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The Economic Impact Of Smart Ledgers On World Trade

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CARDANO FOUNDATION

The Z/Yen Group

World Traders

IACCM

CITY OF LONDON

Cebr

The Economic Impact Of Smart Ledgers On World Trade

April 2018

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Foreword

The Cardano Foundation is delighted to sponsor this essential piece of research into the potential benefits of Smart Ledgers for world trade. This Distributed Futures research work is essential because, while many claims have been made for revolutionary impact, little quantitative economic research has attempted to estimate the economic benefits of Smart Ledgers.

The Centre for Economics and Business Research (Cebr), with assistance from The International Association for Contract & Commercial Management (IACCM) and Z/Yen, have estimated the potential impact as anything from a 'modest' rise in global trade of $35 billion per annum to perhaps as much as $140 billion. The lower estimate of $35 billion may not justify 'revolutionary', yet as Cebr notes even this conservative estimate would be associated with $3 to $6 more gross domestic product per average global worker in a world where many still earn below $2 per day.

This is unlikely to be the last attempt to gauge the economic impact, but we hope that by taking a pioneering attitude towards such a big subject, we encourage other researchers to critique, elaborate, and apply other methods in trying to determine how important Smart Ledgers could be, and how much effort should be expended in supporting their development and adoption.

We are pleased to have sponsored this important research and do hope that the guidance herein is of help to business people, technologists, policy-makers, and regulators in evaluating the opportunities that Smart Ledgers may provide for world trade.

Michael Parsons FCA
Chairman, Cardano Foundation

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Preface

This year I have the honour of being Master of the Worshipful Company of World Traders. We are one of the over 110 livery companies of the City of London. World Traders are individuals committed to developing global trade in order to promote peace and prosperity. Our motto, 'commerce and honest friendship with all', was taken from Thomas Jefferson's inaugural Presidential speech. We were pleased to co-sponsor this research.

The World Traders have 300 members from a wide spectrum of women and men who deal with global trade, consisting largely of three groups:

- Brokers – people who trade services. Many members work within the trading sectors of the City of London, for example, ship brokers, insurance brokers, commodity brokers, mergers & acquisitions specialists, stockbrokers and currency dealers.
- Traders – people who trade tangible goods and products. These members are often importers and exporters, including foodstuffs, pharmaceutical products, metals and various industrial products from electronics to bridges.
- Financial and professional services - members who have a speciality supporting international business. These members include lawyers, bankers, accountants, ICT experts, ambassadors, academics, journalists, and consultants.

So what might Smart Ledgers mean for trade? The Economist reports that "Maersk, the world's biggest container-shipping line, found that a shipment of avocados from Mombasa to Rotterdam in 2014 entailed more than 200 communications involving 30 parties." [1] My view of the potential Smart Ledger trade world is summarised in the following table. Though this report covers the areas in 'green' for 'goods' only, in future we may be able to examine identity, payments, and transactions:

[1] The Economist, "Pulp Friction: Technology and International Trade", (24 March 2018) - https://www.economist.com/news/finance-and-economics/21739159-administrative-obstacles-loom-larger-technological-ones-digitisation.

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Smart Ledger Application Area	Reduce Risks	Enhance Rewards	Increase Certainty (reduce volatility)
Identity			
Documentation			
Agreements			
Payments			
Transactions			

For documentation and agreements on goods, we were pleased to be able to commission and work with Cebr, one of the world's most distinguished economic forecasting firms to examine how reducing trade frictions using Smart Ledgers could help global trade. We were delighted that IACCM volunteered to provide a bit more 'colour' from 247 contract and commercial managers around the world (Appendix 1), who turned out to be well-informed that Smart Ledgers have great potential for trade.

Trade is bogged down with 'frictions' of all kinds. Before you get to corrupt customs officials or arcane trade restrictions, just think bureaucracy and paperwork. For example, regulations around anti-money laundering, know-your-customer, and ultimate beneficial ownership increase legal and regulatory costs, uncertainties, and hassles. Ninety percent of businesses responding to the International Chamber of Commerce's 2016 Global Survey on Trade Finance pointed to anti-money laundering as the most significant [i]impediment to trade. Smart Ledger identity systems may have a large role to play here.

The results are worth discussing. The conservative results were, frankly, a bit lower than I had anticipated. Full digitisation of trade paperwork, according to the UN, could raise just Asia-Pacific exports by $257 billion a year.[2] A widely referenced ratio from the World Economic Forum estimates the costs of processing trade documents at as much as a fifth of those of moving just goods around. Interestingly, this study raises a good question at one point about

[2] United Nations ESCAP (Economic and Social Commission for Asia and the Pacific), "Estimating the Benefits of Cross Border Paperless Trade" (2014) - http://www.unescap.org/sites/default/files/Benefits%20of%20Cross-Border%20Paperless%20Trade.pdf

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whether the dominance of the US$ in trade might itself be a trade friction. Also, according to the World Economic Forum, reducing trade barriers halfway to global best practice could expand trade by 15% and increase global gross domestic product (GDP) by nearly 5%. Yet, Cebr estimates benefits of only $35 billion per annum to perhaps as much as $140 billion for global use of Smart Ledgers alone.

In another sense, the optimistic $140 billion is more than I expected. In context, Smart Ledgers are only one part of 'full digitisation'. Future work on 'services' in addition to 'goods', combined with identity, payments, and transactions, will only increase the scale of benefits.

Trade reaps economic benefits from specialisation and comparative advantage, creates prosperity, distributes success and wealth, and collectively enriches all of our societies and communities. Hopefully, knowing the scale of relative benefits can help speed adoption of some boring technology – 'multi-organisational databases with a super audit trail' - for the benefit of all of us.

Professor Michael Mainelli
Executive Chairman, Z/Yen Group
Master, Worshipful Company of World Traders (2017-2018)

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Executive Summary

This report looks at Smart Ledgers as potential facilitators of global trade flows. Conceptually, the impact of Smart Ledgers will be realised by reduced cost frictions associated with processes such as paperwork and identity checking, facilitating the creation of new business opportunities, and reducing the volatility associated with international trade. The key findings of this report into the potential economic impact of Smart Ledgers on world trade are the following:

- Smart Ledger technology could boost world trade in goods by at least $35 billion dollars per annum.
- The cost of importing a single container could, therefore, be reduced by around $46, by simplifying procedures.
- These potential benefits are driven by a 2.5% cost clawback assumption, supported by case studies on previous technological advancements in trade. One such case study is containerisation, where the cost savings have been calculated to be in the range of 20%[3]. We conceptualise Smart Ledgers as a form of digital containerisation for trade data and processes.
- If reduced uncertainty is, also, taken into account, using option pricing theory, the potential gains become even larger, with a potential monthly net cost saving of $172 million (or, approximately, $2 billion per annum).
- This would boost world GDP by $10 to $20 billion and could, potentially, add between 450,000 and 900,000 to the worldwide demand for labour, boosting wages and living standards worldwide. The World Bank estimates that 10.7% of the world's population still lives in extreme poverty, with an income below $1.90 a day (2011 prices).
- This would be of particular benefit to the United Kingdom (UK), for two reasons. First, as a small island economy, it is relatively more dependent on world trade than most countries, and second, because Smart Ledgers offer particular advantages in solving some of the problems that might emerge from Brexit. The likely gains to UK GDP might be given an

[3] https://voxeu.org/article/containers-and-globalisation

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estimated boost of £0.4 to £0.8 billion, without taking into account the effects of Brexit.

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1. Background On Global Trade

International trade is a key means of transmission for channelling wealth and prosperity throughout the world. An efficient and effective global trading system allows goods to flow to where they are needed most, through price signalling. This, in turn, generates value through economies of scale and specialisation.

Countries that have a comparative advantage in a particular field could realise the gains of full specialisation that would not otherwise be possible in a closed economy. Furthermore, international trade would allow countries to, more effectively, exploit economies of scale, by producing goods and services for a larger mass-market than could be achieved domestically. The efficiency gains are then transferred to consumers, through lower prices. Other economic benefits would, also, be channelled to workers, through potentially higher salaries. Alternatively, the surplus value could also lead to more shareholder wealth and more investment by the exporting firms.

One of the key problems with modern trade narratives is the distinction people make between domestic and international trade. Whereas trade is often framed as being somewhat separate and distinct from overall domestic economic activity, it is essential to consider international trade flows alongside domestic trade flows, as an indication of wealth and prosperity. This economically expansive view of trade would therefore aim to minimise the distortions that hide foreign economic flows, when compared to domestic ones.

It is, nonetheless, true that political borders between countries hinder economic flows for a number of reasons:

- Imported goods can be subject to **direct trade barriers, such as tariffs**. Tariffs increase the cost of imports. As consumers, ultimately, have to pay higher prices for the imported products, it puts imports at a disadvantage relative to domestic products. Sometimes, imports are sufficiently cost competitive to absorb the tariffs and still compete with domestically produced goods, but the tariffs themselves will still be an issue.

- **Non-tariff barriers** are restrictions on international trade that are not as explicit as trade tariffs. One example is when countries make it difficult for importers to meet their domestic market standards, or where imported goods are subject to quotas. Other examples include subsidies

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given to domestic producers allowing them to have an advantage relative to the imported goods, as well as customs delays. Anything that restricts trade other than through direct tariffs can be seen as a non-tariff barrier. Subtler non-tariff barriers include:

- Different degrees of development between countries, which make it difficult for companies to adapt to market dynamics and consumer wealth levels. This affects the pricing and marketing of products.

- Ethnic, linguistic, and cultural differences, often reflected in borders between countries. For instance, if firms attempting to import products into a market don't speak the local language or if they don't understand cultural norms within that market space, it can hamper their ability to sell products effectively. These firms might even antagonise local populations through culturally insensitive marketing practices.

- Institutional divergences between politically separated markets, such as different legal systems. For example, countries that have Common Law systems in place might find it easier to trade with each other compared to those that employ the Civil Code. Companies from countries with compatible legal systems may thus have an easier time trading, as well as dealing with different situations. Differences can be extended to include the differences in administrative practices between countries, adding to paperwork and compliance frictions.

- Despite many developments happening on a global basis, effective governance, politics, and policy still, largely, occur at a national level. This means that many firms have an information bias in favour of their home countries compared to those abroad. For that reason, companies might have to deal with reduced access to information, when in foreign markets. This poses challenges for both supply chains and the distribution of products. Systems that provide counterparty validation and assist in establishing trust are, therefore, very important in facilitating trade.

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  - The infrastructure to support international trade flows may not be as well-developed as domestic infrastructure, partly due to the lack of a central authority that engages in the associated planning and funding of such links, as seen at a national level. Furthermore, fusing together the infrastructures of different countries can take time, as it relies on two different national government processes coming together and successfully coordinating actions. However, technology is helping to combat these challenges. Larger container ships, easier telecommunications, and logistical operations are some of the ways in which technological advancement has helped bridge the infrastructure gaps.

- Despite the fact that global trade has grown remarkably since the 1990s, more progress is needed. Over the last few decades, many classical trade barriers between countries, such as trade tariffs, have been reduced or eliminated. Milestones, such as the creation of the World Trade Organisation (WTO) in 1995, have contributed to this. More recently, though, multilateral progress has somewhat stalled, through the persistent failure to get the Doha round of trade talks restarted. In the absence of multilateral progress, much of the recent global trade gains have taken place bilaterally through free trade agreements, such as the recent European Union (EU)/Canada CETA deal. Aside from slashing tariffs, this agreement has produced some liberalisation in areas such as the equivalence of standards and agriculture, helping to achieve a reduction in non-tariff barriers.

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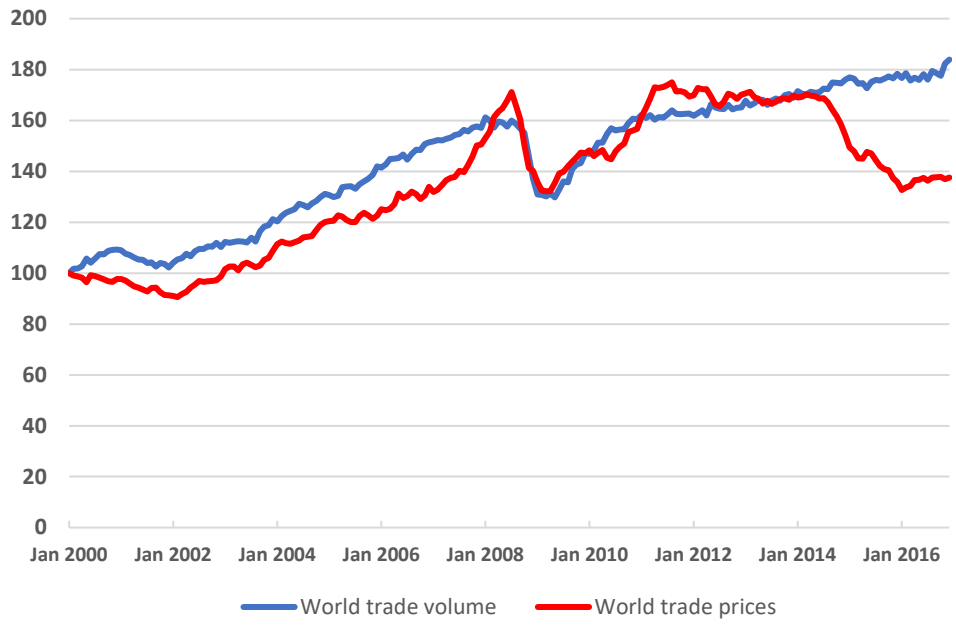
Figure 1: World trade index, volume and prices (Jan 2000 = 100), 2000-2016



Source: CPB Netherlands Bureau for Economic Policy Analysis

As a result of the EU almost doubling in numerical size since 2000, further de facto trade liberalisation has occurred within Europe. The EU single market is more than a tariff free area. It provides deep levels of access through the creation of pan-European common rules and standards, while guaranteeing the free movement of workers, goods, capital and services. Furthermore, the EU has common institutional pillars, such as the European Commission, the European Court of Justice, the European Parliament, and the European Central Bank. These further help minimise some of the aforementioned frictions, through standardised rules, oversight, and enforcement mechanisms.

Substantial tariff and non-tariff barriers continue to exist throughout the world. A freer, more transparent, and more secure flow of information could, potentially, help bridge some of the infrastructure gaps. The importance of increased trade liberalisation can be seen in Figure 2. Although the relationship between global trade and global economic growth is somewhat circular (higher global growth boosts trade, and higher levels of global trade boost growth), the association illustrated is difficult to ignore. Trade is an essential part of the global growth equation.

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Figure 2: GDP growth and trade growth, year-on-year change (%)

Source: World Bank and CPB Netherlands Bureau for Economic Policy Analysis

Since the 2009 financial crisis, we have seen a slowdown in global trade and economic growth. While there might be a correlation between the two, we must, also, consider other factors, such as increases in non-tariff barriers and foreign exchange volatility.

Looking at the WTO data in Figure 3, we observe that global goods trade has exhibited a fair degree of volatility over recent years. Despite the fact that the 2009 slump was followed by a sharp recovery, recently, the value figures have shown a downward bias, driven in part by the lower commodity prices that have pushed down overall values of goods traded. As of 2016, overall world trade stood at slightly more than $15 trillion, a $3 trillion reduction from the 2014 levels.

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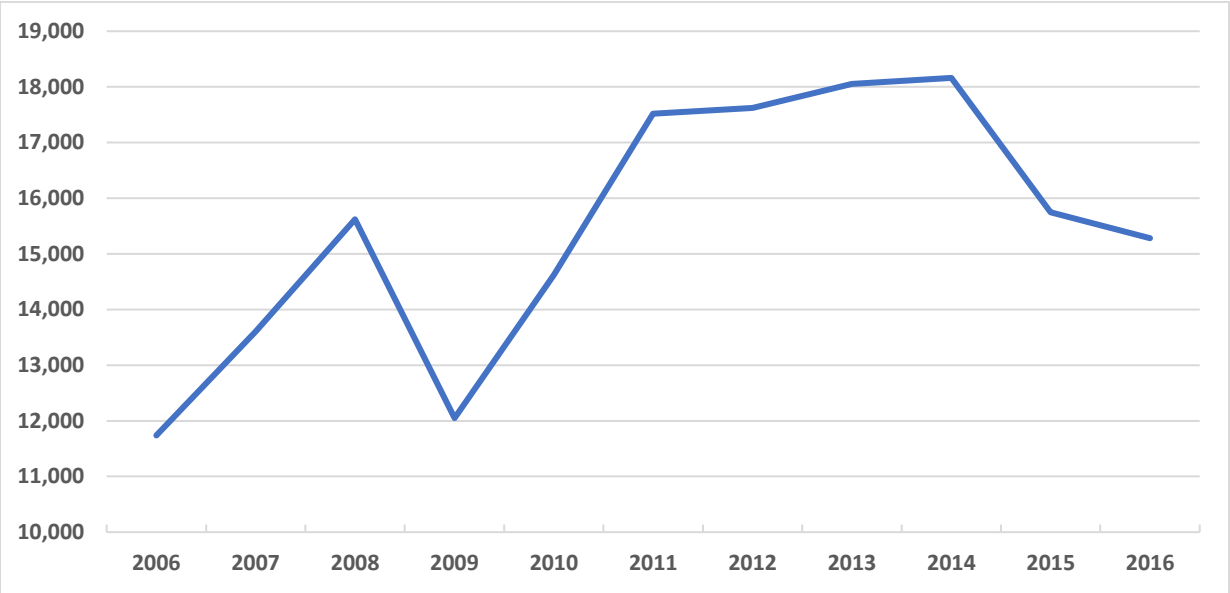
Figure 3: World trade in goods (summed across agriculture, manufactures and fuels/mining products, billions of dollars)



Source: WTO – World Trade Organisation

Furthermore, global trade growth faces political challenges from populist economic policies. The Trump administration in the US, for example, has withdrawn from the Trans Pacific Partnership (TPP) agreement, while also demanding tariffs on a range of goods, from Asian steel to Canadian dairy products. On a related note, the UK, also, faces substantial changes in its trading conditions, the negotiations over EU withdrawal continue. Given that the UK faces a likely reduction of market access to the EU, technological solutions such as MDLs will play a crucial role in minimising the administrative and bureaucratic friction that might emerge. This specific issue is addressed in Appendix 2.

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2. Background On Smart Ledgers

Smart Ledgers are based on a combination of mutual distributed ledgers (i.e., multi-organisational databases with a super audit trail) with embedded programming and sensing, thus permitting semi-intelligent, autonomous transactions.

Smart Ledgers are transforming the way people and organisations handle identities, transactions, debts, and contracts. The ability to have a globally available, verifiable, and high-integrity record or journal provides anyone wishing to provide trusted third-party services the ability to do so openly and robustly.

The technical success and excitement surrounding the cryptocurrency Bitcoin's distributed ledger, 'the blockchain', has convinced many sceptics that distributed ledgers can work securely in harsh environments. The key innovation is a public distributed ledger that eliminates the need for a central counterparty to act as a third party to financial transactions, relying, instead, on a decentralised peer-to-peer network, secured by advanced cryptography.

International trade is an area where Smart Ledgers could have additional tangible, practical relevance. The question this report attempts to answer is how much of an impact Smart Ledger technology can have in alleviating non-tariff barriers for goods. To answer this question, we need to explore the following parameters: The reduction of the costs associated with finding trustworthy suppliers; identity checking; minimising the time spent going through customs; ensuring the quality and integrity of one’s supply chain; better managing logistics to reduce the need for holding inventory on hand; reducing the costs and burdens of paperwork.

Some basic terminology includes:

- ledger – a record of transactions;
- distributed – divided among several or many, in multiple locations;
- mutual – shared in common, or owned by a community;
- mutual distributed ledger (MDL) - a record of transactions shared in common and stored in multiple locations;
- mutual distributed ledger technology – a technology that provides an immutable record of transactions shared in common and stored in multiple locations;

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- blockchain - “a transaction database shared by all nodes participating in a system based on the Bitcoin protocol”;
- Smart Ledger – MDL with embedded, executable code.

Figure 4: Illustration of the classical trade process without Smart Ledgers

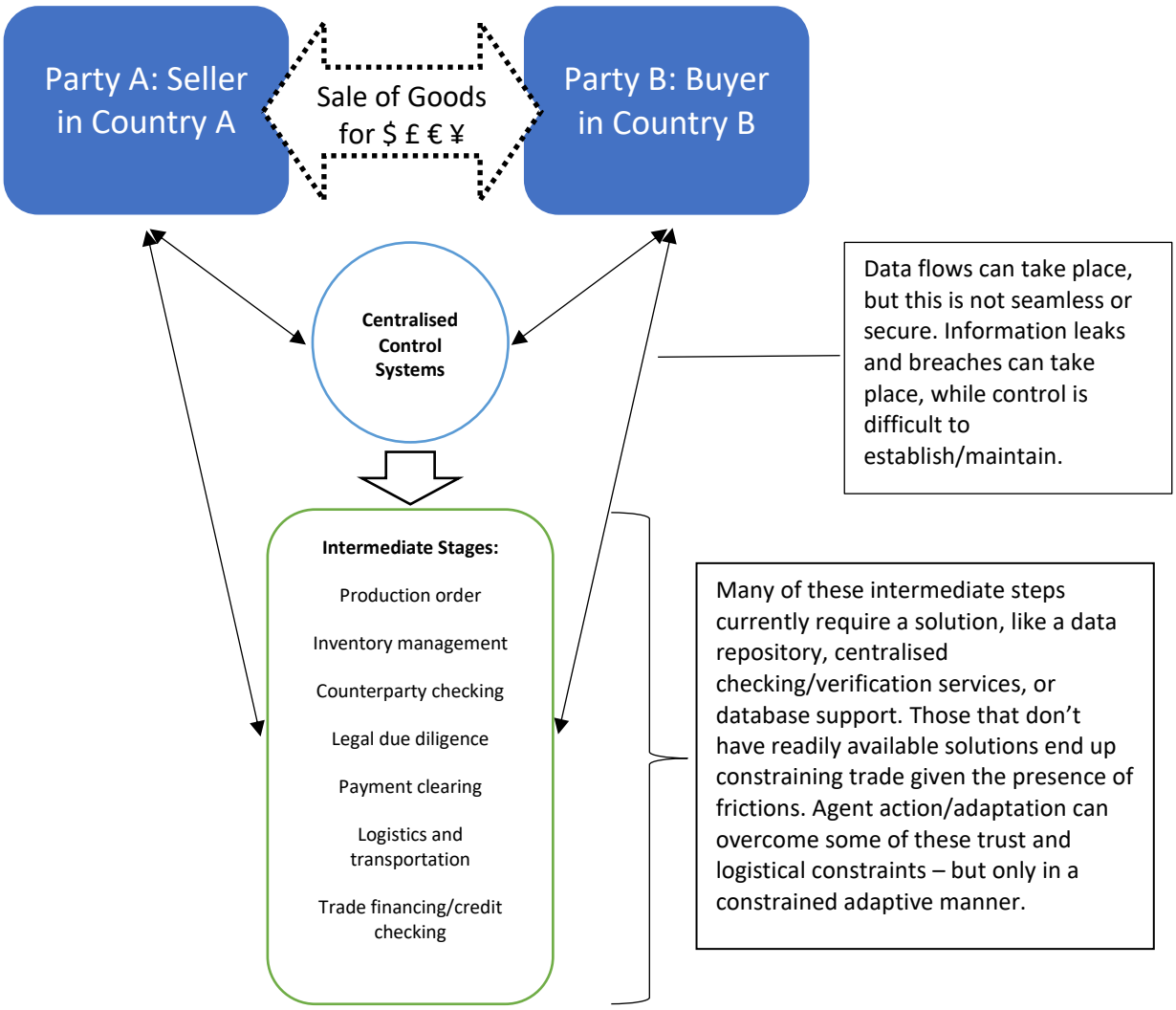

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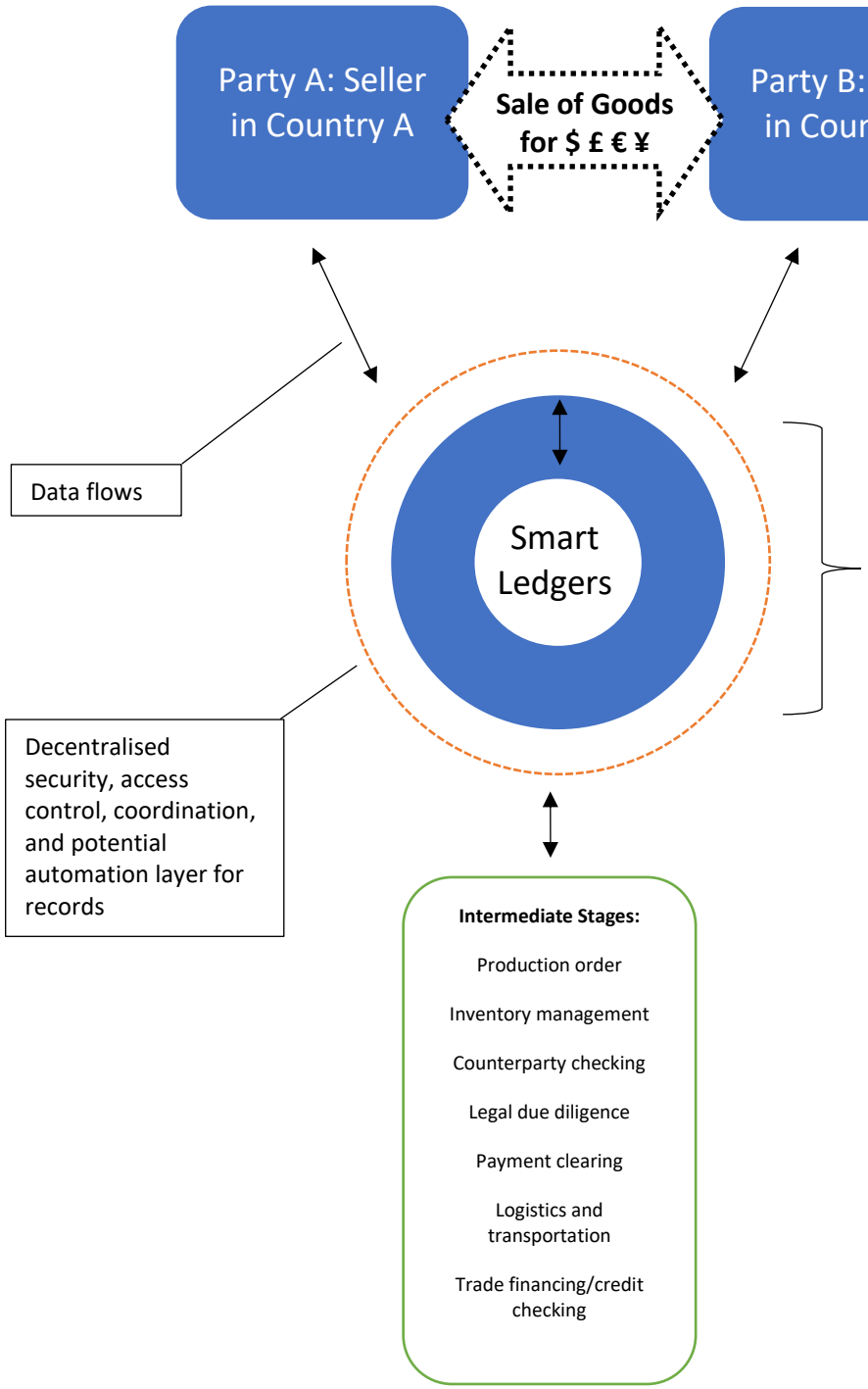
Figure 5: Illustration of a Smart Ledger-assisted international trade process



The MDL platform allows many of the previous constraints to be overcome

The encrypted MDL eliminates the need for 3rd party checking.

- Identity checking
- Security/integrity of supply chain
- Payment clearing

Smart Ledgers help to provide automated solutions relying on collaborative platforms to overcome the need for dedicated specialists focusing on paperwork.

Information sharing though Smart Ledgers allows for fewer information asymmetries, helping to attenuate systemic risks.

Smart Ledgers allow for the automation of complicated tasks.

Consolidation of trade flow information, such as the status of delivery, who has custody, payment status etc.

Smart Ledgers eliminate the need for centralised databases. This means that the supporting mechanisms for trade are, potentially, cheaper to run and less vulnerable to security risks and system failures.

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3. Modelling

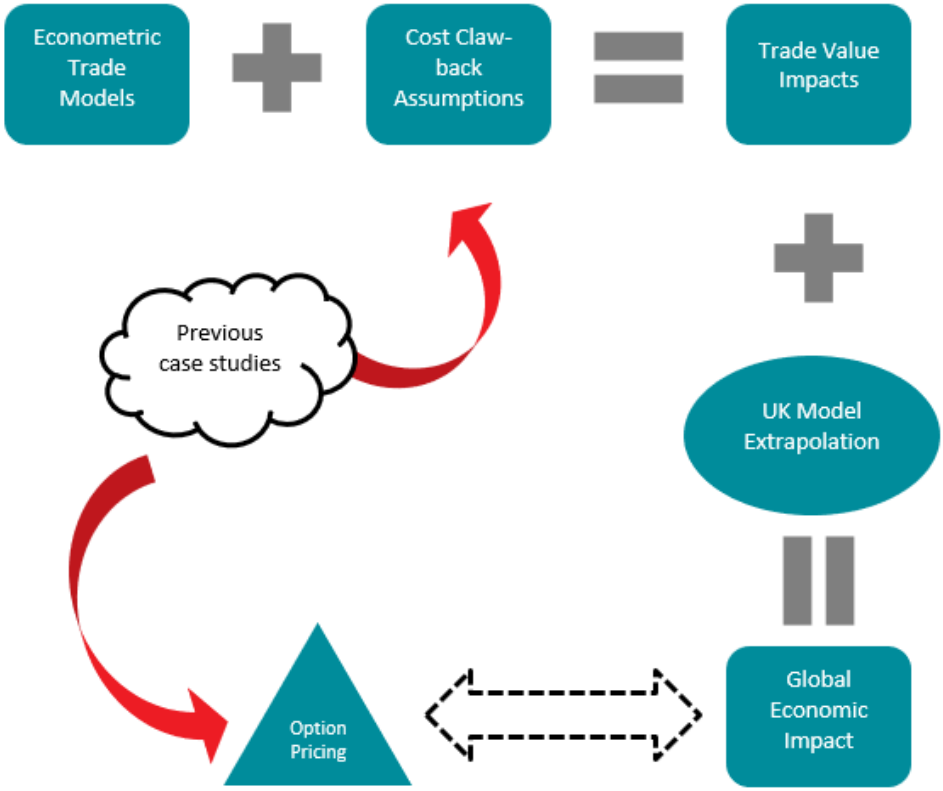
The following section outlines the Cebr methodology and subsequent modelling results for the investigation on the potential impacts of Smart Ledger technology on world trade. This section attempts to empirically investigate the relationship between international trade and the key frictions that could potentially be reduced though Smart Ledgers.

In prior sections, we outlined the theoretical underpinnings to this, namely, that Smart Ledgers will help to create a smoother and better functioning global trade environment. Within this section, we outline the measured results, implications, and modelling techniques.

A. Methodological Background

Given that this analysis is being performed on a global basis, Cebr sought to provide a high-level measure on the impact of Smart Ledger technology. In Cebr's judgement, the most suitable and scalable methodology is applying an econometric approach to global trade flow data on a volume and value basis, by looking specifically at goods trade:

Figure 6: Econometric modelling approach



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Using an econometric modelling approach in this way is useful for a number of reasons:

- Isolation of the macroeconomic variables that can be identified as being key drivers of global trade
- Identification of the supply side variables that contribute to global trade
- Potential to dig deeper and see which of the macro and micro variables have potential links to the frictions associated with Smart Ledger technology. This, in turn, would make it possible to link the model back to assumptions and research on the achievable reductions in frictions and trade constraints that Smart Ledgers systems can facilitate.

While the models are not necessarily causal, there are economic underpinnings to the direction and strength of the impacts. The models put together are, therefore, not only assembled to statistical accuracy, but also structured in an economically meaningful and intuitive way.

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B. Econometric Results

Trade Value Model

The econometric results below cover two principal models. We have looked at the key drivers for trade flows on a volume and a value basis.

Table 1: Econometric results from global trade value model

Dependent Variable: PERCENT CHANGE IN WORLD TRADE VALUE ***Sample: 2005M03 2015M01*** ***Variable***	***Coefficient***	***Prob.***
ISM_DELIVERY	0.05	0.00
Percent TRADE_WEIGHTED_USD	-1.11	0.00
@PC(GDP_PPP)	0.50	0.00
@DURING("2008m11 2008m12")	-6.75	0.00
@PC(BALTIC_DRY_INDEX(-2))	0.01	0.03
@PC(COST_TO_IMPORT(-1))	-0.11	0.23
+ FRICTIONAL TERMS		
R-squared	**0.80**	
Adjusted R-squared	**0.79**	

Table 1 shows the trade value model. The model looks at the respective variables on a percent change basis. This means that the percent changes in global trade value are modelled on the percent changes of various inputs. This is done for technical reasons, such as avoiding the use of non-stationary variables that might result in spurious relationships.

Furthermore, the trade value term has also been slightly modified, in that we have tried to strip out upstream impacts. The main reason for doing this is that we wanted to eliminate a primary source of volatility in trade value flows, seen in upstream commodity prices.

In addition, the Smart Ledger technology is more applicable further downstream and closer to the end user, because that is where the frictions we are trying to capture primarily reside. With this in mind, the model provides for a number of interesting results:

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- There is a strong negatively elastic relationship between the downstream trade value and the trade weighted dollar strength. A relatively strong dollar is associated with a decline in global trade value and vice versa. It could be that a strong dollar is associated with lower commodity and goods prices, as fewer dollars are needed to buy inputs. The volume impacts are less intuitive. It could be argued that a strong dollar weakens global downstream trade because it increases the cost of inputs (in other non-dollar currencies). In essence, a 1% increase in global dollar strength is associated with a 1.1% decrease in global downstream trade value. The volume model discussed in the next sub-section aids our analysis on whether this is a volume or a price transmission impact.

- The relatively solid and significant relationship between trade value growth and the global economy is also important. A 1% increase in the global PPP GDP is associated with a 0.5% increase in global trade growth. While a positive relationship was expected, one could also have expected it to be bigger in magnitude, perhaps even exceeding parity. One of the underlying reasons for this might be that we are only looking at the downstream segment, which has had some of the direct volatility of upstream commodity prices removed. Moreover, the modelling applied is controlling for other drivers, for instance a considerable amount of the volatility in international trade value is explained by other variables, such as currency movements.

- The "Baltic dry index"[4] variable shows a positive relationship with the trade value variable. This is not surprising given that shipping costs need to be covered through the value of goods sold.

- The model also includes some frictional terms, suggesting that underlying movements in international trade do have a degree of persistence to them. This is likely taking place for process reasons, in that it takes time to ship goods across the world. Therefore, some of the observed trade movements are simply spill-overs from processes that started taking place

[4] Data on this was obtained through Macrobond

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in previous periods. These frictional terms should, however, not be thought of as fundamental variables.

The remaining variables in Table 1 need extra scrutiny, as these are most intimately tied to the question at hand, namely how operational frictions can be minimised. In order to achieve this, we have utilised two primary variables, the ISM Delivery PMI Index[5] for the US and World Bank Data on the total cost to import goods. In addition to this, we also experimented with other variables, such as World Bank cost export, time to export data, and various ISM PMI components.

In summary:

- As expected, there is a negative coefficient of -0.11 on the "cost to import" variable. This suggests that a 1% increase in import process costs is associated with a 0.11% decline in global trade value. It is however troubling that this term has a very weak level of significance within the model (25%). Nonetheless, this does give us an interesting (albeit weakly significant) benchmark of where Smart Ledger technology might be effective. If Smart Ledgers allow for frictions to be removed, such that 10% of the costs to import are eliminated, then that may be associated with a 1.1% increase in the value of global trade.

- It is also important to note that the ISM delivery PMI is both positive and significant. Given that this is, essentially, a supply chain proxy looking at delivery times, its interpretation is not wholly intuitive. One should note that this is a diffusion index, so it is already looking at the rate of change. A positive relationship with the index suggests that a deterioration in delivery times is associated with more global trade value. The reason for this could be two-fold. Firstly, delivery delays are associated with tight supply chains, which can drive up downstream commodity prices and, therefore, push up the actual value of goods sold. Secondly, tight supply chains might be signalling fairly rampant demand for certain goods, which would, also, increase trade, through the high level of goods actually consumed.

[5] As part of this research we used Macrobond data on the ISM PMIs as inputs for the models, we have not redistributed this information in any way.

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Overall, the model has a fit of approximately 80%, meaning that only 20% of the underlying variation in global trade value flows is unexplained. The overall model does, however, need to take into account the fact that some of the underlying variation could not be explained by the independent predictor variables. For this reason, two dummy (binary) variables were inserted to cover late 2008, an extraordinarily volatile period of time. Furthermore, the power of the modelling is also weakened by the limited granularity of the World Bank data dealing with the cost of imports. This is because the data had to be converted, from yearly to monthly frequency.

Trade Volume Model

While the global trade value variable may be interesting to look at, it does suffer from the fact that it is composed of two underlying drivers, namely volumes and prices. Movements in these may interact in ways that make it hard to isolate respective impacts that might affect prices and quantities.

Trade volumes are therefore, in a sense, simpler to look at and interpret because the price impacts have been stripped away. Furthermore, trade volumes describe real, physical activity. For instance, when the prices of goods fall, global trade values might also fall, even if the actual quality of global good flows remains robust.

Table 2: Econometric results from global trade volume model

Dependent Variable: PERCENT CHANGE IN WORLD TRADE VOLUME ***Sample: 2006M01 2014M12*** ***Variable***	***Coefficient***	***Prob.***
C	0.22	0.00
ISM_BACKLOG	0.03	0.00
ISM_DELIVERY	0.02	0.00
@DURING("2008m11 2009m1")	-4.65	0.00
@PC(BALTIC_DRY_INDEX(-2))	0.01	0.00
@MONTH=1	0.40	0.00
@PC(COST_TO_IMPORT)	-0.24	0.01
FRCITIONAL TERMS		
R-squared	**0.72**	
Adjusted R-squared	**0.69**	

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Looking at global trade volumes does, of course, have a number of limitations. Firstly, the volumes have less translatable relevance to the economic value added. Even if the physical flow of goods is still robust, lower prices will result in a lower economic contribution. Secondly, whereas a fall in prices can lead to lower values for economic contribution, the impact on volumes can be exactly the opposite if the lower prices lead to more physical consumption.

Putting together a model of similar fit, as part of this exercise, has proved to be a challenging task, despite the fact that trade volumes are simpler to conceptualise. For instance, the trade volume model shown in Table 2 has an overall fit of approximately 70%, which means that 30% of the variation remains unexplained.

As with the value model, we have stripped out upstream impacts and, once again, the model shows a number of interesting results:

- Despite the strong relationship observed between downstream trade value and trade weighted dollar strength, no such relationship could be seen between trade values and related volumes. This would suggest that the previously negative relationship between the dollar and trade values is more likely due to the impact on prices, rather than volumes.

- The “Baltic dry index” variable shows a positive relationship with the “trade volume” variable. This is not surprising, given that a period of high global demand could result in an uplift in shipping rates. It is also interesting that the magnitude of the impact on trade volumes is the same as on trade value.

- As with trade values, the volume model also includes some frictional terms, suggesting that the underlying movements in international trade do have a degree of persistence to them. This is most likely due to logistics; it takes time to ship goods around the world.

- Therefore, some of the observed trade movements are spill-overs from processes that started taking place in prior periods. These frictional terms should not be thought of as fundamental variables, but should still be considered, as they may contain lessons for the future. For example,

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improved logistics and more technological advancements across supply chains may well reduce frictions in the future.

The remaining variables also need extra scrutiny, as they are intimately tied into the question of how operational frictions can be minimised. In order to achieve this, we have utilised three primary variables, namely the ISM Delivery, Backlog PMIs (both for the US), and World Bank Data on the total cost to import goods.

In summary:

- As expected, there is a negative coefficient of -0.24 on the "cost to import" variable. This suggests that a 1% increase in import process costs is associated with a 0.24% decline in global trade value. This term is considerably significant in the specified equation (around 1%) and, also, displays more than double the elasticity compared to the trade value variable. In short, trade volumes are more sensitive to import costs than trade values. Although the sign of the coefficient is the same, the difference might be due to higher costs to import being passed onto consumers through higher prices. Therefore, volumes are more elastic, because of the price offset in values. The implications of the above findings are considerable for our analysis. If Smart Ledgers allow for frictions to be removed, so that 10% of the costs to import are eliminated, a 2.4% increase in the volume of global trade may be witnessed.

- It is also interesting to note that the ISM delivery and backlog PMIs are both positive and significant. Given that these are essentially supply chain proxies, looking at delivery and order times, the interpretation is not evident. One should note that this is a diffusion index, so in a sense, it is already looking at the rate of change. A positive relationship with the index suggests that a deterioration in delivery times and increasing backlogs are associated with more global trade volumes. The fact that we are looking at volumes somewhat simplifies the analysis to a demand-side development. We are seeing tightness in supply chains faced with demand side pressures associated with higher trade volumes.

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4. Building The Economic Impacts

Having recognised the theoretical economic sensitivities associated with trade frictions, the next step is to refine the analysis further, in order to establish how much of the total impact could be realisable through Smart Ledgers. This exercise in itself is fraught with difficulty, owing to the fact that the technology is still at an early stage of development and an even earlier stage of adoption. While Cebr has tried to be prudent in putting together the assumptions below, these are still very tentative, owing to the highly theoretical question at hand.

In formulating these assumptions, we used the basic principles and methodology of an existing Smart Ledger system, namely Fast Track Trade in Singapore, which has become the basis for a central assumption that MDL systems could allow for a clawback of 2.5% of the import costs[6].

A. Estimating The Trade Impacts

In order to augment the econometric results obtained in Section 3.1, we have created a model that produces the potentially realisable trade impacts associated with Smart Ledger solutions. With an initial cost clawback assumption of 2.5%, we have incorporated feedback from essDOCS, based on their own case studies of the realisable cost savings associated with having an automated and digitised solution to trade documents and paperwork. This assumption was also validated with Sweetbridge, based on their experience of the realisable cost savings.

These insights were used to create a benchmark of what a current automated solution can achieve. Smart Ledger systems cover automation, data integrity and elements such as identity checking. Therefore, the potential impact of Smart Ledger technologies should be seen to incorporate these, as well as additional features.

Meanwhile, the container import and export cost figures have been obtained from the World Bank. It is useful to consider these absolute numbers and the maximum achievable gains associated with an automated document solution. At present, the benchmark for document automation appears to exceed 5% of import costs. Even if we make an economic assumption that that Smart Ledgers

[6] Fast Track Trade uses Z/Yen's ChainZy Smart Ledger infrastructure. Z/Yen is a significant contributor to this report.

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would only remove an additional 2.5% from the costs of imports (owing to the impact of other elements such as trust, data integrity, and information sharing) the magnitude of yearly trade value impacts is still relatively high, in the range of $35 billion.

However, this figure could easily be higher, especially when considering case studies looking at containerisation and the magnitude of efficiency gains in extra trade realised there. For instance, if a 5% cost reduction had been assumed through Smart Ledgers, the efficiency gains could have risen close to $70 billion. A bolder assumption, with more symmetry between the savings on imports and exports, would have a global impact on trade value of up to $140 billion.

We estimate that the UK's potential share of the approximate $35 billion global trade impact could be around the $1 billion mark.

Table 3: Assumptions and impact summary

	2014 Baseline
Estimated value per container (USD)	30,770
Assumed B/L per container	1
Assumed L/C per Container	1
B/L+ L/C savings possible (USD)	100
Cost to import per container (USD WB data)	1,877
Cost to export per container (USD WB data)	1,560
Total cost to import & export (USD)	3,437
Cost to import - percent of container value	6.10%
Cost to export - percent of container value	5.07%
BL + LoC as % of import costs	5.33%
BL + LoC as % of import and export costs	2.91%
Additional assumed gains from Smart Ledgers	2.5%
Total potential economic impact (USD)	**34.75 bn**

In terms of scrutinising the aforementioned impacts, a key question concerns the assumption that 2.5% of the import costs can be clawed back, an assumption partly based on the presupposition that Smart Ledger technology can help iron out trade frictions, improve transparency and security to build confidence, and eliminate some of the systemic problems associated with international trade. In order to understand the wider context, it is important to make clear that the

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impacts include the elimination of frictions on overall trade, as well the effect on the volatility of trade.

It looks as though Smart Ledgers are set to provide a boost to trade, as a consequence of frictions being eliminated. Indeed, Smart Ledgers have to also be considered as a means to reduce volatility. This is discussed more extensively in the next sub-section.

In relation to the 2.5% clawback assumption, all of the evidence suggests that it is not only achievable, but quite conservative.

- In simple magnitudinal terms, the clawback is a conservative economic assumption based on previous experience. Savings should be realisable as a result of process and efficiency improvement. Such improvements are consistent with prior Cebr experience with process and profitability improvements.

- Cebr has compared the 2.5% assumption to the efficiency savings of technological solutions provided by platforms such as essDOCS. The essDOCS solution digitises the creation, approval, and exchange of electronic copies original documents. While the scope of Smart Ledger technology is somewhat different to this, we have used the estimated essDOCS savings as a relevant technological comparator. Based on essDOCS figures and case studies, we have estimated that such a solution may result in import cost savings of around 5%. With this ceiling impact in mind, the assumption that 2.5% of the import costs may be clawed back appears to be relatively conservative.

- We have looked at a historic comparator for added insight, namely the impact of containerisation on world trade. An examination of a November 2013 paper called, "Estimating the effects of the container revolution on international trade"[7] , revealed the following:

    - Technology and tariff liberalisation contributed to trade increasing from $0.45 trillion in the early 1960s to $3.4 trillion in 1990 – **a**

[7] http://eprints.nottingham.ac.uk/30487/1/BEK_Aug_2015%20JIE%20Aug%2031%20main%20text%20submit.pdf

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factor of 7. This is important to consider, especially in light of the through-process mapped out earlier, describing blockchain as a type of non-tariff liberalisation process.

- Growth in world trade occurred during a period of increasing technology and liberalisation of tariffs, through the General Agreement on Tariffs and Trade (GATT) legal agreement, between many countries, whose overall purpose was to promote international trade by reducing or eliminating trade barriers such as tariffs or quotas. In addition, a 1972 study by McKinsey and Company looking at the pre-and-post containerisation performance metrics is useful and summarised in Table 4 below[8]:

Table 4: Effects of containerisation (UK/Europe)

	Pre-container: 1965	Container: 1970/71
Productivity of dock labour	1.7 (tons per hour)	30 (tons per hour)
Average ship size (GRT is gross registered tonnage, a ship's total internal volume expressed in "register tons", each of which is equal to 100 cubic feet (2.83 m3))	8.4 (average GRT)	19.7 (average GRT)
Port concentration (number of European loading port, southbound Australia)	11 ports	3 ports
Insurance costs (Australia-Europe trade for imports)	£0.24 per ton	£0.04 per ton
Capital locked up as inventory in transit (Route: Hamburg-Sydney)	£2 per ton	£1 per ton

[8] Reproduced from - http://eprints.nottingham.ac.uk/30487/1/BEK_Aug_2015%20JIE%20Aug%2031%20main%20text%20submit.pdf

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- The research estimates that, for North-North trade, the "cumulative average treatment effect" of containerisation came to around 500% over a 15-year period. When all countries are considered, the effect is approximately 370%.

- Impacts of containerisation are also seen to be considerably bigger than trade policy. For instance, the cumulative impact of a free trade agreement only provides an approximate 60% boost to trade. The cumulative effect of GATT membership is 101%.

- The magnitude of these impacts suggests that the 2.5% cost clawback assumption is indeed prudent, given that a 10% decrease in costs is only expected to result in an approx. 1.1% increase in world trade value.

- Looking more into the containerisation developments detailed above – we also compared the headline assumption with a Cepr study entitled, "Containers and globalisation; Estimating the cost structure of maritime shipping", according to which

  > *"For the distance between China and the US – the countries with the largest trade flow in the world, cost savings from containerisation reach 22%. For the distance between Germany and the US, the cost savings are estimated to be 19.5%."*[9]

  On a cost basis therefore, containerisation represents a very significant advantage over bulk cargo transport. The study shows that, for distances exceeding 100km, containerisation exhibits a greater, and increasing efficiency advantage over cargo shipping. Amid these considerable efficiency gains associated with a previous technological disruption, the 2.5% assumption modelled above appears conservative in nature.

[9] https://voxeu.org/article/containers-and-globalisation

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- We, also, have anecdotal case study evidence of the potential economic impacts of blockchain technology on the specific issue of trade. While the evidence is not empirically rigorous, it does provide us with a useful check on the headline, 2.5% assumption made in the above modelling. In September 2016, Reuters reported[10] that Barclays and an Israeli-based company had carried out a trade transaction that would have usually taken up to ten days to complete, in only four hours, using a blockchain-based process. While translating time savings into monetary terms is tricky, we believe it is reasonable to assume that a 2.5% reduction in trade costs is achievable.

B. Option Valuation Framework

Background

As part of this research, Cebr also looked the value of Smart Ledger technology from an option pricing point of view. The fundamental idea is that a financial option pricing framework can be used to estimate the value of Smart Ledgers, if the technology is able to drive a reduction in global trade volatility. The following assumptions were made as part of this exercise:

- The changes in the value of global trade are examined and evaluated on a monthly basis. We, also, look at the option pricing on a monthly basis by limiting the maturity of a theoretical European option to one month. This is done in order to partly overcome the limitations of a European option pricing framework, such as Black-Scholes.
- The monthly percent changes in global trade value are assumed to be normally distributed. This has not been robustly interrogated, but simply treated as a high-level assumption. Nonetheless, it is useful to consider the below histogram. It shows an approximately normal distribution pattern, which could asymptotically tend towards normality over a large enough sample.

[10] https://www.reuters.com/article/us-banks-barclays-blockchain/barclays-says-conducts-first-blockchain-based-trade-finance-deal-idUSKCN11D23B

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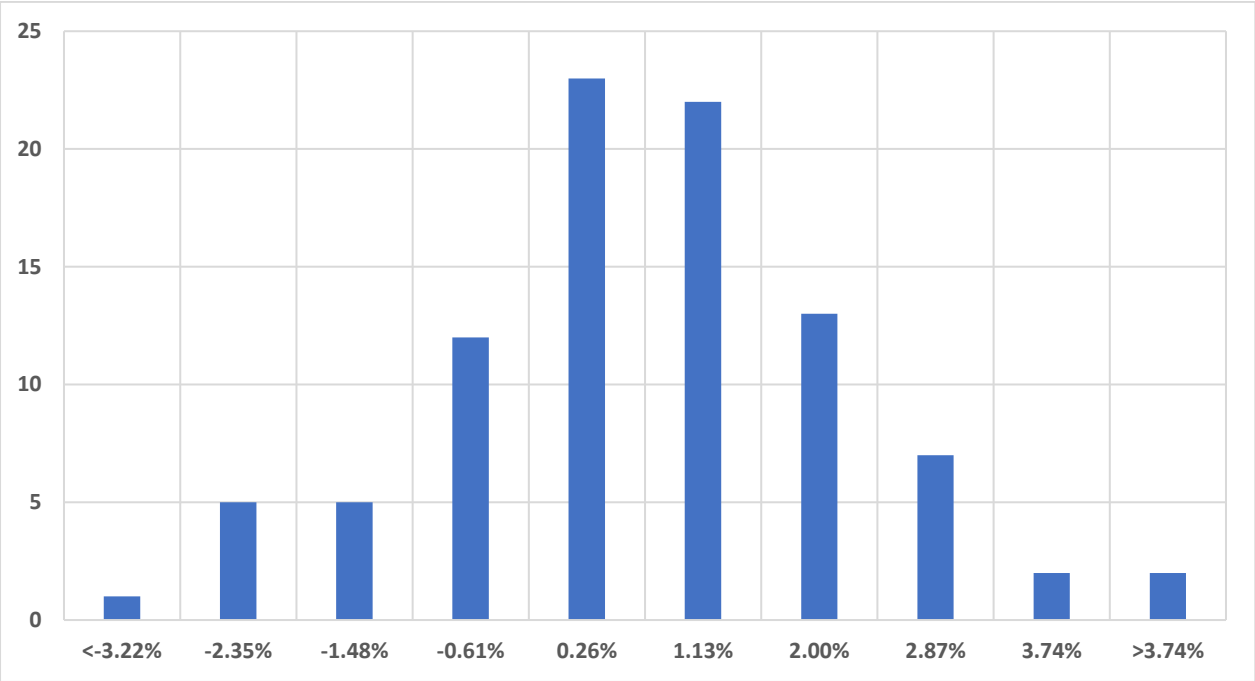
Figure 7: Frequency histogram of the percent changes in global trade value into evenly spaced bins corresponding to the range of the sample from 2010 onwards



- In order to minimise the possibility of structural changes and outliers in the data distorting the findings, we have confined the sample to the post 2010 period. This has the benefit of only considering the post-financial crisis period.

- The Black-Scholes option pricing framework relies on additional assumptions, in addition to the normality distribution issue discussed above: no dividends are payable by the underlying asset during its lifetime; markets are information efficient; there are not transaction costs associated with the option; volatility and the risk free rate is constant during the option's lifetime.

- As with financial asset pricing, these assumptions are not perfectly matched to the case above. The question of dividend payments is not directly applicable to trade flows and, therefore, this assumption is easy to rationalise. Similarly, we can rationalise the risk-free rate assumption, due to the very short maturity of the theoretical option. However, the frictional cost question is more difficult to assume away, given that Smart Ledger systems do, actually, entail implementation costs and investment.

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> Perhaps the greatest limitation to the framework sits with the information efficiency assumption. As shown in the previous modelling section, trade value flows are highly frictional and prior period movements consistently spill over into the following periods. Indeed, if this were a financial market, one could conceivably predict some of the market movements through previous periods, which would suggest that markets only display weak-for efficiency, as per the Efficient Markets Hypothesis.

It is, also, important to clarify what the option pricing framework is seeking to achieve. Simply put, the goal is to value the potential impact of Smart Ledgers on world trade **specifically due to its ability to reduce trade volatility**. The starting point in this subsection is that the trade frictions discussed earlier, (which Smart Ledger technology can help address) can also be expressed as a reduction in trade volatility.

In a world of information asymmetries, relationships between counterparties often need to be bridged through social improvisation and sheer peer-to-peer trust, which is inherently fragile. With these imperfections in mind, international trade can and does take place, but does so in a constrained manner, subject to frictions.

The implications of these frictions can be considerable. In an economically and financially stressed situation, improvised trust-based relationships can break down. For instance, if prices fall and put margins under pressure, the incentives for 'trusted' supply chain partners to cheat become greater and the need for monitoring solutions increases. Similarly, trade-finance based relationships may also come under strain in times of economic volatility, resulting in credit being rationed further and deals being aborted.

Furthermore, one should consider the quasi-institutional argument. If Smart Ledger solutions are able to fulfil institutional gaps in trade, this might itself reduce volatility. For instance, foreign governments may, at times, be driven by political pressures to increase non-tariff barriers, such as increasing the amount of paperwork or bureaucratic hurdles to trade. This means that, aside from the economic and associated frictional volatility, there is an additional political level of volatility observed in international trade flows. Smart Ledger solutions may indeed help to ameliorate this, especially if they result in complicated and convoluted administrative processes to be automated and easily adaptable to changes.

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These aforementioned frictions may contribute in exacerbating the volatility in trade. Some of this may, indeed, be causing international trade to be more volatile than GDP growth, as seen in Figure 2. This insight is useful in terms of pricing the option value of Smart Ledgers, based on their volatility reduction properties. We have, therefore, applied a Black-Scholes option pricing framework, subject to the following parameters that seek to only capture the volatility reduction properties of the underlying technology.

Table 5: Black-Scholes assumptions applied trade volatility [11]

Assumption 1	The option lifespan will only be set at one month. This is done in order to match the option maturity with the frequency of the data and minimise the time value distortion associated with European options only being exercisable at maturity.
Assumption 2	The option is modelled using the assumption that it has zero intrinsic value. The option strike price is set at the same level as the average expected price. The notion of a price is quite abstract in the current context, as we are modelling trade value as opposed to a specific asset. Setting the intrinsic value at zero is important for this kind of valuation, as the remaining residual value of the option mostly captures the likelihood or probability that the option will end up being "in the money" at some future time period. The likelihood of ending up "in the money" with a positive intrinsic value is, in turn, driven by the distributional parameters that go into the option pricing model, such as the underlying asset's volatility.
Assumption 3	As part of this modelling exercise, we have varied the risk-free rate. Given that we are valuing a process as opposed to an asset, the notion of a risk-free rate is difficult to conceptualise. It could arguably be set to zero, but we have, also, modelled a few other scenarios, where it is greater than zero. In support of it being close to zero, one could argue that it reflects the short time to maturity of the option, being only at one month, over which period of time the risk-free rate will be, in any case,

[11] These are supplementary assumptions that go over and above the usual assumptions that constrain the interpretation of the Black-Scholes model

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	very modest. Secondly, since 2010, the world economy has experienced very low interest rates, reflecting extreme monetary accommodation at times, which, again, minimises the impact of a risk-free rate.
Assumption 4	It is not conceptually clear that a "risk-free" rate is applicable to global trade value flows. While it is important in the realm of investment finance, as a benchmark on which the risk-reward relationship takes place, its relevance to trade value flows is ambiguous. One may assume that a "benchmark trend" variable exists to reflect inflation, but there are similar long-term technological trends in many commodity markets that lower the price of commodities and manufacturing over time.
Assumption 5	MDL and Smart Ledger technology should not just be seen as a black box solution that wipes out volatility. The power of the technology is also capped in terms of the achievable volatility reductions. In this case, we have assumed that one could reduce the **volatility in global trade value by 1%.** This is a conservative assumption in relative terms, but we have also drawn parallels below with research on the role of institutions in reducing volatility.

Validating The 1% Volatility Assumption

It is useful to compare our thinking with the results of a 2007 paper entitled, "International Institutions and the Volatility of International Trade" [12]. The conceptual link between this paper and the overall framework of Smart Ledger technology, essentially, rests on how well Smart Ledger technology can replicate or address institutional deficits in international trade. For instance, more advanced trade agreements and frameworks may have institutional pillars that, among other things, tackle concerns such as:

- The enforcement of property rights

[12] http://citeseerx.ist.psu.edu/messages/downloadsexceeded.html

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- The enforcement of minimum labour standards
- The enforcement of basic standards of welfare and human rights
- Rule of law, relating to issues such as identity fraud and deceit
- Mechanisms for dealing with disputes
- The mutual recognition of standards
- The transparency of rules and processes for each market

The 2007 paper makes a number of relevant observations, including:

- *"If trade agreements do indeed reduce volatility, then they should correspondingly increase the amount of trade conducted among the contracting parties as well."*

- *"This indirect effect of trade agreements on the flow of overseas commerce stands apart from any direct effect of the agreements on trade flows stemming from member-states' expanded access to foreign markets. In fact, this indirect effect is likely to be important even if agreements lock in rather than cut members' trade barriers."*

- *"Our results therefore indicate that a critical function of preferential and multilateral trade agreements is to make trade policy and flows more predictable."*

- *"Our argument is that international institutions can play a similar role, reducing the volatility stimulated by heightened economic integration… More specifically, trade institutions help stabilize trade policy and trade flows. Indeed, they help states lock in access to overseas markets even if they do not always lead member-countries to decrease trade barriers. This argument is hardly new, although it has been largely ignored."*

- *"Preferential trading arrangements also aim to reduce the volatility of trade policies and the flow of overseas commerce between members."*

Furthermore, the paper goes on to establish a conceptual framework, through which trade institutions are assumed to reduce the volatility of international trade in three main ways:

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1. Helping to enforce existing market access commitments and deterring the erection of new barriers.

2. Fostering transparency and policy convergence.

3. Altering the characteristics and dynamics of markets, leading to responses by traders that reduce the volatility of trade flows.

These three points touch on the prior, intuitive explanation of why Smart Ledgers might have option value in terms of their ability to reduce the trade volatility. The next layer of the analysis is to establish the actual volatility reduction properties of Smart Ledger technology and determine whether our 1% assumption has an empirical basis. The empirical results of the study are as follows:

- Preferential Trade Agreements and the General Agreement on Tariffs and Trade (GATT) and its successor, the World Trade Organisation (WTO), were observed to lead to a decline in the volatility of exports, at a statistically significant level.

- On an unconditional basis, the addition of the Preferential Trade Access (PTA) and WTO/GATT institutional pillars was shown to decrease trade value volatility, though the actual range of reductions varied significantly between 14% and 76%.

- On an unconditional basis, the PTA terms reduced volatility by up to 35%, compared to a no agreement benchmark.

- On an unconditional basis, the GATT term itself reduced volatility by up to 35%, compared to a no agreement benchmark.

- The more specific, conditional variance shows smaller reductions in volatility – though this still represents a significant reduction. The impact of both the WTO and PTA institutional pillars comes to approximately 16%,

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compared to a no agreement benchmark. The GATT/WTO term by itself reaches approximately 12.3%, while the PTA term by itself comes to 6%.

While it is important to mention that Smart Ledgers cannot offer a complete solution to institutional deficits that characterise international trade, the institutional volatility magnitudes are very useful to consider as upper bounds. Backing up our central conservative assumption that 1% of current trade volatility may be eliminated, is also helpful. Indeed, based on the study above, one could make much bolder assumptions on the volatility reduction properties of Smart Ledgers – far exceeding our 1% benchmark case.

Option Model Results

The model's end result is that a 1% reduction in global trade value volatility would achieve an option-related value of approximately £86 million per month, assuming a zero risk-free rate. This is the symmetrical price of a call or put option. A more detailed summary of the results under different risk-free rate scenarios is provided below.

Table 6: Analysis of option valuation

Risk Free Rate	Assumed Volatility Reduction	Call Value (£)	Put Value (£)	Combined Value (£)
0%	1%	86.2mn	86.2mn	172.4mn
0.1%	1%	157.4mn	39.9mn	197.3mn
0.5%	1%	587.0mn	0.2mn	587.3mn
1%	1%	1,172.2mn	0	1,172.2mn

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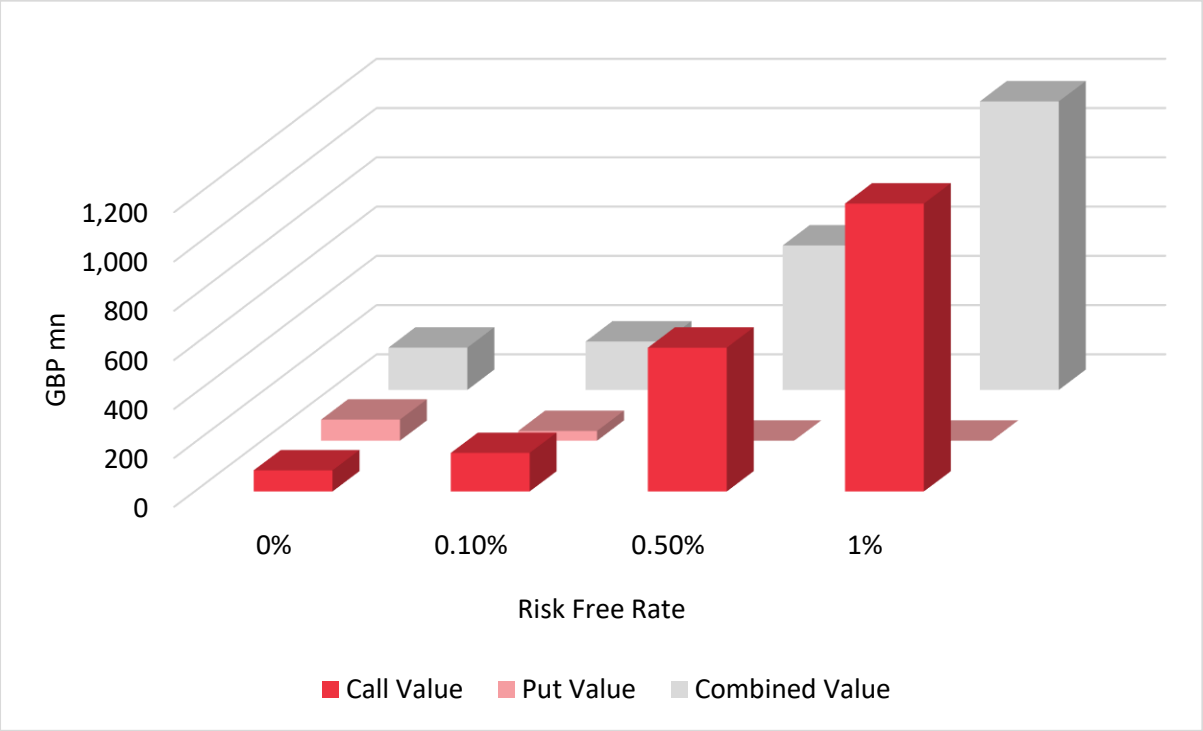
Figure 8: Analysis in graphical form



One of the main difficulties encountered in this analysis, is practical interpretation. One complication is that put or call options will each have values that place greater emphasis on downside or upside volatility respectively, owing to the type of protection provided by the theoretical instruments. For instance, given that a put option protects against downside risk, the option has more value exposure to downside risk, than it does to upside volatility. The converse is true for a call option, whose value is more exposed to upside volatility than it is to downside volatility.

With this is mind, the £86 million (zero risk-free rate) volatility reduction value of these options is, likely, to reflect only half of the expected overall volatility exposure. Capturing the overall volatility reduction potential of Smart Ledgers would, therefore, entail adding the value of the theoretical put and call options (which takes the potential monthly savings to approximately £172 million) under the assumptions producing valuation symmetry in the zero-risk free case. The valuation measures do end up being increasingly asymmetric as the risk-free rate parameter is increased.

Whether one uses the partial or cumulative figures depends on how one looks at the problem at hand. For instance, in operational terms, much of the

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emphasis on reducing risk and volatility focuses on a symmetric scenario, whereby both upside and downside volatility is seen to be a negative.

In the context of global trade value flows, while downside volatility is perceived to be bad for global growth and prosperity, the negative implications of upside volatility are not as straightforward. Upside volatility does have some potentially negative implications, such as producing higher input costs that drive higher inflation. High commodity prices could, also, be associated with tight supply chains and operational stress. Upside volatility is, also, congruent with more value being transacted globally, as well as the fact that higher value flows are often associated with higher global aggregate demand for goods and services.

C. Estimating The Overall Economic Impacts

While we have been able to use the previous modelling results to produce a conservative measure of the potential impact of Smart Ledgers on global trade, this, only, covers one part of global economic impact. As mentioned at the beginning of the report, international trade provides a net stimulus to the global economy through the efficiency gains associated with scope and scale. In the section below, we have tried to estimate these impacts using a secondary econometric model, that links GDP growth to trade openness, measured through the value of trade.

Due to data limitations and model specificity, the starting point of the analysis itself was the UK economy. Cebr constructed two models that linked UK GDP to trade, as a way of expanding the transmission impacts of relative trade flows onto GDP. These coefficients were then applied on a global level. We also adjusted the coefficients to reflect the fact that the UK model is based on trade in goods and services, in addition to reflecting total trade (UK imports + exports), as opposed to global trade flows, where imports must necessarily be equal to exports.

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Table 7: Relative Impacts on UK GDP – Model 1

Independent Drivers	Coefficient	Prob.
Trade value	0.325	-
Real crude oil	0.167	0.000
M1 money supply	0.061	0.000
Constant	15.582	-

Table 8: Relative Impacts on UK GDP – Model 2

Independent Drivers	Coefficient	Prob.
Trade openness	0.455	-
Real crude oil	-0.014	0.014
M1 money supply	0.042	0.013
Constant	14.373	-

We have extrapolated a potential global GDP gain in the range of $10-20 billion. The lower bound of this figure has been driven by the same conservative assumptions previously discussed in the trade value models and relating to the cost clawback that feeds into global trade value, which then feeds into global GDP. The high end of the range below projects a double impact that could, more aggressively, result from an assumed symmetry between the value impacts on both imports and exports. The larger coefficient itself was computed on the basis of gross trade flows (imports + exports), as projected by the original UK model.

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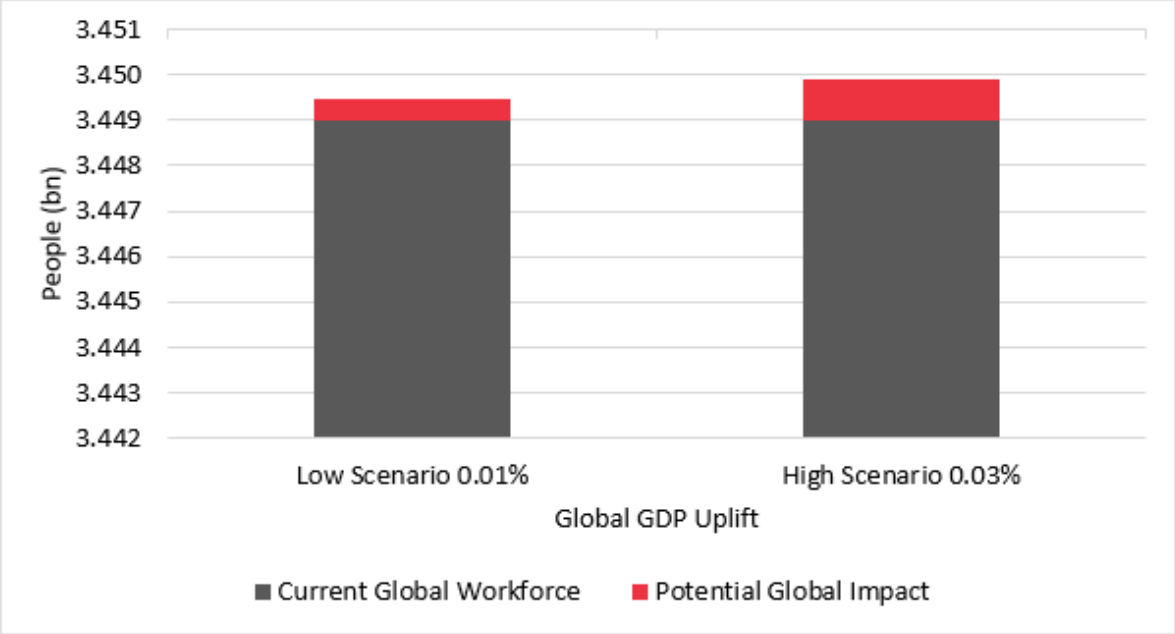
Table 9: Summary of global economic impact

	USD GDP Uplift (USD bn)	Current Global Workforce	Current Global GDP (USD bn)	Potential Global GDP Uplift	Potential global labour market impact
Low scenario	10.33	3.5bn	79,281	0.013%	449,319
High scenario	20.66	3.5bn	79,281	0.026%	898,639

Figure 9: Summary of global economic impact in graphical form



While the global results may be complicated by economic heterogeneity, it is less controversial to compute the UK impact for reference. On a UK wide basis, the potential Smart Ledger impact is in the range of £400 to £800 million, as shown in Table 10. However, this impact is computed based on empirical data, which is premised on the UK's current trade relationships.

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Table 10: Summary of UK economic impact

	UK GDP Uplift (GBP bn)	Current UK Workforce	Current UK GDP (GBP bn)	Potential UK GDP Uplift	Potential labour market impact
Low scenario	0.39	32.2mn	1960	0.02%	6,456
High scenario	0.79	32.2mn	1960	0.04%	12,911

As shown in Appendix 2, the UK-specific impacts of Smart Ledgers could end up being considerable, far exceeding the figures in the conclusion. Therefore, the figure above should be seen as a lower bound, in the case that the UK ends up in a situation where there are substantial trade barriers with the EU. The much higher economic impact of Smart Ledgers in that case will be due to their ability to reduce frictions and offset some of the economic damage that would otherwise occur.

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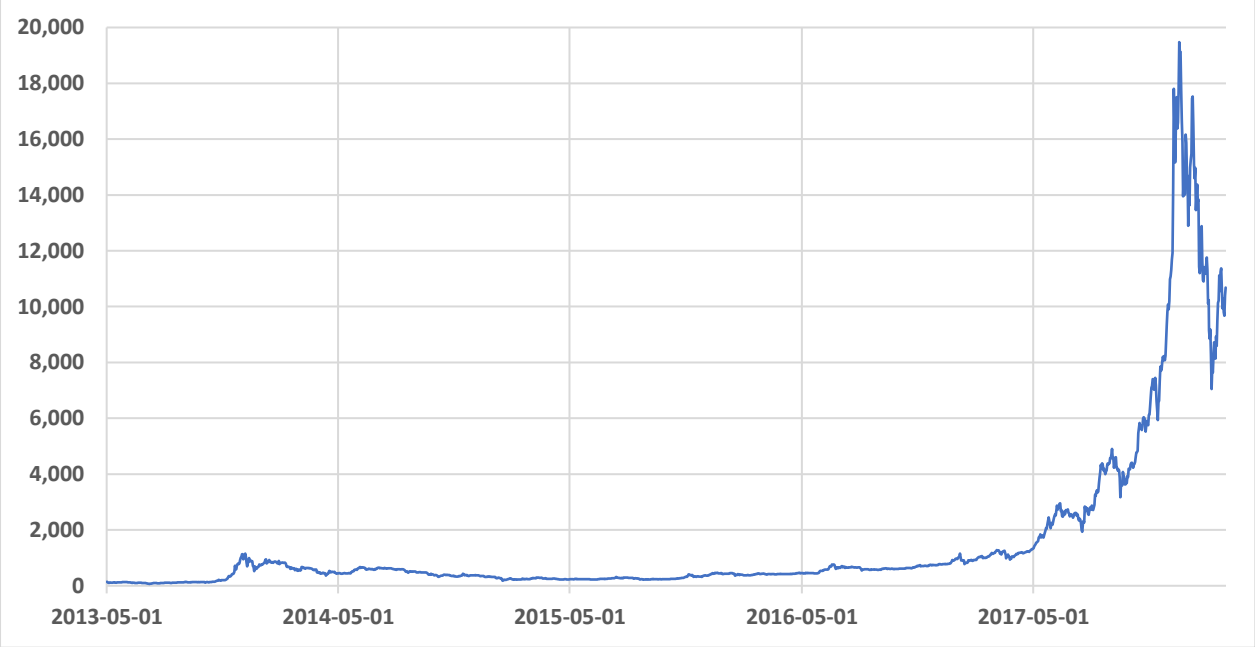
5. Further Applications Of Smart Ledger Technology

A. Beyond Cryptocurrencies

Interest in Smart Ledger technology is strongly associated with the price surges in Bitcoin and other cryptocurrencies throughout the course of 2017. This price association distracts from the wider application and benefits of Smart Ledgers. In fact, the recent Bitcoin developments may well turn out to be counterproductive if the associated bubble ends up tainting the associated technologies.

Figure 10: The price of Bitcoin ($/token)



Source: Coinmetrics

The cryptocurrency debate may be too narrow, focusing excessively on platforms, such as Bitcoin and Ethereum, as replacements for current fiat monetary systems. Taking a more nuanced view, cryptocurrencies should not be thought of as actual currencies in the first place.

Looking at the price trends and extraordinary levels of volatility, instruments such as Bitcoin and Ethereum could be better thought of as commodities, or even an alternative asset class. One could, also, argue that the extreme volatility seen in these currencies precludes them from offering a dependable store of value within any rational monetary system.

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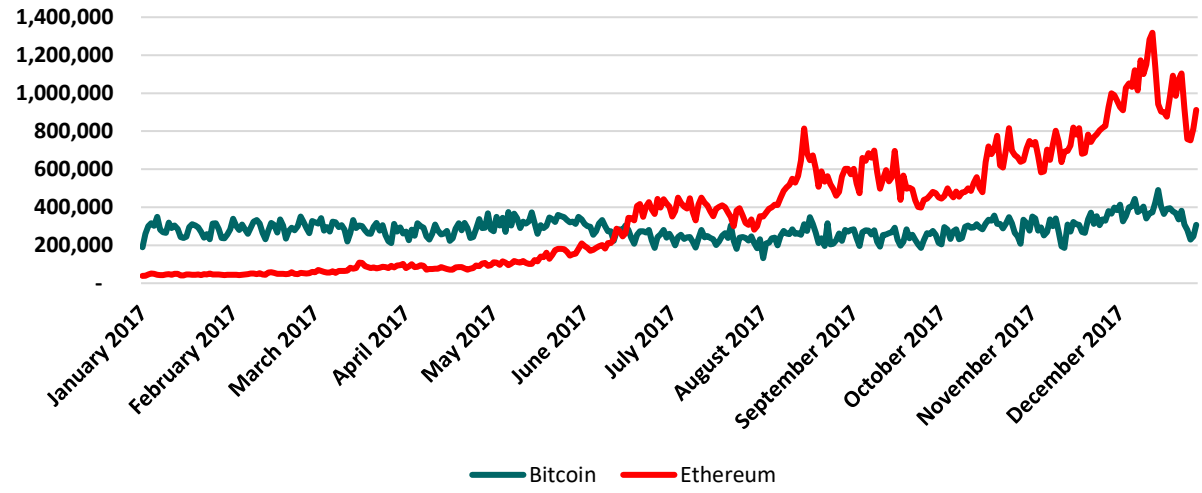
Figure 11: Number of Bitcoin and Ethereum daily transactions



Source: Coinmetrics

Nonetheless, the idea of utilising technological features of Smart Ledger technology as a replacement for aspects of physical cash transactions in the monetary system does have some economic grounding. Whilst keeping the current fiat framework intact, creating a digital fiat currency system could potentially help to curb illegal activities, since economic cash flows would be, effectively, traceable (as opposed to only deposit and credit bank balances today, as is currently the case).

B. Government Operations

The knowledge and information sharing features of blockchains and Smart Ledgers can, also, be an important lever in public policy. For instance, the government's information sharing of health records, import-export records, registrations, licenses, inspections, tax payment certificates, in fact records of all kinds with government, could be transformed. Many of these pieces of information are crucial to trade processes, e.g. certificates of origin. Operational savings could be realised through government processes more smoothly and reliably coordinating taxation, policing, national defence, and health resources. In turn, these operational improvements could go a long way to reducing some forms of current trade friction originating from government bureaucracy and

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inefficiency. The country of Estonia has taken action on many of these fronts, through the e-Law, e-Court, e-Police and e-Health platforms[13].

C. Internal Trade

While we have modelled the potential impact of Smart Ledger technology on international trade, it is, also, important to understand that the trade related applications of the technology are, also, relevant on a national basis. For example, national credit information systems or registries of mortgages and liens could be facilitated by the technology. Even within an integrated marketspace such as the UK or the broader EU, trade frictions continue to exist. International trade, as discussed in this report, is economically analogous with national trade, and national trade can, also, be improved through frictional reductions.

There are potential information lapses in terms of checking the integrity of the supply chain, verifying trade counterparties, and sharing information. This becomes extremely important, when considering that domestic economic flows are likely to significantly exceed external ones.

[13] https://e-estonia.com/solutions/security-and-safety/e-police

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Conclusions

This research report has explored the potential impact of Smart Ledgers on world trade. The impact has been measured through a number of different channels, ranging from the direct barrier reductions on trade, to volatility reductions. The report, also, outlines a potential global economic impact associated with Smart Ledger technologies.

The main conclusions of the research can be summarised as follows:

- Smart Ledgers could conservatively result in approximately $35 billion in extra global trade on an annual basis, based on a range of assumptions regarding the potential cost savings and the respective trade transmissions. If we were to assume that the import savings costs are symmetrically replicated in terms of export savings, the global trade boost could rise towards $70 billion per annum. If we were to be even bolder and assume that there was a symmetrical cost clawback on both imports and exports of 5%, as opposed to our 2.5% baseline assumption, then the value impacts could rise towards $140 billion.

- Within this research we adapted an option pricing model to show the potential gains associated with the volatility reduction properties of Smart Ledgers. We estimate that these savings could rise to approximately $172 million on a monthly basis. In linear terms, this comes to more than $2 billion per annum, just as a result of the volatility savings.

- A UK trade model was applied to the global economy, in order to estimate the potential uplift to the global economy associated with the removal of frictions that Smart Ledgers would allow. Through a process of scaling the UK impacts, the total projected global impact comes to at least $10 billion. If one assumes that both the cost of imports and the cost of exports can be symmetrically reduced, then the potential global economic impact could rise to approximately $20 billion. Furthermore, if the cost clawback is increased from 2.5% to 5%, the impact could be in the $40 billion range. The aforementioned ($10 to $20 billion) global economic impacts are, also, associated with approximately 450,000 to 900,000 additional jobs worldwide.

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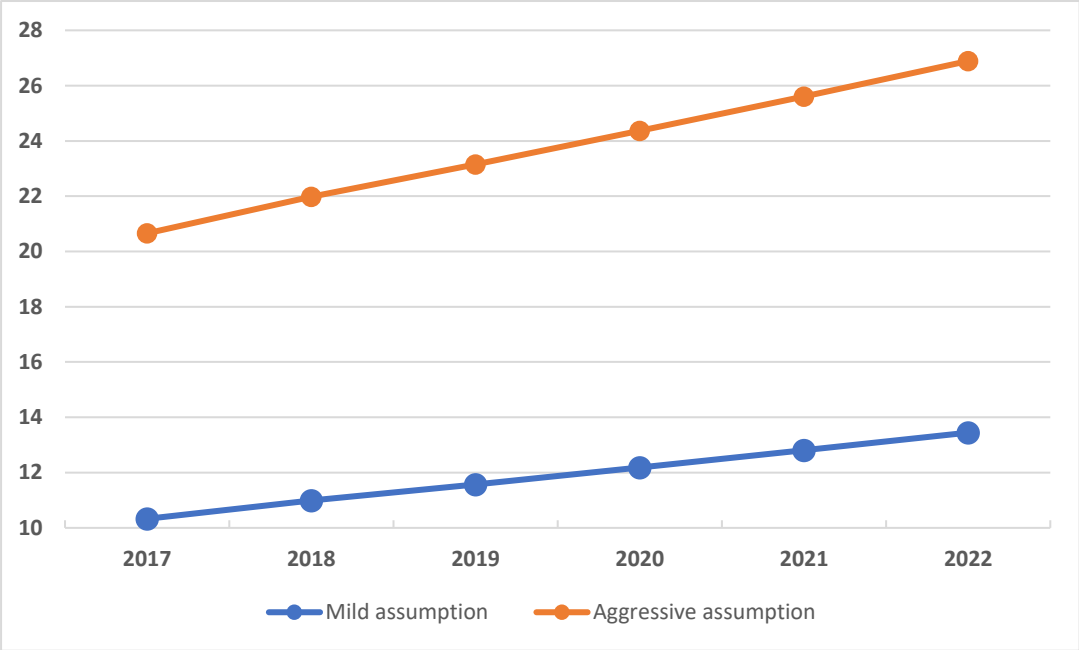
- The $10 to $20 billion of extra global GDP is also associated with $3 to $6 more gross domestic product per average global worker on an annual basis. This is a significant increase, especially when considering that many of the world's poorest people still live on less than $2 a day. Furthermore, over a ten-year period the cumulative global economic gains could reach $100 to $200 billion. When we apply the relative economic impacts for 2017 onto IMF forecasts for world GDP, the impacts are very positive, as shown in Figure 12, reaching the $13 to $27 billion range by 2022.

Figure 12: Forward projection of global economic impacts (USD bn)



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Appendix 1 - IACCM Survey Results

Established in 1999, The International Association for Contract & Commercial Management (IACCM) is a not for profit association that is dedicated to raising individual, organizational and institutional capabilities in contracting and commercial management, providing research, benchmarking, learning, certification and advisory services to a worldwide, cross-industry audience of practitioners, executives and government.

IACCM is a recognised global leader for driving innovation in trading relationships and thought leadership in commercial competencies and commercial models and is unique in its coverage of both buy-side and sell-side perspectives. Today IACCM represents over 45,000 members within more than 16,000 cross-industry organisations across 165 countries. 'Smart' fits in with IAACM's automation agenda, as well their improvement objectives. 'Ledgers' fits with IACCM's collaboration objective among its members.

In order to provide some colour from firms already involved in World Trade, and provide some food for thought alongside the findings of this report, we asked IACCM to survey its global membership, asking them the following Smart Ledger-related questions:

Question 1: Smart Ledger (aka blockchain or distributed ledger) technology is touted as a technology for fair play in a globalised world. It provides multi-organisational databases with solid audit trails that are useful for collaboration systems. Are you:

1) Unaware of this technology and these claims?
2) Sceptical that this technology would make much difference to contracting and trade?
3) Planning to trial this technology or collaborate with others on trialling it?
4) Or have you trialled this technology?
5) Using Smart Ledgers for operational purposes?

Question 2: There are a host of technologies with the potential to improve contracting and trade, particularly cross-border. Would you please rank, in order of importance?

1) Smart ledger (aka blockchain or distributed ledger) technology
2) Artificial intelligence using deep learning
3) Statistical techniques such as statistical learning theory

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4) Identity systems that streamline individual and corporate anti-money laundering and know-your-customer processes
5) Collaborative documentation platforms
6) Common data standards for trade documentation
7) Cheaper and faster payments systems
8) Micropayment systems

Question 3: There are a number of impediments to contracting and trade. Would you please rank in order of 'pain', i.e., overly onerous processes?

1) Contract 'onboarding', individual and corporate anti-money laundering and know-your-customer processes
2) Defining/negotiating the contract and supplier agreements
3) Credit information and validation
4) Government reporting and trade interaction, e.g. customs & excise and other taxes
5) Supporting documentation, e.g. certificates of insurance, import-export certificates
6) Making and validating payments
7) Contract execution and reporting
8) Contractual disputes

IACCM received responses from 247 of its members, of which 179 were from the top seven industry sectors, namely:

1) Engineering, Construction, and Real Estate
2) Legal
3) Oil, Gas, Minerals, and Utilities
4) Public Sector and Government
5) Services, Outsourcing, and Consulting
6) Technology and Software
7) Telecommunications

We have shown all the results below, highlighting the responses from those 179 in the top seven industry sectors ("top 7") as well as those from all 247 respondents ("all"). We have, also, provided a regional breakdown to highlight geographical differences.

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Location Of Respondents

There was a truly global response to the questions, although the majority came from companies based in Europe and North America.

Figure 13: Summary of geographic location - all

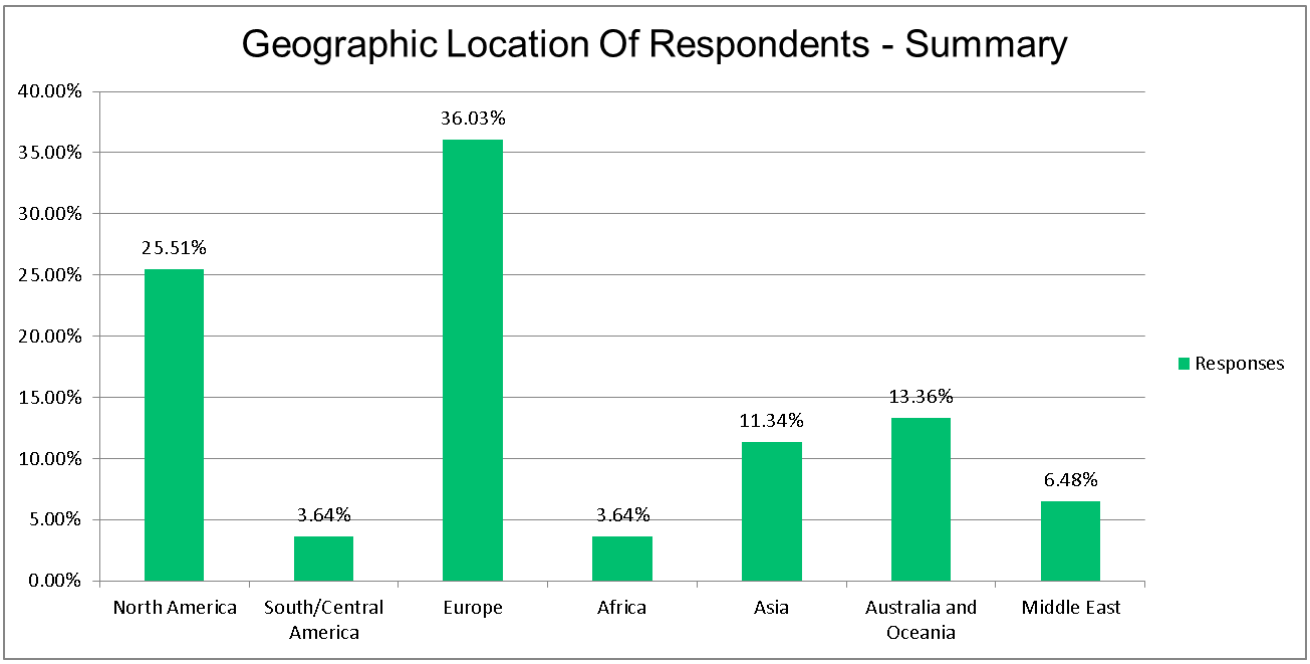

Figure 14: Geographic region of respondents - top 7 sectors

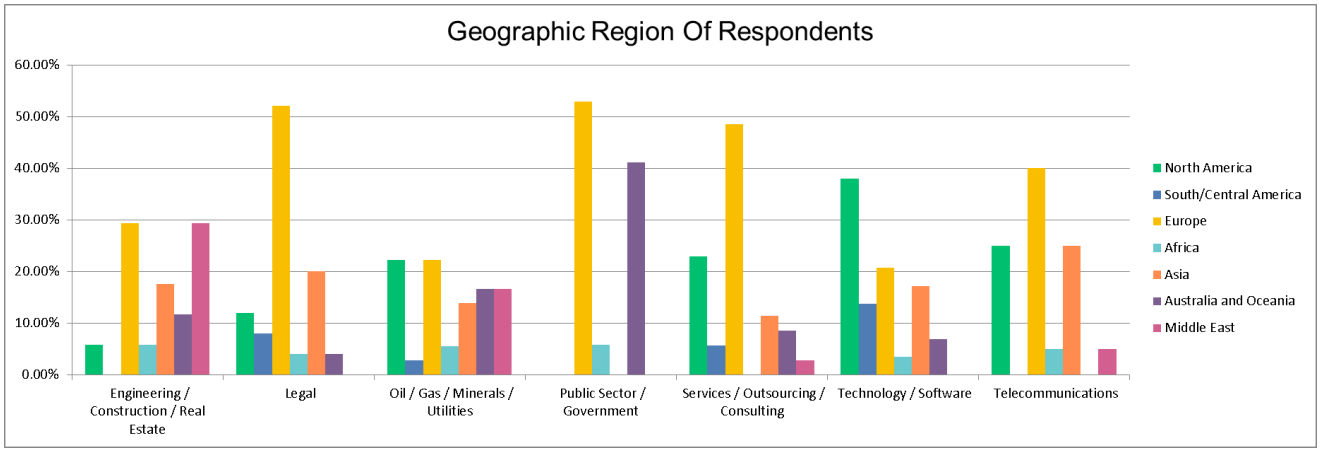

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Figure 15: Industry sectors – all respondents

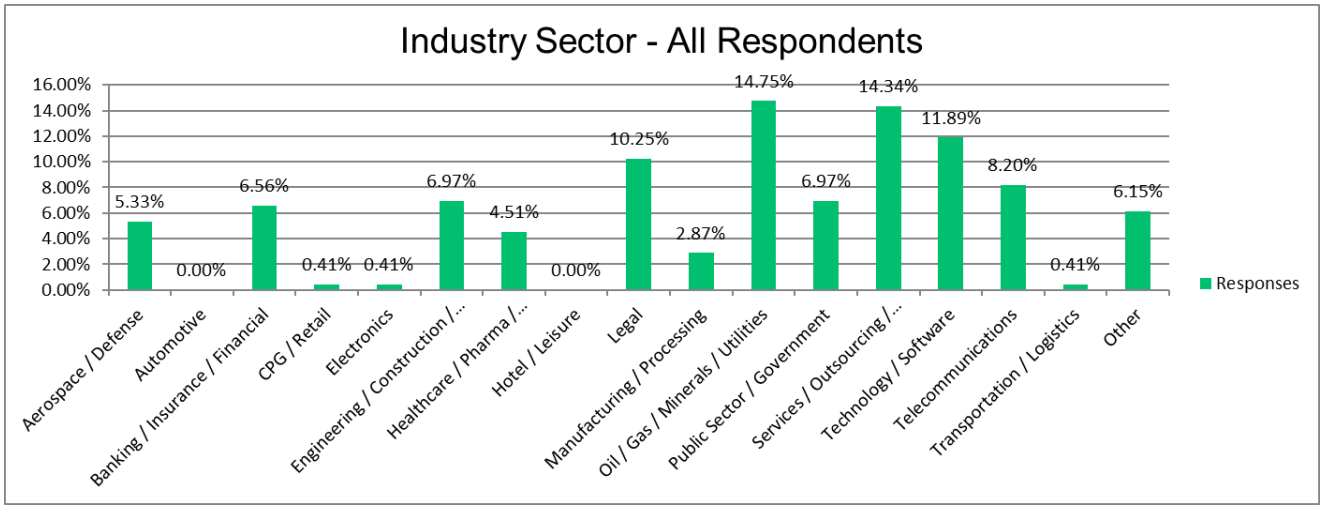

Figure 16: Industry sectors of respondents – all – by region

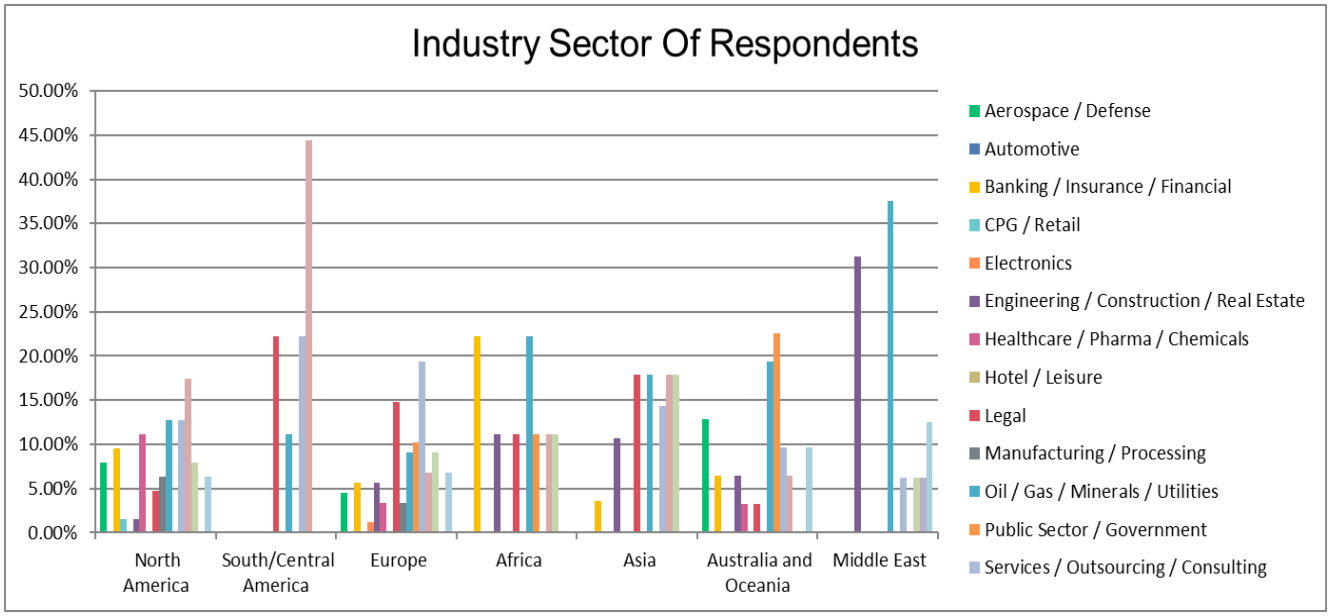

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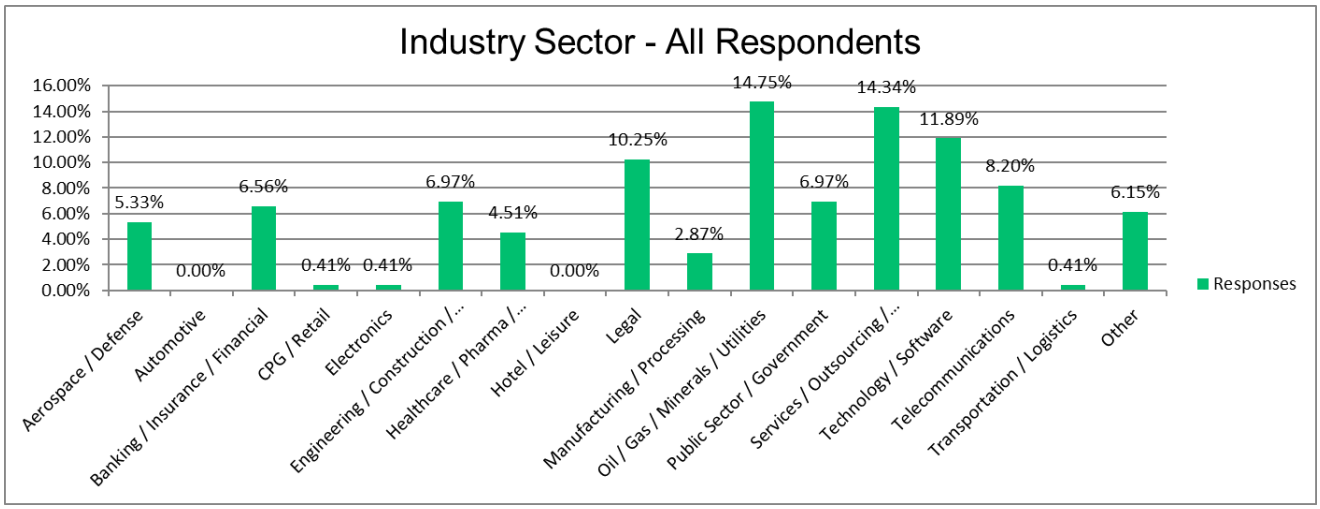
Figure 17: - Industry sectors – all respondents



Responses To Questions

Question 1: Smart Ledger (aka blockchain or distributed ledger) technology is touted as a technology for fair play in a globalised world. It provides multi-organisational databases with solid audit trails that are useful for collaboration systems. Are you:

1. Unaware of this technology and these claims?
2. Sceptical that this technology would make much difference to contracting and trade?
3. Planning to trial this technology or collaborate with others on trialling it?
4. Or have you trialled this technology?
5. Using Smart Ledgers for operational purposes?

While over 30% of respondents were unaware of this technology, and 25% were sceptical, it is perhaps encouraging to see that the highest percentage, over 36%, are planning trials or collaborations. This is balanced somewhat by the fact that only 3.33% are presently using.

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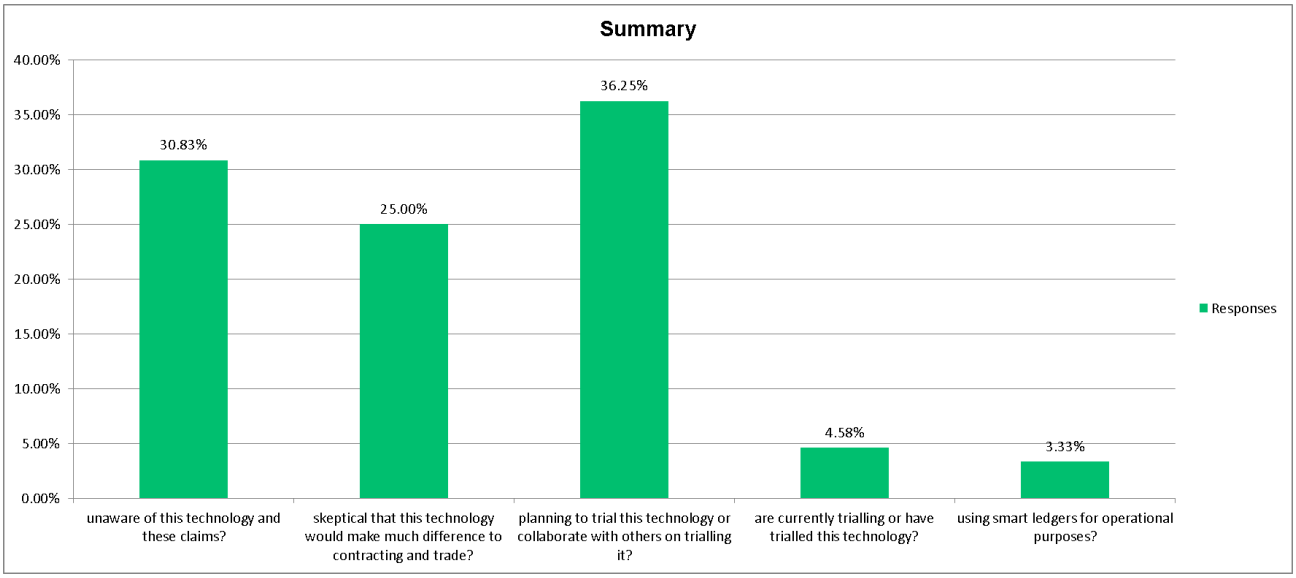
Figure 18: Summary of awareness, plans, use - all



Globally, there is a fairly even mix between firms that are unaware of the technology and, conversely, those that are planning to trial it. Across the various sectors, however, there are some subtle differences, such as:

- Technology firms are, perhaps obviously, far more likely (over 60%) to be trialling or collaborating with others.
- Higher degrees of scepticism in the 'Public Sector & Government' and 'Oil & Gas etc'.
- 10% of 'Engineering etc.' and Telecommunications firms are already using Smart Ledgers.
- Surprisingly perhaps, there is a significant percentage of plans in the Legal sector (over 50%).

Figure 19: Awareness, plans, use of respondents - top 7 sectors

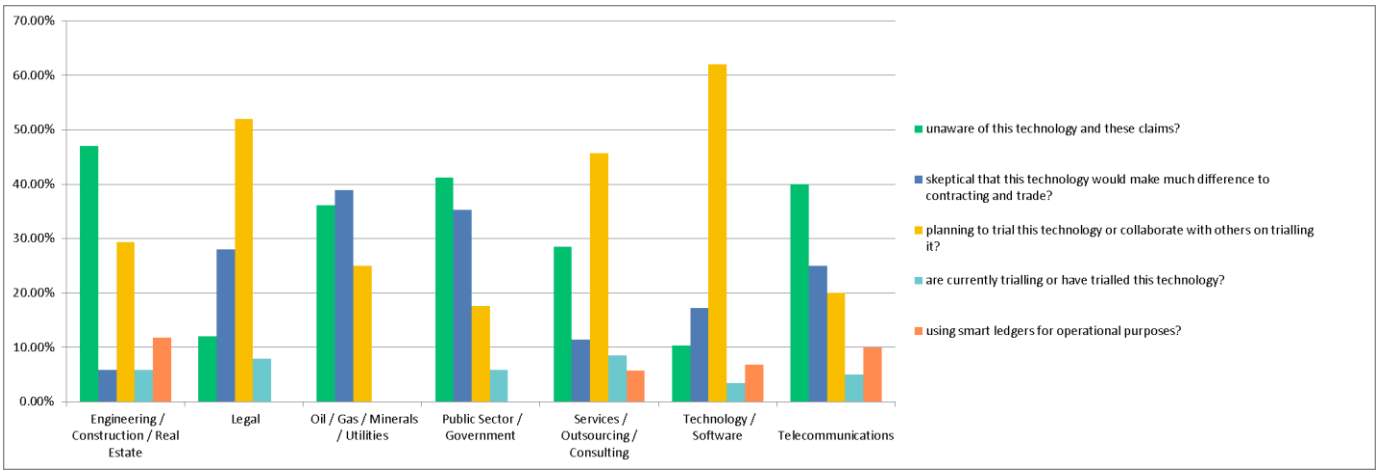


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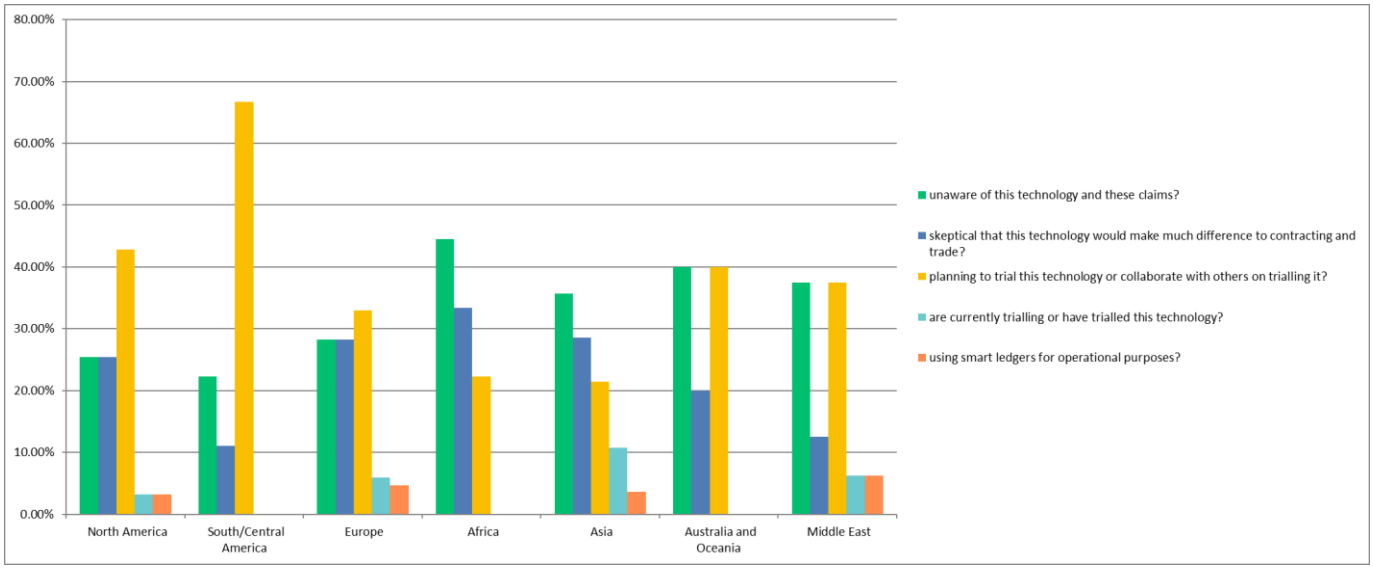
Figure 20: Awareness of respondents - all - by region



Question 2: There are a host of technologies with the potential to improve contracting and trade, particularly cross-border. Would you please rank in order of importance?

1. Smart ledger (aka blockchain or distributed ledger) technology
2. Artificial intelligence using deep learning
3. Statistical techniques such as statistical learning theory
4. Identity systems that streamline individual and corporate anti-money laundering and know-your-customer processes
5. Collaborative documentation platforms
6. Common data standards for trade documentation
7. Cheaper and faster payments systems
8. Micropayment systems

The results of the combined responses are shown below, in order of importance. Overall, respondents ranked 'Artificial intelligence using deep learning' as the most important and 'Micropayment systems' as the least important. We have shown the detailed results, 'top 7' alongside 'regional – all' below, in order of the overall importance attached.

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Figure 21: Summary of Importance – all respondents

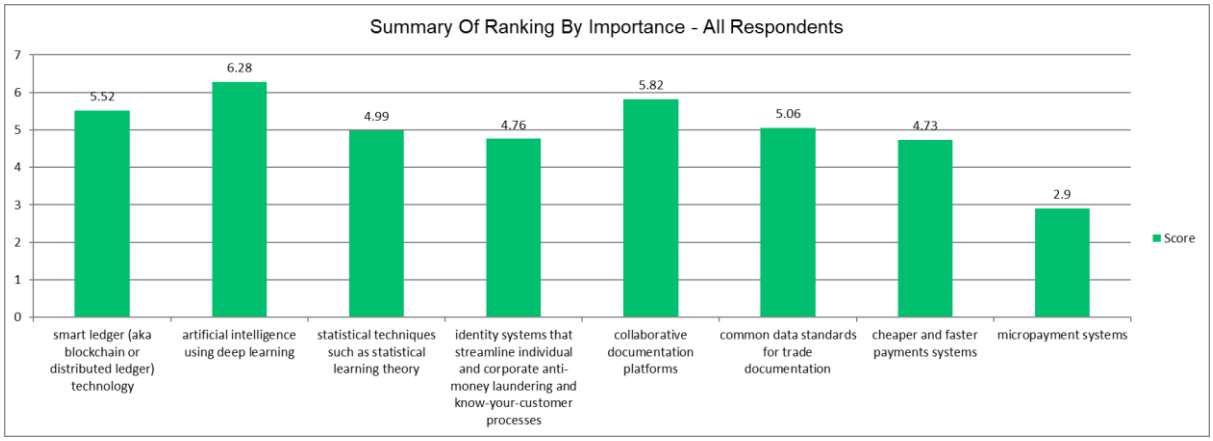
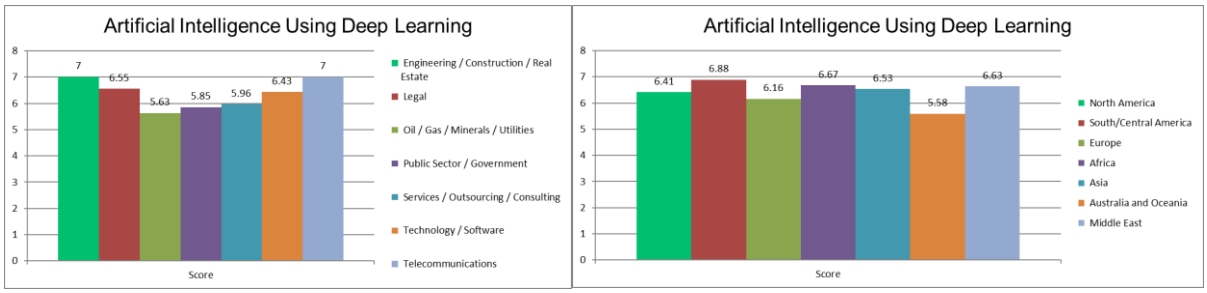
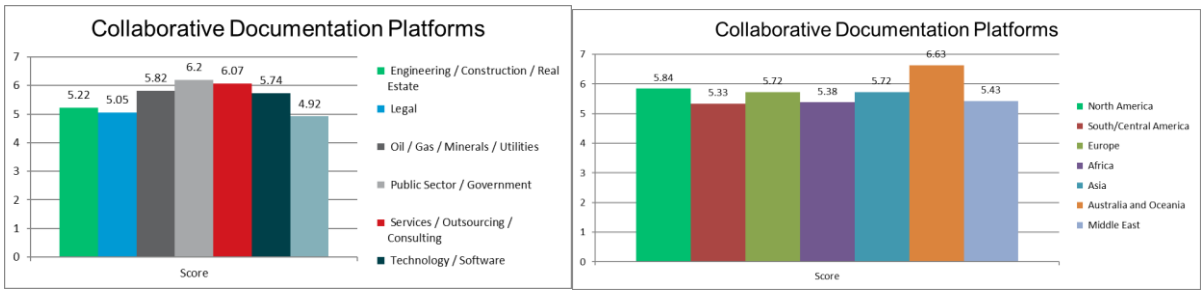


Figure 22: Artificial intelligence using deep learning – importance – top 7 sectors vs. regional



- Observation: There is a fairly consistent geographical view, with 'Telecommunications etc.' sectors attaching most and significant importance.

Figure 23: Collaborative Documentation Platforms – importance – top 7 sectors vs. regional



- Observation: Fairly consistent geographical view, with 'Public and Services etc.' sectors attaching most importance.

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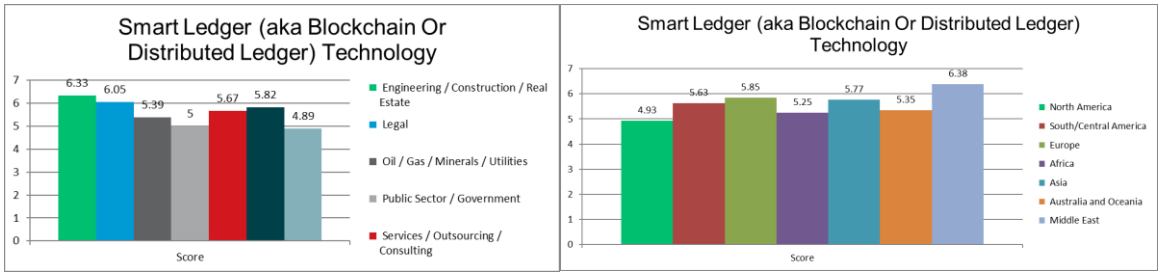
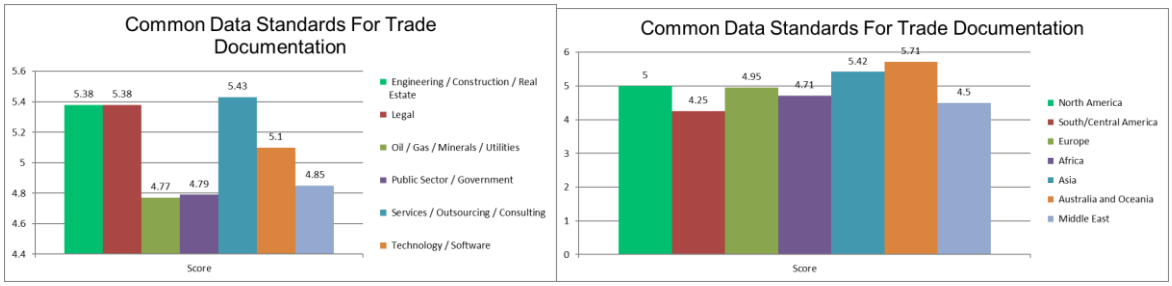
Figure 24: Smart Ledger (aka blockchain or distributed ledger) technology – importance – top 7 sectors vs. regional



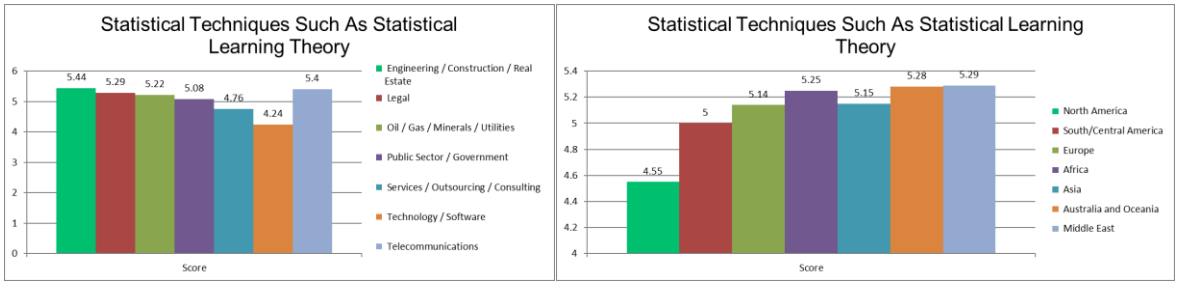
- Observation: Fairly consistent geographical view, with 'Engineering etc.' and Legal sectors attaching most importance.

Figure 25: Common data standards for trade documentation – importance – top 7 sectors vs. regional



- Observation: Fairly consistent geographical view, and yet relatively low importance attached by 'Oil & Gas etc.', 'Public and Engineering etc.', and Legal sectors.

Figure 26: Statistical techniques such as statistical learning theory – importance – top 7 sectors vs. regional



- Observation: Geographically, less importance attached by firms in North America, with the Technology/Software sector attaching less importance than most.

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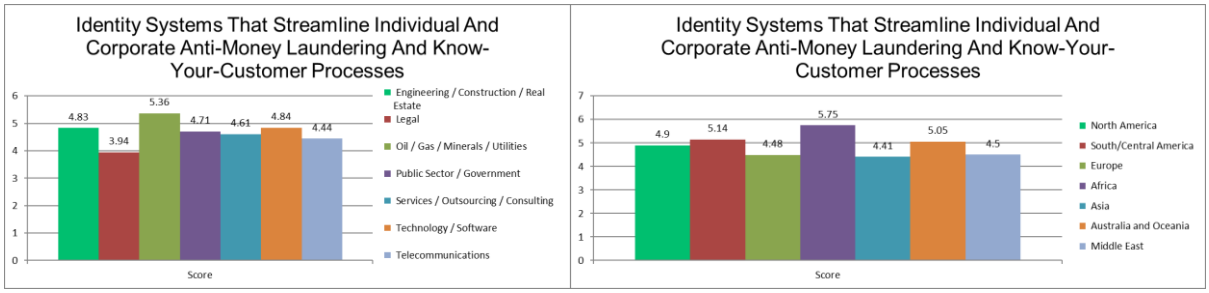
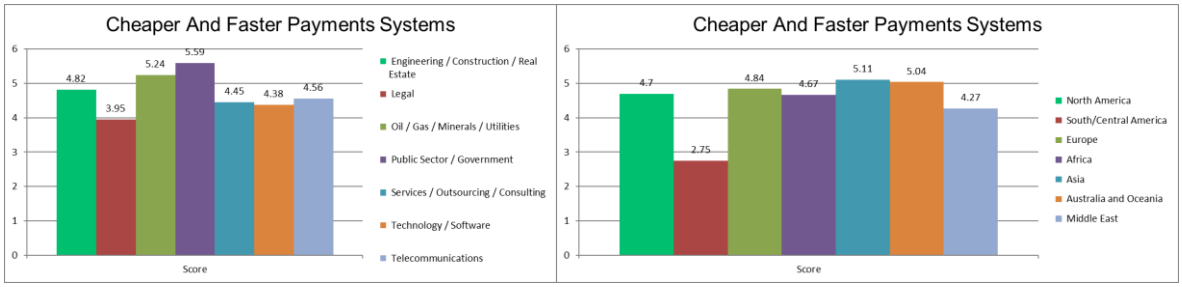
Figure 27: Identity systems that streamline individual and corporate anti-money laundering and know-your-client processes – importance – top 7 sectors vs. regional



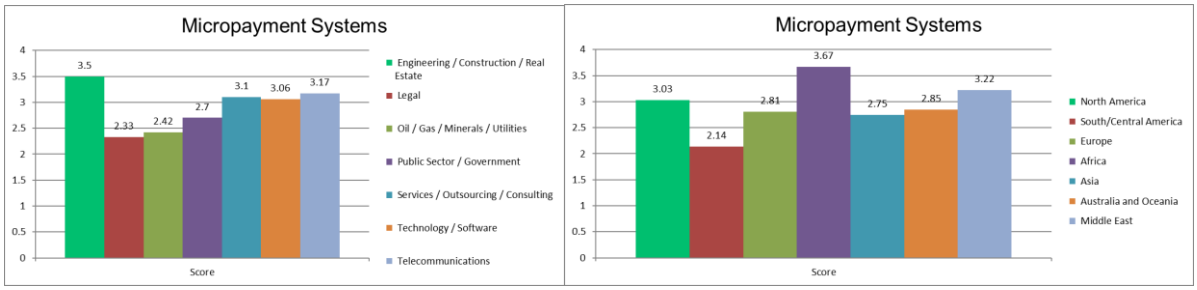
- Observation: Geographically, most importance attached by firms in Africa, with the 'Oil & Gas etc.' firms attaching most importance and Legal firms the least.

Figure 28: Cheaper and faster payments systems - importance - top 7 sectors vs. regional



- Observation: Geographically, much less importance attached by firms in South & Central America, with the Public and 'Oil & Gas etc.' firms attaching most importance and again, Legal firms the least.

Figure 29: Micropayment systems - importance



- Observation: Geographically, most importance attached by firms in Africa and the least in South/Central America, with the 'Engineering etc.' firms attaching most importance and Legal firms the least.

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Question 3: There are a number of impediments to contracting and trade. Would you please rank in order of 'pain', i.e. overly onerous processes?

1. Contract 'onboarding', individual and corporate anti-money laundering and know-your-customer processes
2. Defining/negotiating the contract and supplier agreements
3. Credit information and validation
4. Government reporting and trade interaction, e.g. customs & excise and other taxes
5. Supporting documentation, e.g. certificates of insurance, import-export certificates
6. Making and validating payments
7. Contract execution and reporting
8. Contractual disputes

The results of the combined responses are shown below, in order of the highest average score across the sectors. So collectively, in order of 'most painful'. Overall, and by some way, 'defining/negotiating the contract and supplier agreements' was seen as the most painful aspect, while 'Credit information and validation' and 'making and validating payments' were seen as the least painful.

Figure 30: Summary of 'Pain' – all respondents

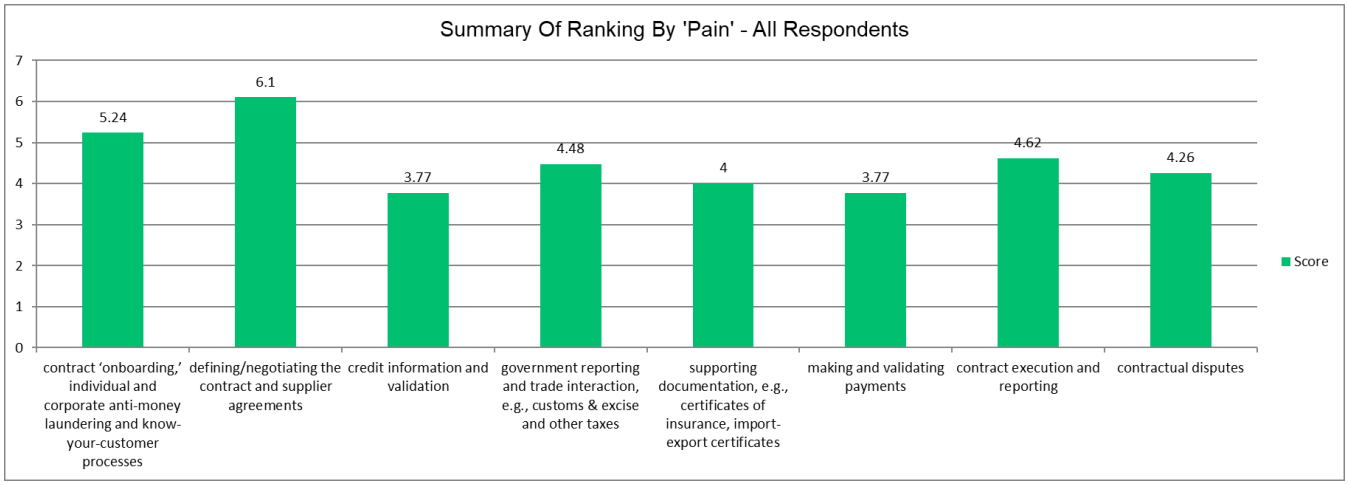

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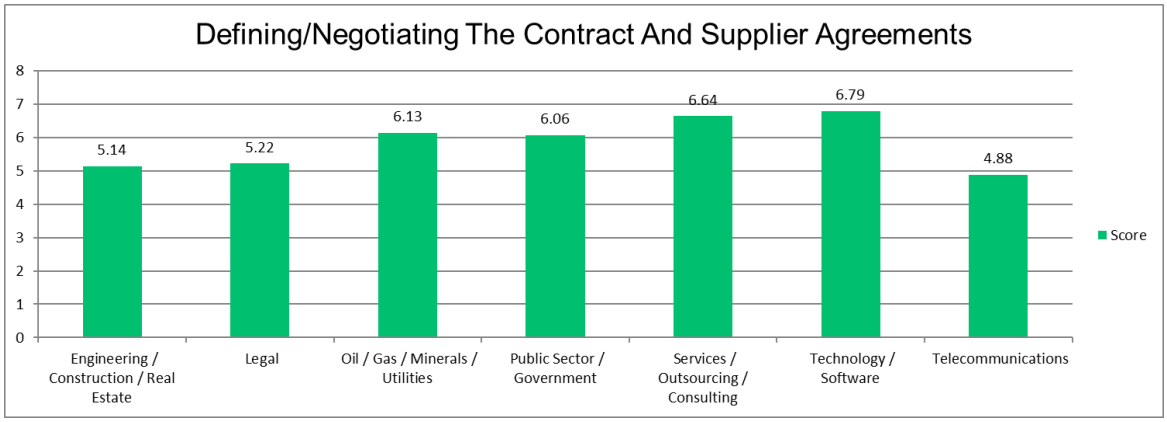
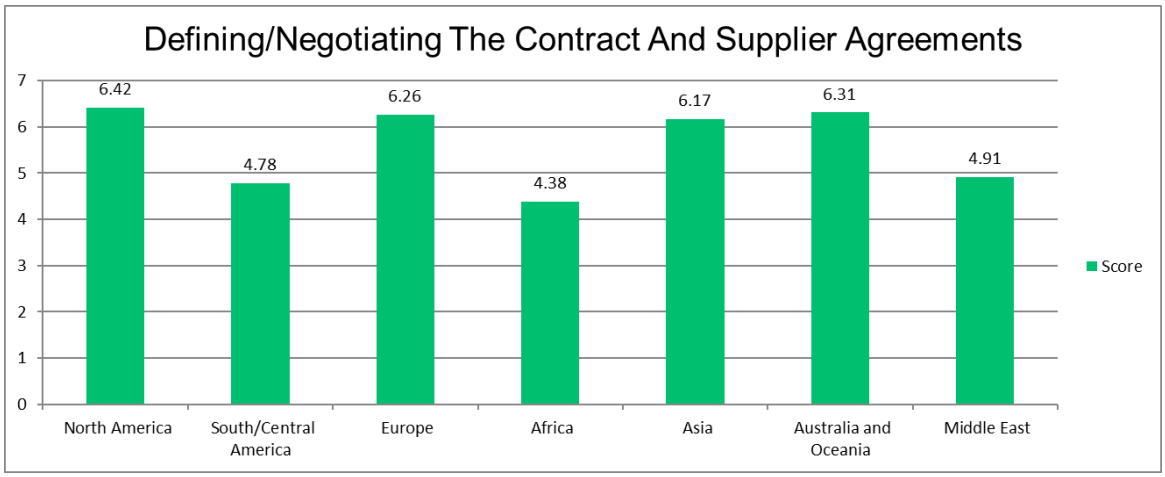
Figure 31: Defining/negotiating the contract and supplier agreements – most painful – top 7 sectors vs. regional





- Observation: Geographically, significantly less pain experienced by firms in South/Central America, Africa and the Middle East. Notably, Technology and Software firms experience the most pain, while Telecommunications firms experience the least.

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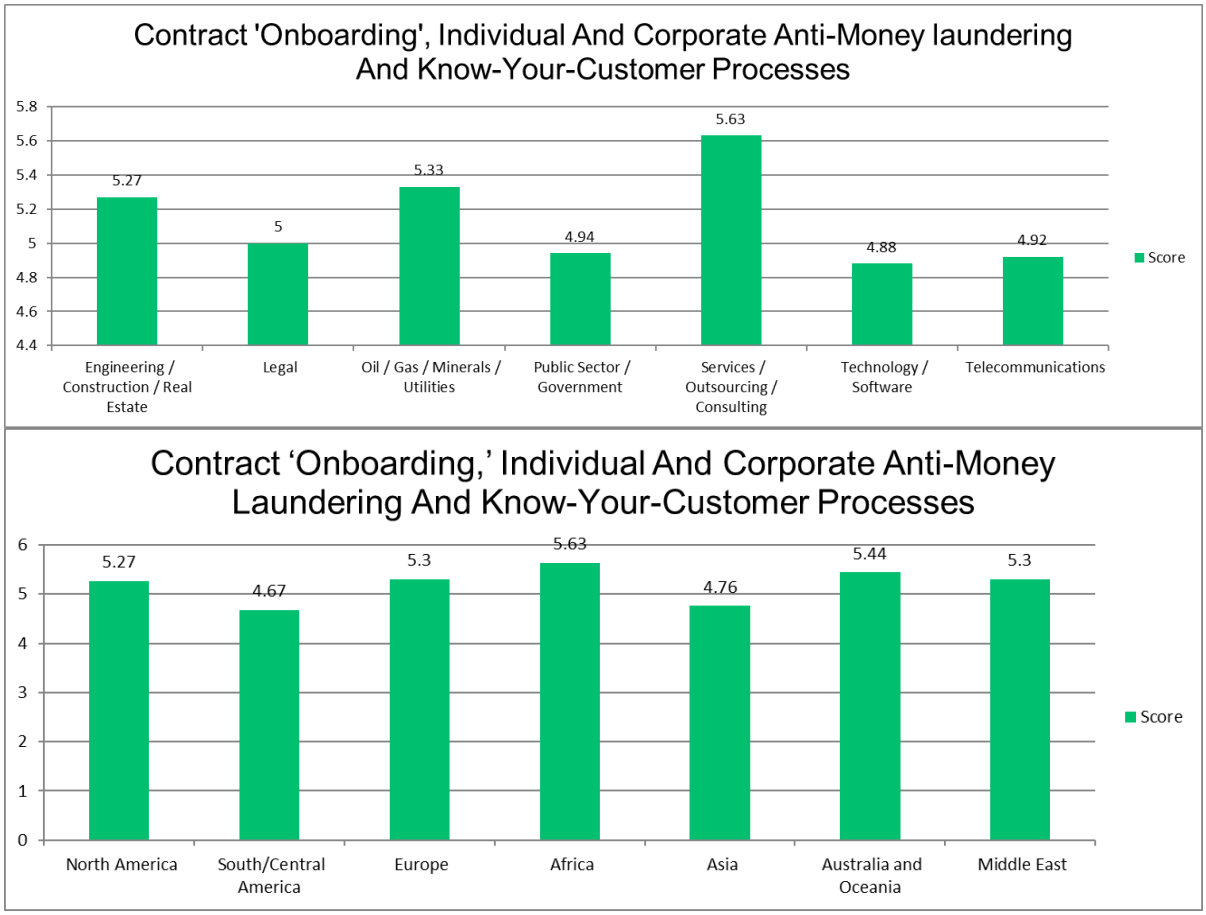
Figure 32: Contract 'onboarding', individual and corporate anti-money laundering and know-your-customer processes – most painful – top 7 sectors vs. regional



- Observation: Geographically, relatively consistent feedback, but much more pain experienced by firms in the Services/Outsourcing/Consulting sector specifically.

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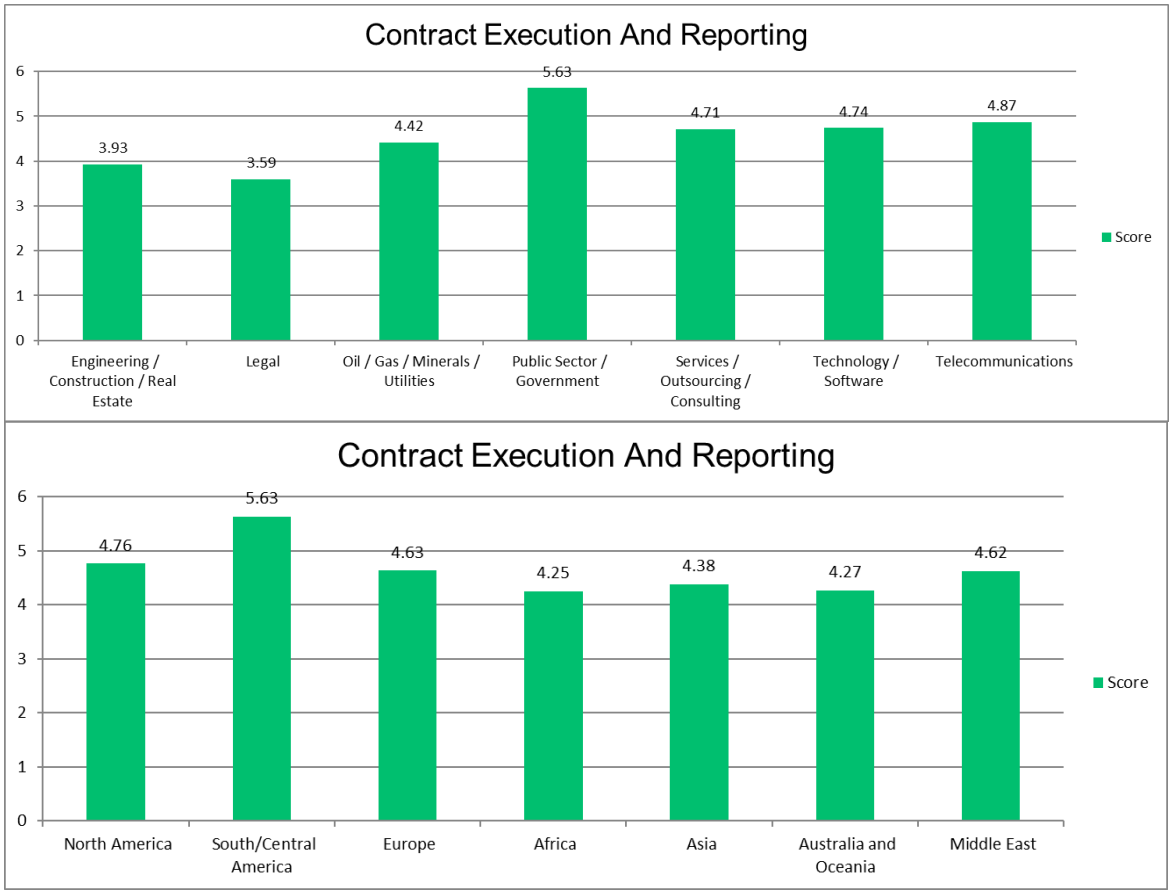
Figure 33: Contract execution and reporting – most painful – top 7 sectors vs. regional



- Observation: Geographically, most pain experienced by firms in South/Central America, but fairly consistent elsewhere. Public sector firms feel the most pain and Legal firms the least.

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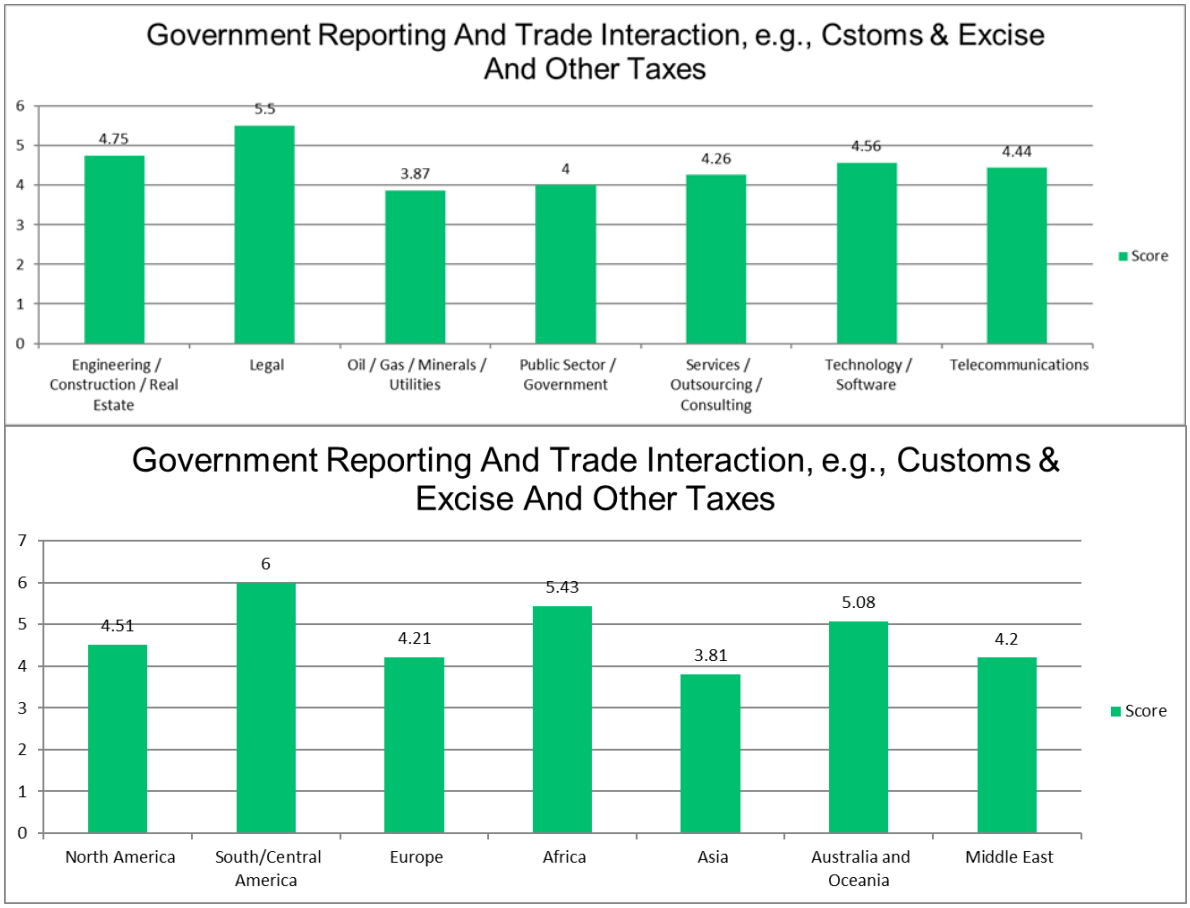
Figure 34: Government reporting and trade interaction, e.g., customs & excise and other taxes – most painful – top 7 sectors vs. regional



- Observation: Geographically, significantly different experiences, with most pain being felt by firms in South/Central America and the least by those in Asia.

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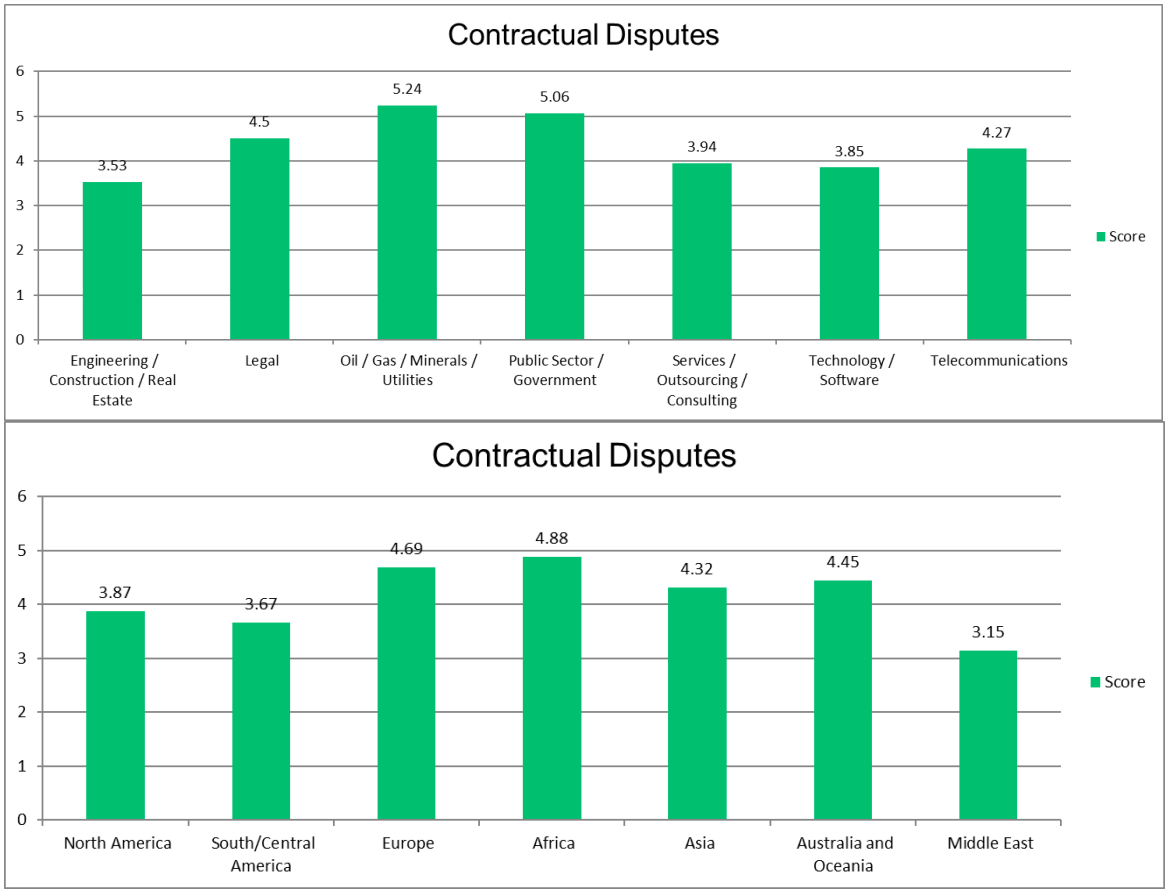
Figure 35: Contractual disputes – most painful – top 7 sectors vs. regional



- Observation: Geographically, most pain is experienced by firms in Africa and Europe and considerably less by those in the Middle East.

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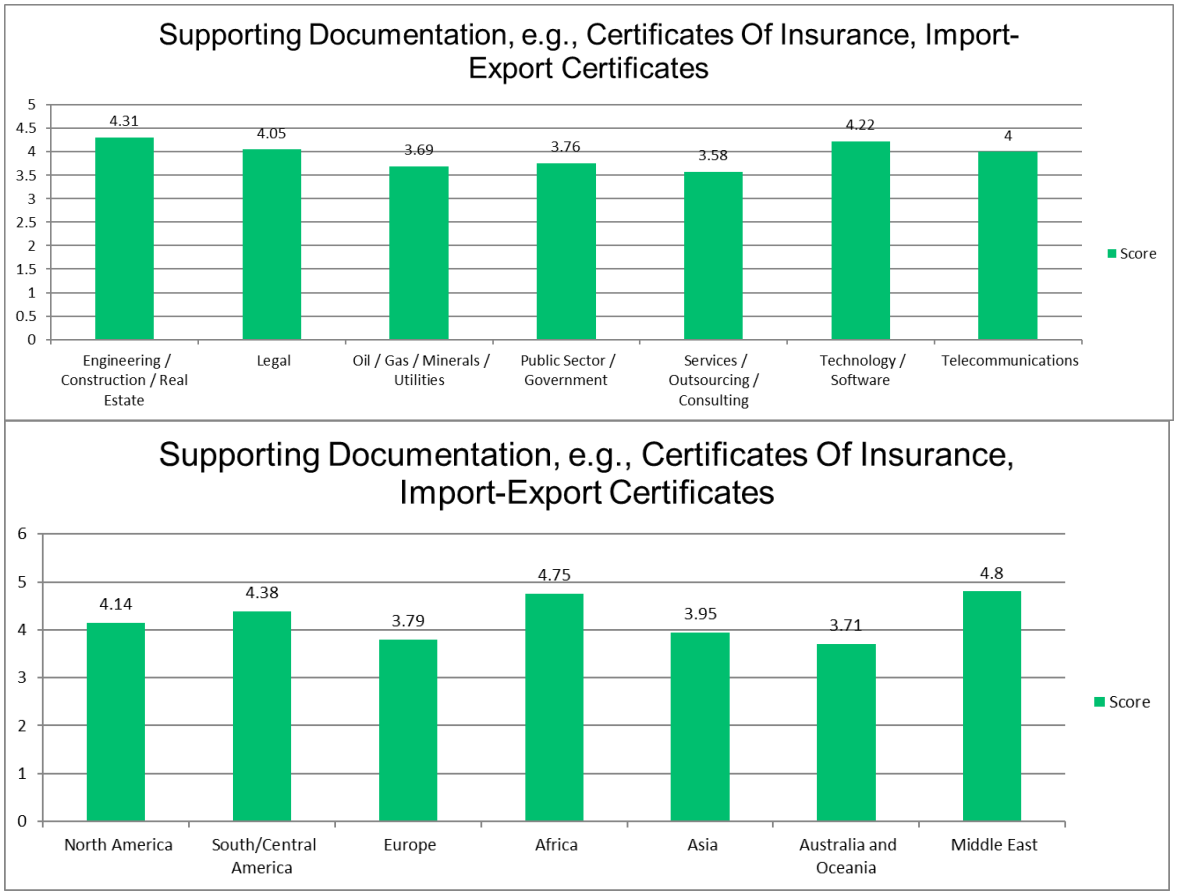
Figure 36: Supporting documentation e.g., certificates of insurance, import-export certificates – most painful – top 7 sectors vs. regional



- Observation: Geographically, relatively consistent feedback, with firms in the Middle East and Africa witnessing a little more pain than most. Across sectors, there is also a fairly consistent spread, with 'Engineering etc.' firms witnessing a little more than most.

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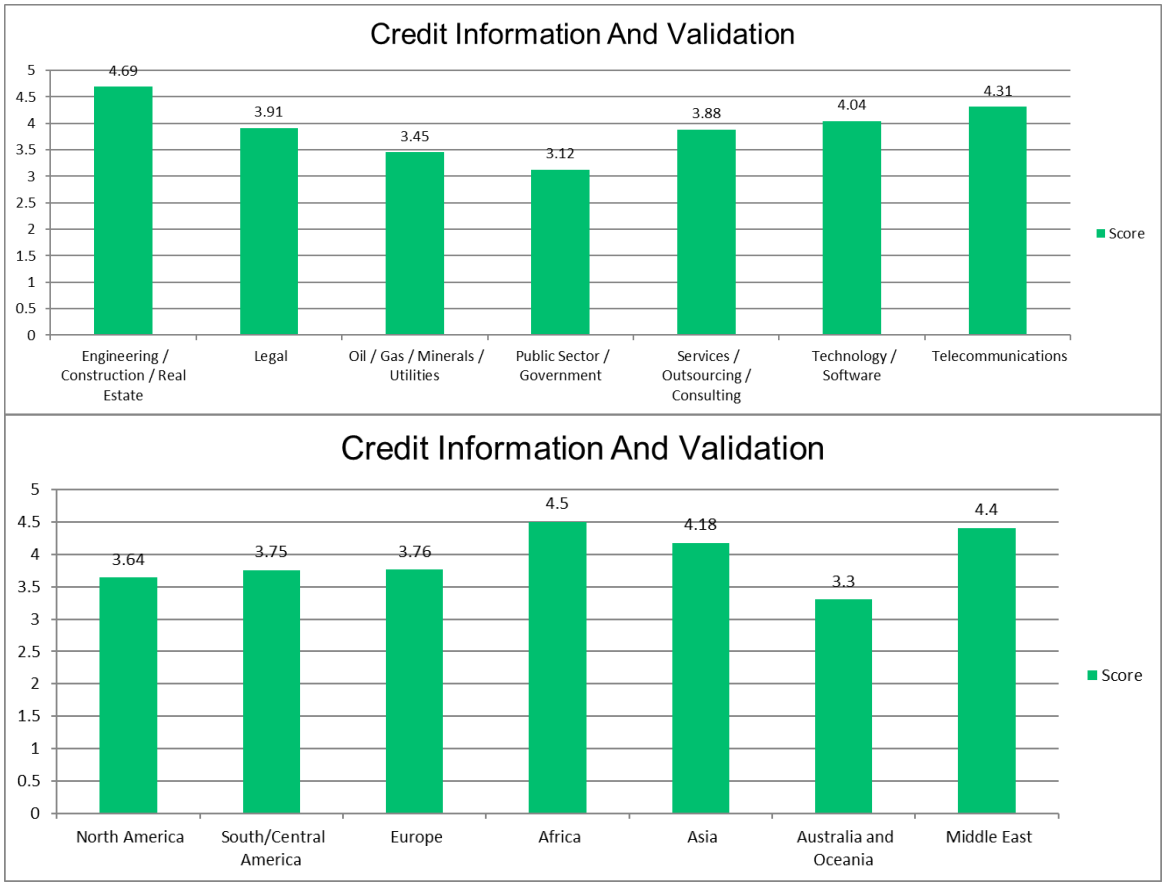
Figure 37: Credit information and validation - most painful - top 7 sectors vs. regional



- Observation: Geographically, firms in Africa, The Middle East and Asia feel the most pain, and those in Australasia and Oceania the least. There is a quite a spread by sector, with 'Engineering etc.' firms being hit hardest, while the Public sector is significantly less impacted.

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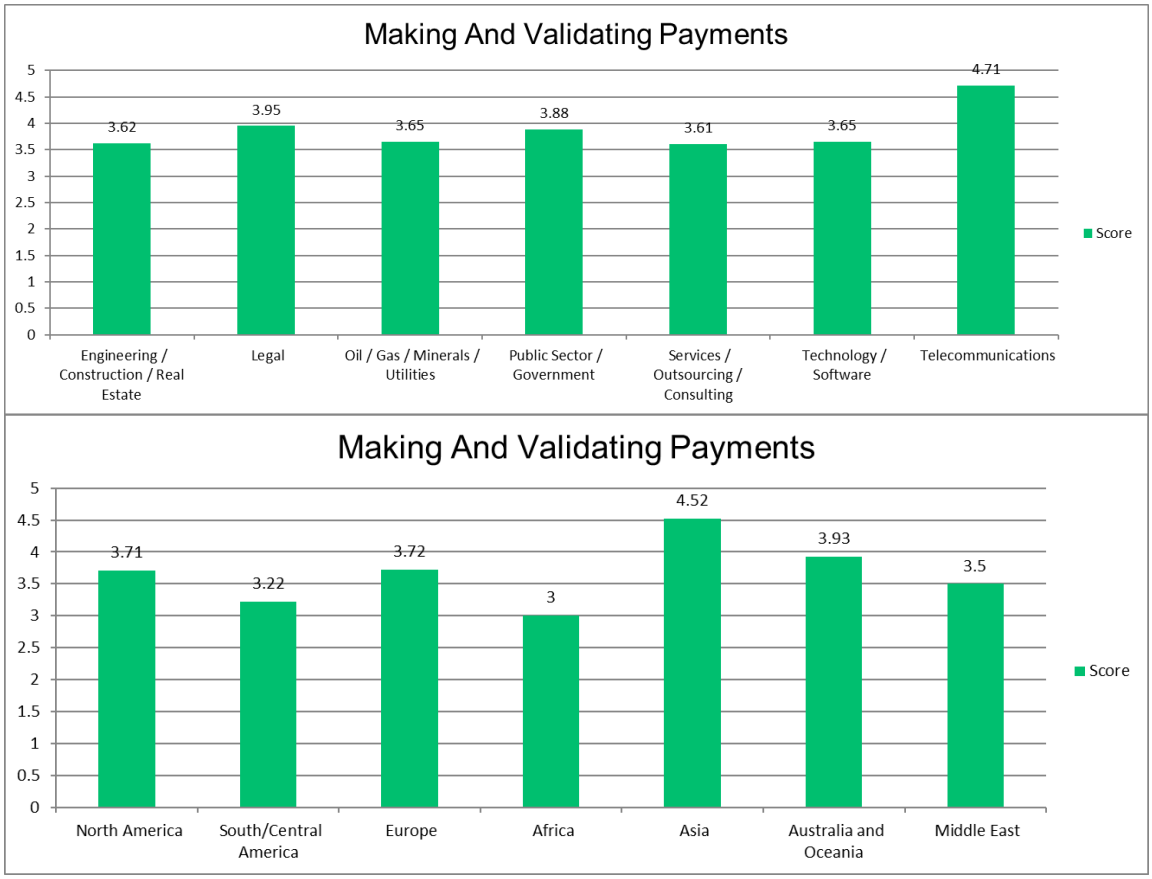
Figure 38: Making and validating payments - most painful - top 7 sectors vs. regional



- Observation: Geographically, firms in Asia 'hurt' the most. By sector, telecommunications firms feel the most pain.

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Appendix 2 - Case Studies

Fast Track Trade In Singapore

Aside from the theoretical notion that Smart Ledgers could help the UK's future trading arrangements, such platforms are already helping SMEs in Singapore. Singapore benefits from a number of driving factors that make it well suited to the adoption of Smart Ledger trade solutions:

- The ACRA regulator certifying the existence of corporate entities through identifiers, such as UEN numbers. This means that regular information profiles are kept on various companies operating in the city state, which is made available to everyone, and updated on a weekly basis. The ACRA database can then be embedded into a block chain platform.

- Furthermore, the local regulators have been pushing for digital KYCs through platforms like MyInfo. For instance, the Monetary Authority of Singapore has issued new guidance to Singapore financial institutions technological solutions as a means of facilitating on boarding.

The Fast Track Trade platform in Singapore helps business partners and distributers buy and sell goods, as well as tracking shipments and handling payments. Furthermore, Fast Track Trade also helps the on-boarding of business partners who will bring clarity to KYC (Know Your Customer) issues - such as entering the Star hub "white list". Fast Track Trade can be made available to any business which has access to a wifi network, meaning that it is widely accessible. In Fast Track Trade's own words:[14]

"Our vision is to offer a trade network where small value transactions can be processed with international standards of safety, connectivity, and visibility to support existing trade corridors and to open new emerging market corridors. We are using Mutual Distributed Ledger technology to create this secure commerce network whereby any corporates can carry out seamless and safe automated trade transactions."

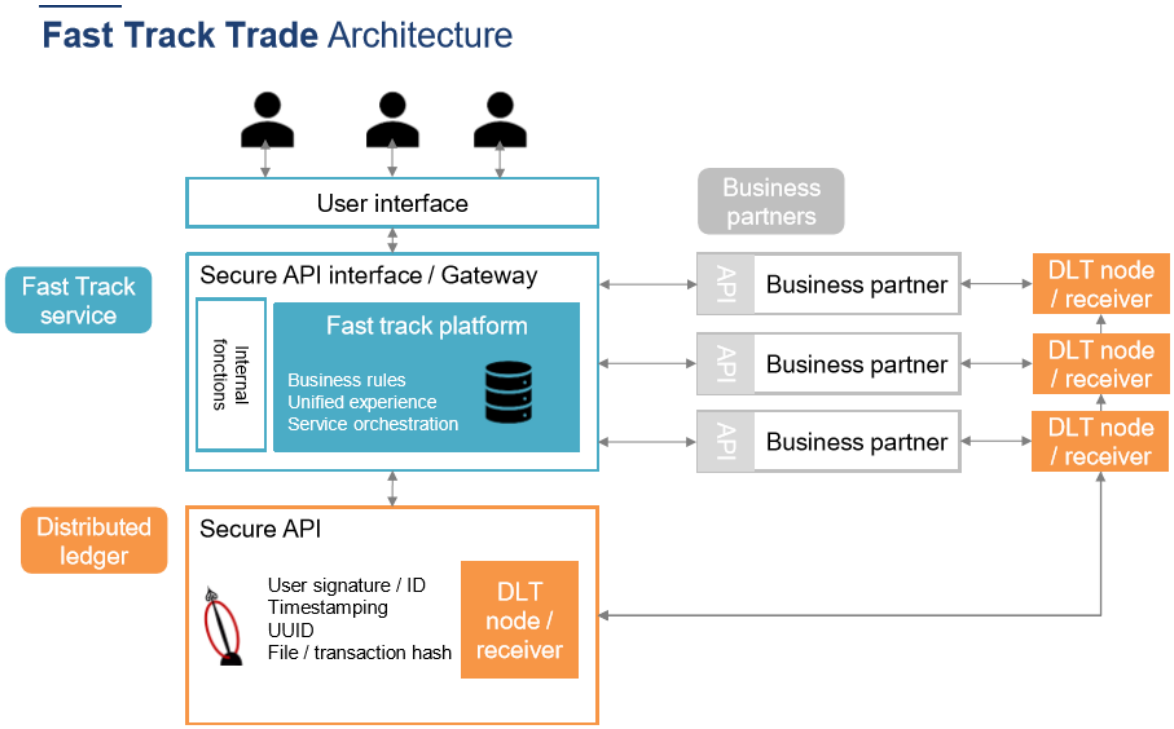
[14] http://www.citesgestion.com/4/fast_track_trade_1001284.html

 © Z/Yen Group, 2018

Figure 39: Illustration of the Fast Track Trade system

The platform was established though a partnership between Starhub and Prudential. The chart below outlines the Smart Ledger and Distributed Ledger Technology (DLT) concepts in Figures 4 and 5 earlier in this report:

Figure 40: Illustration of the FAST TRACK TRADE system



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Smart Ledgers Can Help Britain's Post-Brexit Trading Arrangements

The UK has been engaged in extensive Brexit negotiations with the EU over recent months. Britain's referendum decision in June 2016 to leave the European Union has resulted in a considerable amount of uncertainty regarding the country's trade relationships with EU and non-EU countries alike.

Given the UK's negotiating stance since Article 50 was triggered in March 2017, it is difficult to see an outcome where the current depth of trade access to the EU is completely maintained. Although the principle of tariff free trade is itself uncontroversial, and the EU has many such agreements with other countries, the UK may face non-tariff barrier challenges in accessing the EU market and the customs union, as well as the EU itself.

These non-tariff barriers will likely affect goods as well as services. For instance, many regulated services, such as financial services are subject to considerable regulatory oversight, and UK-based providers may face barriers from EU regulators, in offering services to the EU market as a whole. Furthermore, standards in the UK may end up not being recognised by the EU, meaning that exported products may have to go through a certification process.

There are, however, other subtle barriers that could emerge. For instance, leaving the EU Customs Union will lead to extra frictions for goods exports, even if the UK manages to secure regulatory alignment with the EU and tariff-free trade in goods. Outside of the EU Customs Union, UK exports will have to go through customs screening, to ensure that exports to the EU did actually originate from the UK, as opposed to other countries that may not enjoy preferential access to the European internal market. This kind of customs process could well add cost and time overheads to UK exports, given the European integrated supply chains that currently link the UK to much of the rest of the EU.

Cebr has previously suggested the implementation of a UK-EU Virtual Customs Union (VCU) solution, to help navigate these challenges. The theoretical framework is that the UK would run a dual trade policy. The first pillar of this solution would focus on exactly replicating EU trade policy and trade agreements (the "EU pillar"). The second pillar of UK policy would focus on gaining additional trade access to countries that have no preferential access to the EU (the "EU + pillar").

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Goods coming into the UK could, upon entry, be marked and certified as being compliant with EU trade policy, or not. Those that **are** complaint with EU trade policy would be digitally marked/certified, meaning that sectors using inputs may be exempt from customs processing and rules of origin. Exporters that rely on supply chains will therefore be able to choose whether to use EU complaint goods, or to use those from third countries, that may be cheaper, but are also liable to customs and procedural delays.

Within such a system of digital tagging and marking, blockchain technology may be of considerable use:

- Upon entering the UK's borders, the ID tag of products can be recorded in an MDL. That MDL will be an open, incorruptible record of where the particular product came from, specifically which ports it was shipped through, and when it actually entered the UK. Upon scanning, manufacturers such as automobile producers will know whether it is a product that complies with the EU pillar or the EU+ pillar and can perform cost benefit analyses accordingly, as can the UK firms deciding on a particular course of action.

- A product compliant with EU trade policy would be one that either originates in the UK, or alternatively originates in another country where the UK and the EU both have similar terms of access. If such a product is indeed certifiably compliant with EU trade policy, then firms should be able to skip the usual customs procedures when transacting between the UK and the EU. If the EU recognises these products as being complaint with its trade policy, it should therefore treat correspondingly marked products as equivalent to imports inside its full customs union.

- The smoothness of such trade activity would however critically depend on two factors:

    - Firstly, the EU would have to recognise the UK's "EU pillar" as being equivalent to its customs union. This could conceivably take place through some form of associate membership for the UK inside the present EU customs union, or another customs union arrangement between the UK and EU. It is however, by no means a foregone conclusion that the EU would agree to this, the decision on whether to grant such recognition would depend on the EU's legal, political

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and economic constraints. Irrespective of the UK's trade policy and technological solutions implemented, non-recognition by the EU would still likely pose considerable challenges, thus hampering the process.

- Secondly, the EU trade compliance pillar is something that the UK would have to agree to. As opposed to running a wholly independent trade policy, the UK would have to make a political decision to be partly constrained by EU structures and decisions. This basically entails having a trade division that replicates EU market access agreements with third parties. In this sense, the UK would be a partial "policy-taker".

- The UK's remaining trade policy autonomy would then be confined to other countries, where the EU has not negotiated free trade access. Even here, some restrictions might apply, such as having to renegotiate existing trade deals following the eventual completion of EU deals. It is also important to note that, logically, there is a finite number of countries that trade deals can be executed with. The existence of trade blocks limit this further. Essentially, whatever supplementary free trade pillar the UK may achieve, this will, over the long term, eventually diminish if the EU continues to negotiate substantial market access - as it is presently doing with large economic geographies such as Mercosur and Japan.

- The EU+ trade pillar would however also be useful to consider from the point of view of UK-EU supply chains. Products that come from other third-party countries that don't have preferential EU market access may indeed turn out to be cheaper. Furthermore, UK manufacturers may be able to exploit favourable rules of origin when importing into the EU. However, the ultimate decision will be up to the UK companies to decide, as to whether they choose to opt for potentially more cost competitive third-party country impacts and expose themselves to supply chain frictions in terms of customs and rules of origin, or whether they choose to opt for a stricter list of producers and by-pass the additional frictions.

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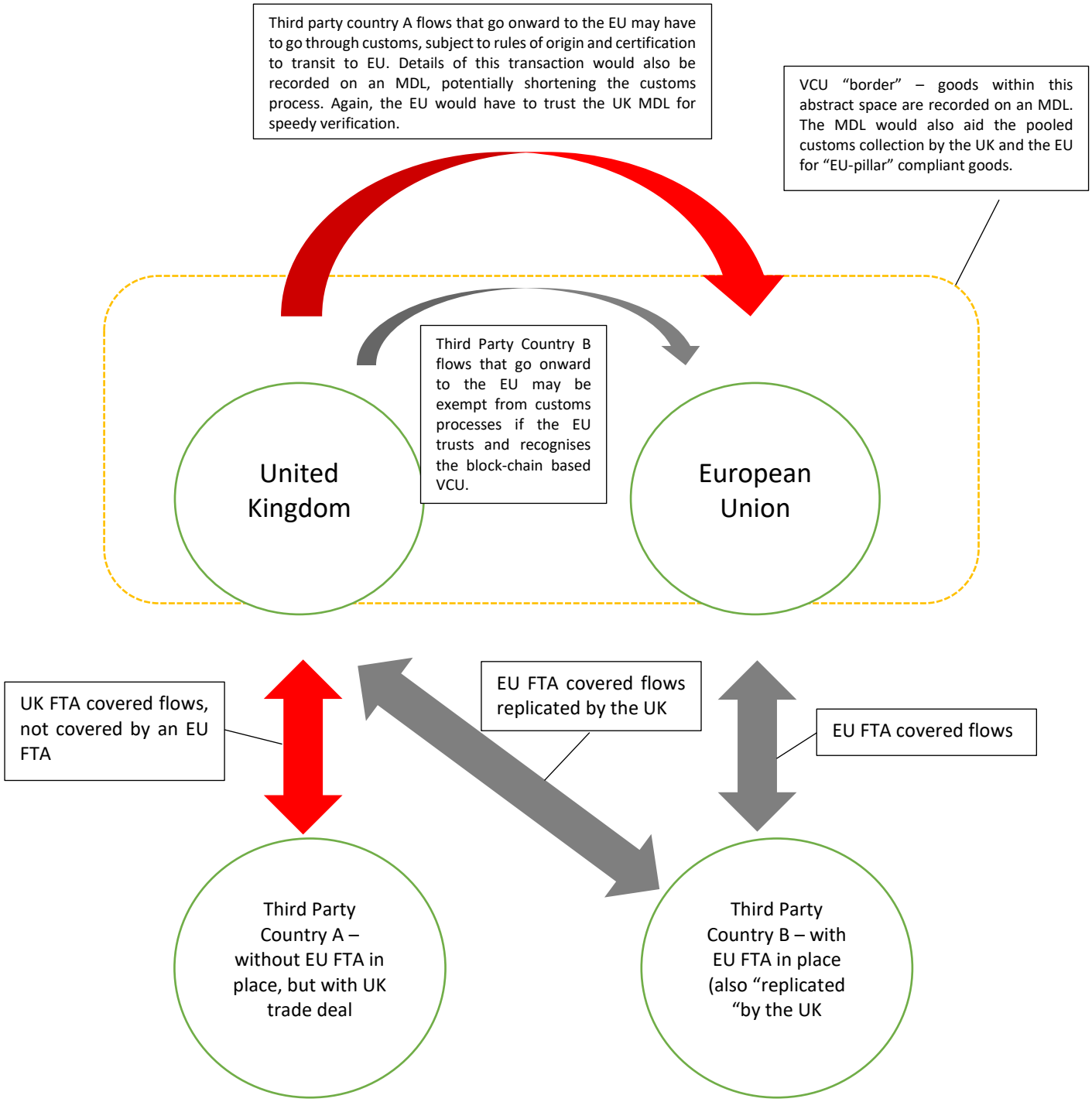
Figure 41: Illustration of Cebr's Virtual Customs Union concept, coupled with a Smart Ledger solution



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Douglas is one of the world's leading economists and was chosen in 2012 from over 300 applicants to become the Gresham Professor of Commerce. His Gresham lecture series 'The world's greatest ever economic event' looking at the impact of globalisation on the Western economies attracted widespread attention and large audiences. He has recently published an updated paperback version of his book, The Flat White Economy. He covers all aspects of economics but is best known for his work in forecasting, the economics of the IT and telecoms sectors and transport economics and for his knowledge of the Far East economies. He works with clients who are particularly looking for an economist with a public presence to help make their case. After setting up Cebr, he was our Chief Executive for 20 years, as well as Executive Chairman. Previously he was Chief Economic Adviser to the Confederation of British Industry and Chief Economist for IBM UK.

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- essDOCS – www.essdocs.com
- Fast Track Trade – www.fasttracktrade.co
- Her Majesty's Revenue and Customs (HMRC) - https://www.gov.uk/government/organisations/hm-revenue-customs
- International Association for Contract & Commercial Management (IACCM) – www.iaccm.com
- Policy Connect - www.policyconnect.org.uk
- Sweetbridge – www.sweetbridge.com
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The Foundation aims to influence and progress the emerging commercial and legislative landscape for blockchain technology and cryptocurrencies. Its strategy is to pro-actively approach government and regulatory bodies and to form strategic partnerships with businesses, enterprises and other open-source projects. The Foundation's mission is the promotion of developments of new technologies and applications, especially in the field of new open and decentralised software architectures.
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