used to estimate

[69] World Gold Council (2011) *The economic contribution of large-scale gold mining in Peru*, March 2011.

Country	Estimation approach	Sources	Note
			company-level GVA per worker.
Uzbekistan	No information available	No information available	N/A

Investment

Another measure of the economic significance of gold mining is the level of capital expenditure (capex) made by companies operating in the sector. It is a forward looking indicator of future GVA. It should not, however, be seen as additional to GVA as some of the resources used to fund capex (such as retained profits) are already captured in the calculation of GVA.

The estimates distinguish between *ongoing capex* – spending to maintain existing operations - and *expansion capex* – spending used to expand current operations or develop new operations. These values are taken directly without further adjustment from Thomson Reuters GFMS Mine Economics. The following calculation is used to estimate total investment:

$$Total\ investment = Ongoing\ capex + Expansion\ capex$$

It should be noted that capital expenditure estimates are reported only for a sample of mines for each country, with some countries having better coverage than others. The total investment estimate, therefore, does not capture the full scale of investment taking place in these countries. In addition, the total capital investment reported also excludes expenditure on exploration. Although these are not reported due to the lack of consistent data across mines, it is acknowledged that exploratory activity is potentially significant and generates value for the local economy. It may also result in the subsequent establishment of full-fledged mining operations which add more value and provide further employment opportunities within the local economy.

Exports

For some countries, gold mining represents a significant source of exports and, therefore, foreign exchange earnings. Data on exports of gold are collated by UNCTAD from national sources and are reported directly in this report without further adjustment.

Some care is needed in interpreting the export data as several apparent discrepancies are noted when reviewing the trade data collated by the UN.

First, comparing data on the value and volume of gold exports allows an implied unit value to be derived. In Mexico, Argentina and Peru, this implied unit value of gold is significantly less than the world gold price in the same year[70]. In the other leading producing countries, the implied value is extremely close to the world gold price. This apparent anomaly may reflect several factors:

- Data integrity issues: for example, it is suggested that gold commodity trade may sometimes be coded inaccurately;
- The influence of artisanal gold production; and
- The impact of foreign exchange controls.

Furthermore, the lower unit value of exports in these countries is not consistent with the realised price per ounce of gold reported in the company reports of a sample of producers, which tend to be close to the world price of gold.

In addition, the data on export values are significantly higher than mine production values for some countries, notably the United States and Canada. Gold is a highly-traded commodity and many countries import and export large quantities of gold at different stages of the fabrication process.

Recycling of gold

Data limitations mean that the economic contribution of gold recycling cannot be estimated as easily and with the same degree of confidence as that associated with gold mining. Whilst there are data on where gold is recovered, the lack of data on where recycled gold is refined prior to re-entering the market (where most of the value added from gold recycling is generated) rules out further analysis at a country level. The potential contribution of global recycling is, therefore, only analysed at the global level.

[70] London Bullion Market Association, London PM fix.

The contribution of gold recycling globally is estimated by determining the value of gold produced by recycling to estimate the revenue attributable to recycling and then estimating the element which is GVA by applying the turnover/GVA ratio.

$$Direct\ GVA\ of\ gold\ recycling = Revenue\ from\ gold\ sales\ x\ turnover/GVA\ ratio$$

The volume of gold produced through recycling is derived from the World Gold Council (based on data from Thomson Reuters GFMS Gold Survey 2013). This volume is then multiplied by the average price of gold for 2012 to estimate the revenue generated by gold recycling.

The GVA generated by gold recycling is estimated by multiplying revenue by the estimated turnover/GVA ratio. This ratio is not available specifically for gold recycling so the ratio for the total recycling sector is used as a proxy. It is not known whether this ratio is an accurate representation of gold recycling activities. It is also recognised that gold recycling may involve some elements of fabrication. To reflect this uncertainty, and to test the sensitivity of the results to the assumption, the global turnover/GVA ratio for the manufacturing sector is also used to estimate GVA.

Sensitivity analysis is also conducted by applying country-specific ratios of manufacturing and recycling turnover/GVA ratios (where available) to generate lower and upper bound estimates of global gold recycling GVA. These figures show the estimates of GVA that would be generated if the whole of global gold recycling and refining activity were to take place in each country. These results of the analysis are shown in Table 24, whilst the sources for turnover/GVA ratios that are used in this sensitivity analysis are presented in Table 25. For all countries (with the exception of India), the manufacturing sector ratios yield the lower bound of gold recycling GVA estimates and the recycling sector ratios provide the upper bound of the estimates.

Table 24: Estimated turnover and GVA of global gold recycling using country-specific ratios (US$ millions, 2012)

	Country	Using manufacturing sector ratios	Using recycling sector ratios
Global gold recycling GVA using a selection of country-specific ratios	United States	36,200	37,300
	Switzerland	29,700	33,400
	China	17,900	32,700
	Turkey	15,600	21,000
	India	15,300	14,500

Source: PwC analysis using data from Thomson Reuters GFMS Gold Survey 2013, World Input-Output Database (WIOD) and national statistical offices

Table 25: Turnover/GVA ratios and data sources used in the sensitivity analysis of GVA estimates

	Manufacturing	Notes and source	Recycling	Notes and source
China	4.85	Data from WIOD	2.65	Data from WIOD[71]
India	5.67	Data from the Ministry of Statistics and Programme Implementation	5.99	Data from WIOD
Switzerland	2.92	Data from Eurostat	2.60	Data from Eurostat
Turkey	5.57	Data from the Turkish Statistical Institute	4.14	Data from WIOD
United States	2.40	Data from the United States Census Bureau	2.33	Data from WIOD

Source: PwC analysis using data from Thomson Reuters GFMS Gold Survey 2013, World Input-Output Database (WIOD) and national statistical offices

Demand for gold

This part of the Appendix describes the methodology used to estimate the direct economic and fiscal impacts associated with the activities which support the demand for gold. In practice, the approach used follows similar principles for each application, and builds on the approach used to estimate the direct economic impact of gold recycling. Thus, this part of the Appendix begins by highlighting the key issues linked to the sources of available data, rather than repeating the principles described in relation to gold recycling. It then considers each of the three main areas in turn: bar and coin, jewellery and other technological fabrications which use gold.

[71] World Input-Output Database (WIOD).

The scope of this analysis covers the top 13 gold consuming countries. There is an important distinction to be made here between gold fabrication demand and consumption demand. Fabrication refers to "*the first transformation of gold bullion into a semi-finished or finished product*"[72], whereas consumption refers to the end use of gold (whether in the form of jewellery or investment products such as bars and coins) by the final consumer.

Estimating GVA attributable to gold demand

There are two broad ways of estimating the GVA attributable to gold. These are outlined as follows.

First, the bottom up approach (which is used in this report) starts from estimates of the fabrication and consumption demand of gold and then uses the average gold price to estimate the cost of gold as an input to the fabrication process. The revenue earned by fabricators and producers is then estimated by applying a mark-up to this input to give the turnover/revenue attributable to gold. Then, the ratio of turnover to GVA is applied to the turnover/revenue to estimate the value added to gold as an input into the production process.

$$\textit{Gold consumption by sector} \xrightarrow[\textit{Multiply by world gold price}]{} \textit{Cost of gold input}$$

$$\xrightarrow{\textit{Mark-up}} \textit{Turnover attributable to gold} \xrightarrow[\textit{Apply turnover/GVA ratio}]{} \textit{Direct GVA attributable to gold}$$

In summary, the key components of the analysis include:

- The fabrication and consumption demand for gold by use which provide an indication of the cost of gold inputs;
- The fabrication (and retail for jewellery) mark-ups which allow the estimation of turnover attributable to gold; and
- Turnover/GVA ratios which are used to convert turnover to estimates of GVA attributable to gold.

National data sources, such as national accounts, industry surveys and input-output tables, are used in the first instance to derive turnover/GVA ratios. Where these are not available, data compiled by international sources are used, such as the WIOD. Detailed sector level data are also used where available (e.g. jewellery fabrication, manufacture of electronic and optical goods, jewellery retail etc.). In practice, however, the data on turnover and GVA at detailed sector levels (e.g. 4-digit NACE Rev.2 or 4-digit ISIC Rev.4 sectors[73]) are not available on a consistent basis for some countries. In these cases, estimates using higher level sector aggregates are used instead.

Bar and coin

This category of demand includes global investment in physical gold in bar form, official coin, medals and imitation coin fabrication and sales. Specific data on mark-ups and turnover/GVA ratios are not available for detailed manufacturing sectors such as the striking of coins or the fabrication of gold bars. Instead, estimates of mark-ups are derived on the basis of publicly-available financial accounts of government mints and major gold fabricators and refiners. Turnover/GVA ratios are for the manufacturing sector for each country. More details of the sources used to generate these estimates are set out in Table 26.

Table 26: Assumptions made in deriving GVA estimates for bar and coin fabrication

	Mark-up	Notes and source	Turnover/GVA ratio	Notes and source
China	31%	Indian Government Mint	4.85	Data from WIOD
Egypt	80%	Turkish State Mint	2.53	Proxied by Saudi Arabia ratio Data from the Central Department of Statistics and Information
Germany	3%	European and United States fabricators (see note below)	3.84	Data from Eurostat
India	31%	Indian Government Mint	5.67	Data from the Ministry of Statistics and Programme Implementation
Indonesia	31%	Indian Government Mint	2.69	Data from WIOD
Russia	3%	European and United States	3.37	Data from WIOD

[72] World Gold Council (2013) *Gold Demand Trends: Full Year 2012*, February 2013.
[73] European Classification of Economic Activities (NACE) Revision 2, 2008, Eurostat and the International Standard Industrial Classification of All Economic Activities (ISIC) Revision 4, 2008, UN statistics.

	Mark-up	Notes and source	Turnover/GVA ratio	Notes and source
		fabricators (see note below)		
Saudi Arabia & Yemen	80%	Turkish State Mint	2.53	Data from the Central Department of Statistics and Information
Switzerland	3%	European and United States fabricators (see note below)	2.92	Data from Eurostat
Thailand	31%	Indian Government Mint	4.15	Data from the Central Statistical Office
Turkey	80%	Turkish State Mint	5.57	Data from the Turkish Statistical Institute
United Arab Emirates	80%	Turkish State Mint	3.03	Data from the National Bureau of Statistics
United States	4%	Data using the United States Mint, Royal Australian Mint and the Perth Mint	2.40	Data from the United States Census Bureau
Vietnam	31%	Data using the Indian Government Mint	4.21	Data from the General Statistics Office

Note: the European and United States fabricators referred to include Allgemeine Gold AG, Aurubis AG, Heraeus Holding GMBH, Metalor Technologies International SA, Matsuda Sangyo Co., Johnson Matthey plc, and Umicore SA.

To estimate the value associated with the consumption of gold bar and coin, mark-ups are first derived by comparing the sale price of gold products from gold bullion and coin dealers and brokers (on a US$per ounce basis) to the LBMA gold price[74]. Estimates for mark-up are obtained from dealers for various countries. Turnover/GVA ratios are for the retail sector for each country. More details of the sources used to generate these estimates are set out in Table 27. Table 29 lists the various gold bullion and coin dealers that were consulted in deriving estimates for margins. It should be noted that 2012 data for margins were not available on a consistent basis, and as such the data presented in these tables are for 2013.

Table 27: Assumptions made in deriving GVA estimates for bar and coin consumption

	Mark-up	Source (dealer country)	Turnover/GVA ratio	Notes and source
China	7%	Data for China	1.66	Data from WIOD
Egypt	7%	Data for UAE	2.88	Proxied by Saudi Arabia ratio. Data from the Central Department of Statistics and Information
Germany	6%	Data for Germany	4.91	Data from Eurostat
India	14%	Data for India	1.12	Data from the Ministry of Statistics and Programme Implementation
Indonesia	14%	Data for China	1.69	Data from WIOD
Saudi Arabia & Yemen	14%	Data for UAE	2.88	Data from the Central Department of Statistics and Information
Switzerland	6%	Data for Germany	4.11	Data from Eurostat
Thailand	7%	Data for China	4.34	Data from the Central Statistical Office
Turkey	7%	Data for UAE	1.35	Data from the Turkish Statistical Institute
United Arab Emirates	7%	Data for UAE	1.31	Data from the National Bureau of Statistics
United States	8%	Data for US	1.40	Data from the WIOD
Vietnam	7%	Data for China	1.69	Data from the General Statistics Office

Table 28: Detailed sources of mark-up estimates for bar and coin retail

Dealer country	Detailed sources *All data from 2013 unless otherwise stated*
China	China Construction Bank, Guoding National Bank, Agricultural Bank of China, Merchants Bank, QJX Gold, Shanghai Si Erwo, Ying Jie Sheng, Heng Tai Da Dong
India	Allahabad Bank, Andhra Bank, Bank of Baroda, Bank of India, Corporation Bank, HDFC Bank, ICICI Bank, India Overseas Bank, IndusInd Bank, Kotak Mahindra Bank, Oriental Bank of Commerce, Punjab and Sind Bank, Punjab National Bank, State Bank of Hyderabad, State Bank of India, Union Bank of India
United Arab Emirates	Gold Arab Emirate

[74] London Bullion Market Association, London PM fix.

Dealer country	Detailed sources *All data from 2013 unless otherwise stated*
US	Bullion Supermarket (AU Trading, GoldSilver.com, Kitco)
Germany	Coin Invest Direct, Pro Aurum

Larger bars and coins also attract smaller price premia on a per ounce basis compared to smaller denominations in usual market conditions, i.e. a 1/10 ounce gold coin will usually sell for a higher premium than a 1 ounce gold coin. However, due to the lack of data on bar and coin demand by size, refining the analysis on this basis is not possible.

Jewellery

For the majority of countries in the study, the turnover/GVA ratios for the jewellery fabrication sector are largely available. Where this is not the case (e.g. China, Indonesia, Russia and UAE), the manufacturing sector ratios are used instead. Similarly for retail, where jewellery-specific retail estimates are not available, the data for the total retail sector are used instead. Table 29 and Table 30 show the mark-ups and turnover/GVA ratios used in generating estimates of the GVA associated with gold jewellery fabrication and retail for each country respectively.

Table 29: Assumptions made in deriving GVA estimates for jewellery fabrication

	Mark-up	Notes and source	Turnover/GVA ratio	Notes and source
China	4%	Asia-Pacific jewellery fabricators from S&P Capital IQ	4.85	Data from WIOD Not specific to jewellery fabrication
Egypt	4%	Middle East and African jewellery fabricators from S&P Capital IQ	2.42	Proxied by Saudi Arabia ratio Data from the Central Department of Statistics and Information
Germany	25%	European jewellery fabricators from S&P Capital IQ	2.89	Data from Eurostat
India	4%	Asia-Pacific jewellery fabricators from S&P Capital IQ	4.31	Data from the Ministry of Statistics and Programme Implementation
Indonesia	4%	Asia-Pacific jewellery fabricators from S&P Capital IQ	2.69	Data from WIOD Not specific to jewellery fabrication
Russia	14%	European and Middle East/African jewellery fabricators from S&P Capital IQ	3.37	Data from WIOD Not specific to jewellery fabrication
Saudi Arabia & Yemen	4%	Middle East and African jewellery fabricators from S&P Capital IQ	2.42	Data from the Central Department of Statistics and Information
Switzerland	25%	European jewellery fabricators from S&P Capital IQ	2.97	Data from Eurostat
Thailand	4%	Asia-Pacific jewellery fabricators from S&P Capital IQ	3.25	Data from the Central Statistical Office
Turkey	14%	Middle East and African jewellery fabricators from S&P Capital IQ	12.92	Data from the Turkish Statistical Institute
United Arab Emirates	4%	Middle East and African jewellery fabricators from S&P Capital IQ	3.03	Data from the National Bureau of Statistics Not specific to jewellery fabrication
United States	17%	North American jewellery fabricators from S&P Capital IQ	1.96	Data from the United States Census Bureau
Vietnam	4%	Asia-Pacific jewellery fabricators from S&P Capital IQ	2.25	Data from the General Statistics Office

Table 30: Assumptions made in deriving GVA estimates for jewellery consumption

	Mark-up	Notes and source	Turnover/GVA ratio	Notes and source
China	39%	The data for retail mark-ups are obtained from Thomson Reuters (2010) *Gold Jewellery Value Report*, report prepared for the World Gold Council	1.66	Data from WIOD Not specific to jewellery retail
Egypt	25%		2.88	Proxied by Saudi Arabia ratio Not specific to jewellery retail Data from the Central Department of Statistics and Information
Germany	163%		3.92	Data from Eurostat
India	11%		6.79	Data from the Ministry of Statistics and Programme Implementation
Indonesia	15%		1.69	Data from WIOD, not specific to jewellery retail
Russia	147%		1.46	Data from WIOD, not specific to jewellery retail
Saudi Arabia & Yemen	24%		2.88	Data from the Central Department of Statistics and Information Not specific to jewellery retail
Switzerland				Data from Eurostat
Thailand	13%		4.34	Data from the Central Statistical Office Not specific to jewellery retail
Turkey	110%		14.23	Data from the Turkish Statistical Institute
United Arab Emirates	23%		1.31	Data from the National Bureau of Statistics Not specific to jewellery fabrication Not specific to jewellery retail
United States	169%		2.06	Data from the United States Census Bureau
Vietnam	19%		1.69	Data from the General Statistics Office Not specific to jewellery retail

Technological fabrications which use gold

This category of demand includes all gold used in the fabrication of electronics, dental, medical, industrial, decorative and other technological applications, including gold destined for plating jewellery.

In estimating the GVA attributable to gold in electronics, the data on mark-ups are obtained from industry and market analysis reports for electrical components and equipment manufacturing, while the turnover/GVA ratios are obtained for the manufacturing of electrical and optical equipment sector from national and international sources. More details of the sources used to generate these estimates are set out in Table 31.

Table 31: Assumptions made in deriving GVA estimates for electronics

	Mark-up	Notes and source	Turnover/GVA ratio	Notes and source
China	2%	Asia-Pacific electrical components and equipment manufactures from S&P Capital IQ	6.19	Data from WIOD
Germany	11%	European electrical components and equipment manufacturers from S&P Capital IQ	2.99	Data from Eurostat
India	2%	Asia-Pacific electrical components and equipment manufacturers from S&P Capital IQ	5.13	Data from the Ministry of Statistics and Programme Implementation
Russia	11%	European and Middle East/African electrical components and equipment manufacturers, data from S&P Capital IQ	2.93	Data from WIOD
Switzerland	11%	European electrical components and equipment manufacturers from S&P Capital IQ	2.77	Data from Eurostat
United States	16%	North American electrical components and equipment manufacturers from S&P Capital IQ	1.84	Data from the United States Census Bureau

For the use of gold in dental equipment, the data on mark-ups are obtained from industry and market analysis reports for dental care equipment manufacturing, while the turnover/GVA ratios are obtained for the manufacturing of medical and dental supplies (with the exception of Russia) from national and international sources. More details of the sources used to generate these estimates are set out in Table 32.

Table 32: Assumptions made in deriving GVA estimates for dentistry

	Mark-up	Notes and source	Turnover/GVA ratio	Notes and source
Germany	12%	European dental care equipment manufacturers from S&P Capital IQ	2.34	Data from Eurostat
Russia	12%	Average for European and Middle East/African dental care equipment manufacturers from S&P Capital IQ	2.93	Data from WIOD Not specific to dental equipment manufacturing
Switzerland	12%	European dental care equipment manufacturers from S&P Capital IQ	2.27	Data from Eurostat
United States	28%	North America dental care equipment manufacturers from S&P Capital IQ	1.65	Data from the United States Census Bureau

For the use of gold in other industrial processes or for decorative purposes, the data on mark-ups are obtained from industry and market analysis reports for manufacturing, while the turnover/GVA ratios are obtained for the total manufacturing sector from national and international sources. More details of the sources used to generate these estimates are set out in Table 33.

Table 33: Assumptions made in deriving GVA estimates for other industrial

	Mark-up	Notes and source	Turnover/GVA ratio	Notes and source
China	4%	Asia-Pacific manufacturing companies from S&P Capital IQ	4.85	Data from WIOD
Germany	8%	European manufacturing companies from S&P Capital IQ	3.84	Data from Eurostat
India	4%	Asia-Pacific manufacturing companies from S&P Capital IQ	5.67	Data from the Ministry of Statistics and Programme Implementation
Russia	8%	European and Middle East/African manufacturing companies from S&P Capital IQ	2.92	Data from WIOD
Switzerland	4%	European manufacturing companies from S&P Capital IQ	4.15	Data from Eurostat
Thailand	11%	Asia-Pacific manufacturing companies from S&P Capital IQ	2.40	Data from the Central Statistical Office
United States	4%	North American manufacturing companies from S&P Capital IQ	4.85	Data from the United States Census Bureau

Contacts

Authors

Tim Ogier
Consulting
T: +44 (0) 207 804 5207
E: tim.ogier@uk.pwc.com

Mark Ambler
Consulting
T: +44 (0) 207 213 1591
E: mark.d.ambler@uk.pwc.com

Yong Jing Teow
Consulting
T: +44 (0) 207 804 4257
E: yong.jing.teow@uk.pwc.com

Industry

John Gravelle
Canada
Global Mining Leader
T: +1 416 869 8727
E: john.gravelle@ca.pwc.com

Hein Boegman
South Africa
Partner
T: +27 11 797 4335
E: hein.boegman@za.pwc.com

John Campbell
Russia & Central & Eastern Europe
Partner
T: +380 (44) 490 6777
E: john.c.campbell@ua.pwc.com

Kameswara Rao
India
Partner
T: +91 40 6624 6688
E: kameswara.rao@in.pwc.com

Ronaldo Valino
Brazil
Partner
T: +55 (21) 3232 6015
E: ronaldo.valino@br.pwc.com

Jason Burkitt
UK
Partner
T: +44 (0) 20 7213 2515
E: jason.e.burkitt@uk.pwc.com

Sacha Winzenried
Indonesia
Partner
T: +62 21 5289 0968
E: sacha.winzenried@id.pwc.com

Steve Ralbovsky
U.S.A.
Partner
T: +1 (602) 364 8193
E: steve.ralbovsky@us.pwc.com

Jock O'Callaghan
Australia
EU&M Industry Leader
T: +61 (3) 8603 6137
E: jock.ocallaghan@au.pwc.com

Ken Su
China
Partner
T: +86 (10) 6533 7290
E: ken.x.su@cn.pwc.com