

# INVESTIGATING DOLLAR INVOICING TRENDS USING UNITED KINGDOM EXPORT DATA

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## Abstract

Our knowledge about currencies in which exporters invoice trades and the motivating factors behind such decisions has been evolving constantly in the last 20 years. An overwhelming conclusion is that much of world trade tends to be invoiced in a vehicle currency, mainly the US dollar, even when the US is not an involved trading partner. Prior work has also shown that dollar invoicing levels tend to be higher in non-differentiated industry sectors where exporter herding plays a big role in promoting the use of a single vehicle currency. This paper builds on prior research by using the latest sector-level trade data for UK exporters. Using this disaggregated data, I uncover two novel findings. Firstly, in contrast to prior research with older data, sectors with differentiated goods have also seen increasing levels of dollar invoicing that outstrip the growth of exports to the US. I will offer a few explanations as to why this is the case related to the role of imported inputs from non-differentiated sectors, and potential lack of trust in the pound. The increase in dollar invoicing in differentiated sectors has come from a decrease in pound invoicing which could be related to factors specific to the United Kingdom. Secondly, I show through panel data that among these differentiated sectors, high sector level growth rates are associated with higher shares of dollar invoicing even when controlling for share of exports to the US. This same trend is not seen in non-differentiated sectors. While the reasons for this warrant further investigation, it shows that dollar invoicing is here to stay despite the increasing importance of non-differentiated sectors in trade.

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## **I. Introduction**

An exporter has three choices when deciding which currency to invoice transactions in. They can either use their own currency/PCP (Producer Currency Pricing), the importer's currency/LCP (Local Currency Pricing) or some vehicle currency like the US Dollar or some combination of the three pricing strategies. The choice of invoicing currency can have large implications for exchange rate fluctuations in scenarios of rigid prices, leading to changes in real trade balance and growth (Gopinath et al. 2016). The factors behind such choices are not straightforward, and much research has been done to model an exporting firm's invoicing decisions. Suggested factors from prior research include degree of differentiation in an industry sector, herding and hedging initiatives, security of dollar reserves, degree of imported inputs, "exorbitant privilege" of the dollar, ability to raise dollar debt and a tendency of inertia in invoicing decisions. I will go over some of these in detail in the next section where I review relevant literature and situate my analysis. Moreover, there is relatively scarce granular data that documents invoicing currencies in trade transactions.

In this paper, I use the latest export data from the United Kingdom which contains sector-level invoicing data from 2010-2019. I demonstrate that in contrast to hypotheses presented in prior research, the share of dollar invoicing has increased even in industry sectors with more differentiated product offerings where some of the assumed herding advantages of dollar invoicing are not as prevalent. I will also reveal a link between growth rates of differentiated sectors and shares of dollar invoicing by running appropriate regressions. Spurts of high sector growth rates tend to be accompanied by increases in shares of dollar invoicing. This is further evidence in support of the pervasiveness of the US dollar as a vehicle currency. I will show how increases in dollar invoicing in United Kingdom exports have largely come from decreases in pound invoicing levels, which may signal a decline of trust in pound deposits in recent years. I will discuss possible reasons for this uptick in dollar

invoicing especially in UK's biggest export sector of Machinery and Transport equipment. Building off Goldberg and Tille (2008), Gopinath et. al (2016), and most recently, Amity, Itskhoki and Konings (2020), I will argue that increasing levels of dollar invoicing in reference priced sectors have spilled over into differentiated sectors due to firms in differentiated sectors importing inputs from non – differentiated sectors. Dollar invoicing has persisted and increased in non-EU United Kingdom exports and shows no signs of dwindling. The paper is organized as follows – Section II outlines the relevant literature and further situates my work, Section III outlines the data sources used and the process of segregating industry sectors based on the degree of differentiation, Section IV discusses preliminary trends seen in invoicing shares over the past decade, Section V goes over the novel link between sector growth rates and invoicing shares and outlines the regression results, Section VI attempts to provide possible theoretical explanations behind the results based on prior literature, while Section VII summarizes and outlines areas of improvement and future work.

## **II. Literature Review**

There is a rich body of work that aims to model invoicing decisions and explain the prevalence of vehicle currency invoicing effectively. Rey (2001) was one of the first papers to explore the use of vehicle currencies. He suggests a three-country general equilibrium model that explains a currency's "thick market externalities" coming from a dominant position in global trade and low transaction costs. Krugman (1980) also made important contributions to our knowledge of invoicing decisions. He outlined the notion of inertia in invoicing decisions to show that once a dominant currency is established in the market, a firm has no incentive to invoice in another currency. The higher transaction cost and volatility of sales would discourage exporters from switching to another currency. Macroeconomic fluctuations have also been attributed as potential causes which influence invoicing decisions.

Devereux, Engel and Storegaard (2004) show that in a two-country model, exporters prefer to invoice in the currency that has a less volatile exchange rate. This is another reason why emerging markets show higher levels of dollar invoicing.

Goldberg and Tille (2008) was a seminal paper in the field as it was one of the first to look at sector level invoicing data from different countries and back up their findings with a partial equilibrium model. They found that an even more consequential factor than macroeconomic volatility is the type of industry sector. Non - differentiated products that are often reference priced tend to exhibit higher levels of invoicing compared to more differentiated products. They apply the Rauch network (1999) to come up with an export composition index for each country in their dataset. Countries with more non-differentiated exports exhibited higher levels of vehicle currency invoicing. They claim this is due to a herding phenomenon as it is more optimal for firms in non-differentiated sectors to limit price movements in comparison to their competitors. Movements of prices in industries where goods are more substitutable lead to large fluctuations in quantities sold. They also claim that differentiated industry sectors care more about macroeconomic volatility with respect to wages and demand when deciding currencies to invoice their trades in. Non - differentiated sectors pay closer attention to the herding dimension in deciding their invoice currencies. Goldberg and Tille go on to hypothesize that as differentiated sectors become more and more dominant in global trade and emerging economies become more stable, we can expect to see lower levels of herding and thereby, lower levels of dollar invoicing. My work builds on this consequential paper in some key aspects. I attempt to answer a few unanswered questions through the latest data. Though non-differentiated sectors have higher base levels of dollar invoicing compared to other sectors, how has this evolved over time for the United Kingdom? Have differentiated sectors seen increasing or decreasing levels of dollar invoicing over time and why? Is there a link between short -term growth rates of

industry sectors and levels of dollar invoicing? What can we expect dollar invoicing levels to be in the future? Have dollar invoicing changes in the United Kingdom come in tandem with changes in levels of pound invoicing?

Other relevant papers are Gopinath and Stein (2018) and Gopinath, Gourinchas et. al (2016). The former dives into the relationship between demand for safe dollar deposits and the dollar's prevalence as a dominant invoicing currency. They propose a model that shows the link between dominance in trade invoicing and global banking. I believe my findings further support this argument since I show that differentiation in industry sectors itself cannot explain changes in invoicing decisions over time. The latter paper proposes the Dominant Currency Paradigm, which aims to provide a robust theoretical model to explain invoicing decisions. They focus on strategic complementarities in pricing and use of imported inputs in production. I will particularly use this claim of theirs to show how more differentiated sectors may invoice in the dollar due to their imported inputs from non-differentiated sectors that may already be invoiced in the dollar.

Other than Goldberg and Tille (2008), the literature on sector level invoicing trends is scarce due to lack of available data. Only a few countries (United Kingdom, Chile, Japan, Australia etc.) publish invoicing currency data with their trade data and even this data is limited in scope and time. Takatoshi et. al (2016) focus on sector wise invoicing trends in Japan and find that although very differentiated export sectors like product machinery tend to be invoiced in Yen, the share of dollar invoicing is still high in other sectors. They also claim that some sectors like semiconductor exports show high levels of Yen invoicing which may still be evidence for herding since the global sector largely involves only Japanese firms. They show that despite growing economic interdependence between Asian and Japan, the US dollar is still the dominant invoice currency which could signal the importance of global inertia and role of safe assets in invoicing decisions. Guilano and Luttini (2019) focus on

Chilean import data and demonstrate the dominant position of the dollar atleast in influencing short-term exchange rate passthrough. They also show that high short-term dollar ERPT is seen across all sectors. They do not find sector specific trends with respect to the impact of the dollar exchange rate on prices. Most recently, Amiti, Itskhoki and Konings (2020) show that large import intensive firms in Belgium tend to be more inclined to invoice their exports in the dollar, exhibiting a low exchange rate pass-through of euro-destination exchange rate.

My work aims to nest some of these papers and suggest which factors have influenced invoicing decisions for UK exports. I chose to primarily focus on UK exports due to the ability to isolate change over time. UK import data does not show too many short-term changes in invoicing levels due to the high volume of trade and inability to isolate firm specific decisions. Dollar invoicing levels have remained largely constant for UK imports in the last decade. By using export data, I aim to paint a picture of how dollar invoicing has evolved over a shorter horizon of time across sectors and suggest some reasons for this evolution. Export data will also help consider firms that are most directly in competition with each other.

### **III. Data**

The United Kingdom Trade department has publicly available data on sector specific volume and currency invoicing shares for both exports and imports since 2010. The data follows the Standard International Trade Classification (SITC) commodity codes and includes data on 10 sectors –

<b>Non – differentiated sectors</b>	<b>Differentiated sectors</b>
Food and Live Animals	Beverages and Tobacco
Crude Materials, inedible, except fuels	Chemicals and related products, not elsewhere specified
Mineral fuels, lubricants and related materials	Manufactured goods classified chiefly by material
Animal and vegetable oils, fats and waxes	Machinery and Transport equipment
	Miscellaneous manufactured articles
	Commodities and Transactions not classified elsewhere in the SITC

I classified these sectors as ones characterized by non – differentiated or differentiated goods as seen above based on the Rauch index. The index has a more granular segregation of goods into organized exchange, reference priced and differentiated goods, but United Kingdom invoicing data is only available at the broad, sector level. Sectors with a higher share of organized exchange or reference priced goods were presumed to be less differentiated sectors, while those with a higher share of differentiated goods were presumed to be differentiated sectors. It is important to note that assigning sectors as differentiated versus non-differentiated is an oversimplification since some sectors have both reference priced and differentiated goods. The chemicals and related products, and beverages and tobacco sectors were the most difficult to characterize effectively since they contain a mix of both differentiated and non – differentiated goods; I tried to not focus too much of my analysis on these sectors. The animal and vegetable oils, fats and waxes sector is a relatively small sector for UK exports compared to the others, hence year on year changes here should also be taken with a grain of salt. From 2010-2019, there is yearly data on the sector level export volume as well as invoicing shares among the four most popular invoicing currencies and a category for any other invoicing choice. The four most popular invoicing currencies were the Pound, US Dollar, Euro and Yen till 2016. Interestingly, the Chinese Renminbi

replaced the Yen post 2016 as the fourth most popular invoicing currency, though its share of invoicing is small compared to the other three currencies. The data available is only for non-EU exports since a majority of EU exports are invoiced in the Euro and are not fruitful to look at when considering changing levels of dollar invoicing. Any reference to shares of exports from now on will refer to share of non-EU exports. I also wanted to control for the share of exports to the United States in my analysis to look at dollar invoicing levels beyond exports to the US. I aggregated sector level, monthly customs data that included exports to the United States to estimate a yearly, sector-level, share of non-EU exports to the US variable that I could include in my regressions.

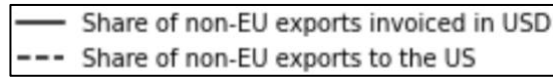
#### **IV. Preliminary Results of invoicing trends**

There has been a general increase in dollar invoicing in the United Kingdom from 25% of exports in 2010 to close to 35% of exports in 2020. Breaking down growth trends by sector there are two patterns -

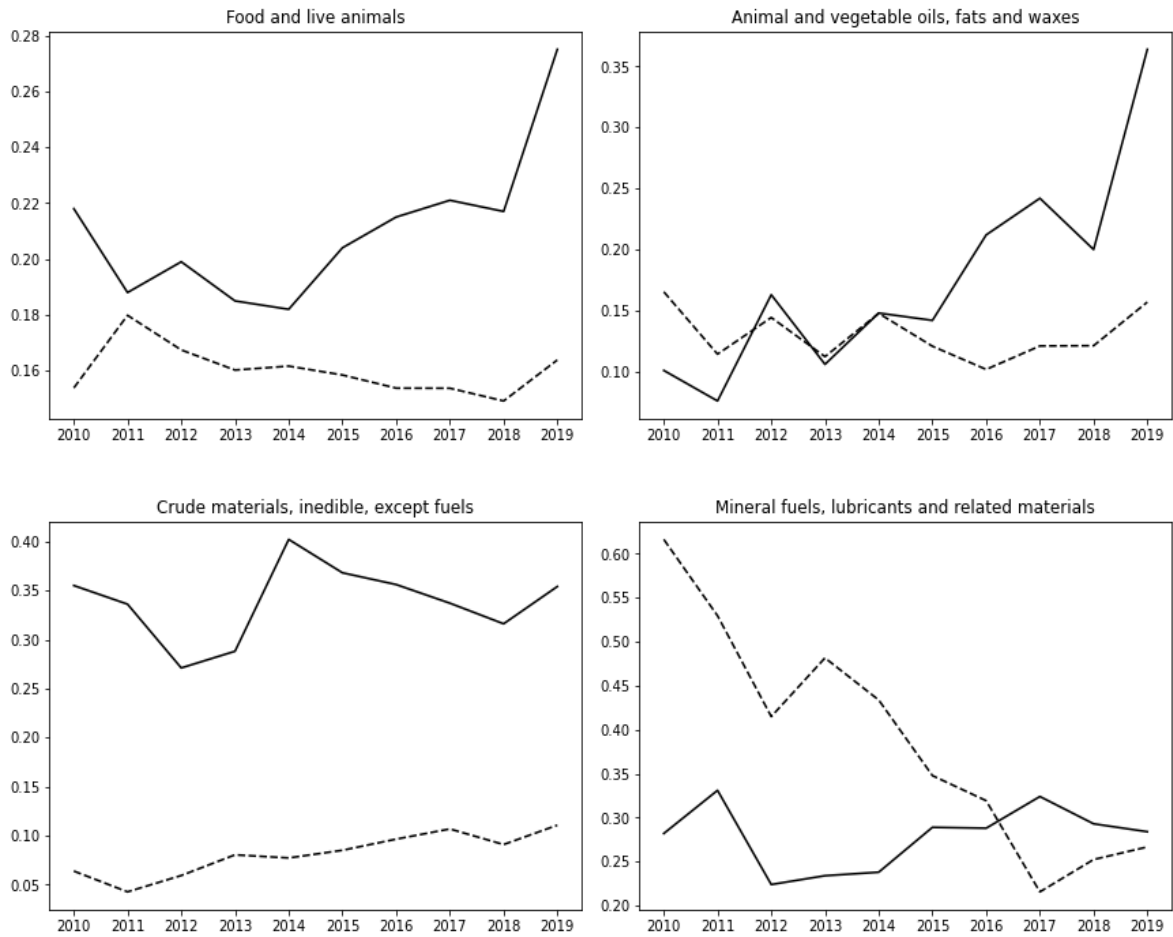
1. The share of exports invoiced in the dollar has been either consistently high or often increasing even for differentiated sectors.



Figure 1: Dollar invoicing share versus share of US exports over time



**Non – differentiated sectors**



## Differentiated sectors



Each of the figures above denote the share of non-EU exports invoiced in the US dollar with the bold line and the share of exports to the US with the dotted line. The most discernible fact is that there is a lot of sector wise variability in the shares of dollar invoicing. With the exception of Beverages and Tobacco, all sectors have seen increasing or somewhat constant levels of dollar invoicing. Some differentiated sectors have seen rapid increases in shares of dollar invoicing, sometimes even outpacing growth seen in non-differentiated sectors. The largest export sector of the United Kingdom, Machinery and Transport Equipment is the starkest example of this trend. It has seen an increase in share of dollar invoicing from 34% of exports to 55% of exports across 10 years while share of exports to the US have hovered around 30%. The chemicals and related products sector has also seen steadily increasing levels of dollar invoicing despite share of US exports remaining largely constant. This could imply that more exports to the US are being invoiced in the dollar and newer exports in general tend to be invoiced in the dollar. Manufactured goods chiefly classified by material were already heavily invoiced in the dollar in comparison to share of US exports. Post 2014, this sector has seen increasing levels of invoicing from 35% to 40% of exports while share of exports to the US has stayed consistent at around 22%. Commodities not classified anywhere else in the SITC have seen massive jumps in dollar invoicing shares despite decreasing US exports. These commodities are characterized by large, highly differentiated transactions that are customized to fit a particular purpose for an importing firm. It is telling that shares of dollar invoicing have shot up rapidly in this sector which is arguably the most differentiated. Miscellaneous manufactured articles have seen increases in dollar invoicing and increases in share of US exports in tandem so it is difficult to draw meaningful insights.

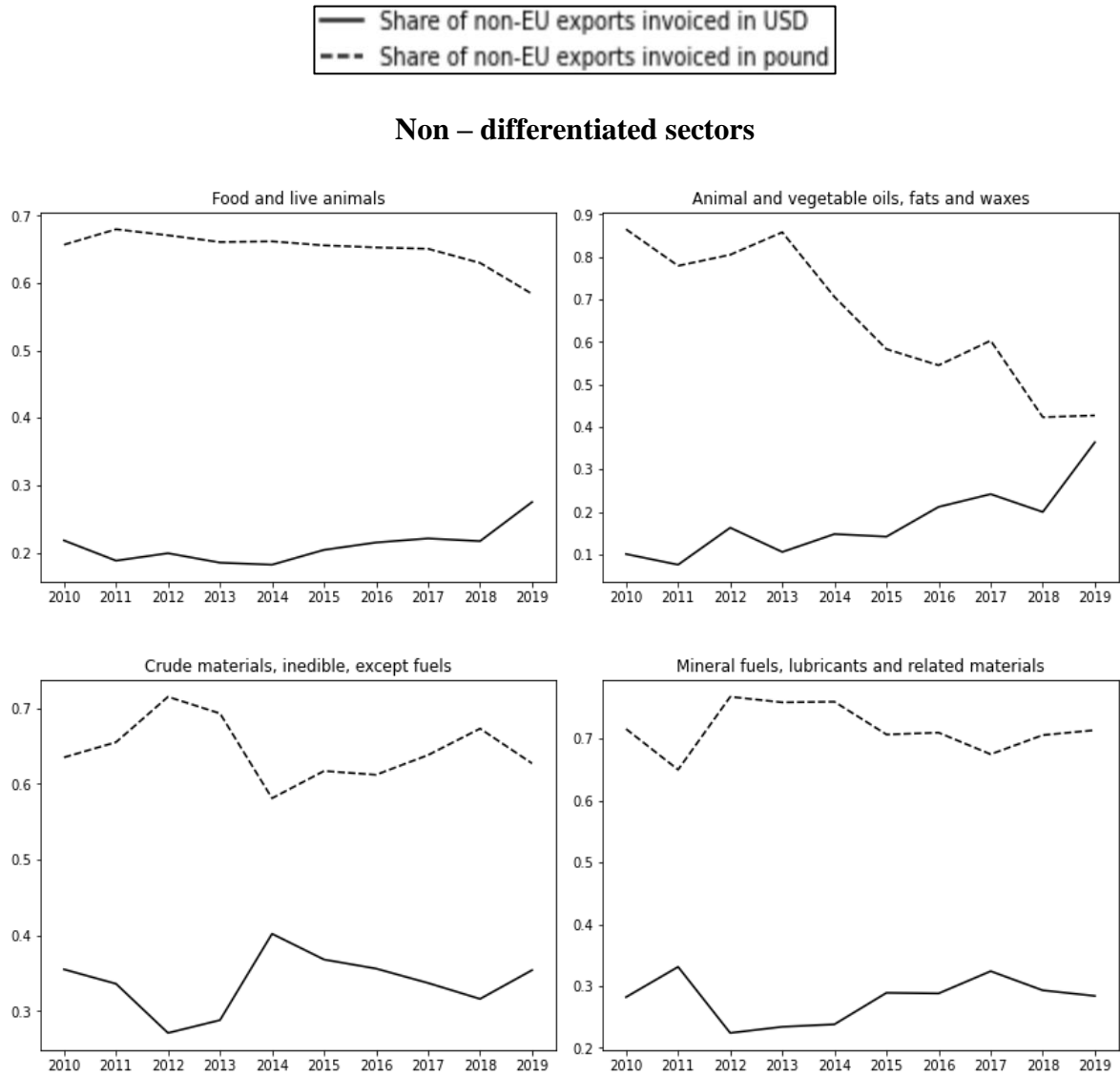
Among non – differentiated sectors, crude materials which expectedly has highest levels of dollar invoicing in comparison to US exports, has not seen any changes in levels of dollar invoicing. Food and live animals and animal and vegetable oils have seen increases in dollar invoicing levels. The mineral fuels and lubricants sector has seen constant levels of dollar invoicing despite rapidly decreasing US exports, which implies that the use of the dollar with other export partners is extensive and increasing. Overall, even when looking at raw levels of dollar invoicing relative to share of exports to the United States in 2019, most differentiated sectors have as high if not higher levels of dollar invoicing than non – differentiated sectors other than crude materials. This is in contrast with prior research done by Goldberg and Tille in 2008, thus showing that differentiated sectors have caught up to non-differentiated sectors in their levels of vehicle currency invoicing.

The Beverages and Tobacco sector is a clear outlier with decreasing levels of dollar invoicing. It also has seen negative growth with respect to non-EU exports in the last decade. UK's main export partners in this sector are overwhelmingly in the EU, so it could be that firms prefer euro or pound invoicing to align more with European conventions, however further investigation is necessary.

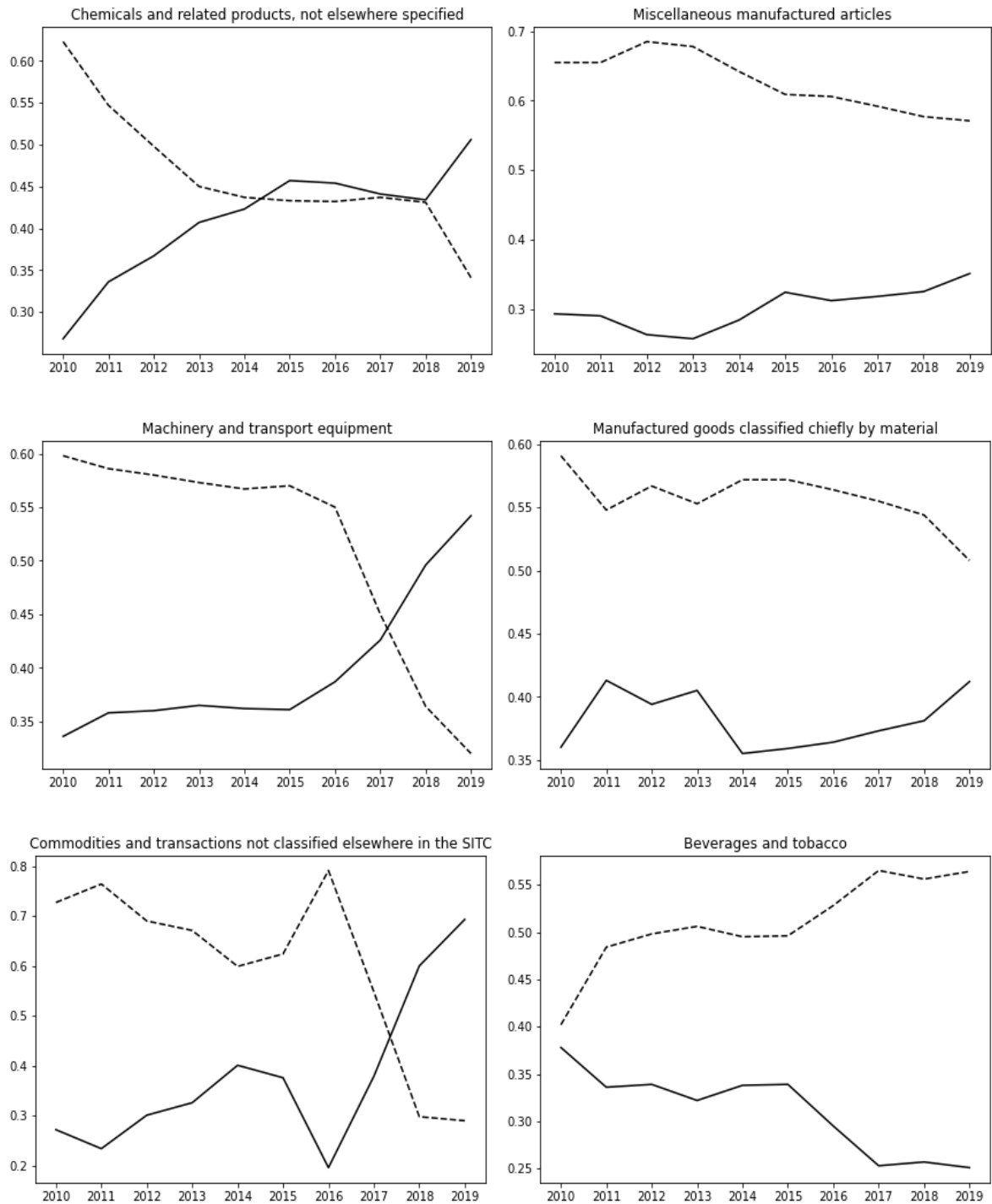
2. The increases in dollar invoicing seen across sectors have come from decreases in pound invoicing

I wanted to also look at where the increases in shares of dollar invoicing were coming from. With respect to non-EU United Kingdom exports, it seems that more transactions tend to be invoiced in the dollar due to abandoning of the pound. The below graph shows sector level trends of share of exports invoiced in the pound.

Figure 2: Dollar invoicing share versus pound invoicing share over time



## Differentiated sectors



Across all sectors except Beverages and Tobacco, there has been a steady decline in shares of exports invoiced in the Pound. The trend is particularly evident for some differentiated sectors, especially the biggest export sector in the country of machinery and transport equipment. It has seen a decline of pound invoicing from 60% of non-EU exports in 2010 to around 35% of non-EU exports in 2019. The US dollar has overtaken the pound as the dominant currency in the 3 sectors – machinery and transport equipment, chemicals and related products, and unclassified commodities. All other sectors, excluding Beverages and Tobacco, have seen slight increases of dollar invoicing levels at the cost of pound invoicing levels. Though, it is not shown in the above figures, Euro invoicing has remain largely constant and low with respect to non-EU exports, suggesting that dollar invoicing shares have mainly cannabilized on pound invoicing shares. Another interesting phenomenon as mentioned earlier is that the rmb took over the Yen in 2016 as the fourth most popular choice of invoicing currency. This came from two main sectors – machinery and transport equipment which currently invoices 4% of transactions in rmb and animal and vegetable oils which invoices 2% of transactions in rmb. Due to lack of invoicing data at the country level, it is unclear if firms are invoicing more Chinese exports in rmb or are also invoicing other exports in rmb. However, shares of rmb invoicing are still very low, implying that rmb’s rise as a vehicle currency may take a much longer time than anticipated, due to the pervasiveness of the dollar’s exorbitant privilege.

## **V. Regression methodology and results**

Current literature has done a good job of accounting for factors that explain levels of vehicle currency invoicing, but we still don’t have a good grasp of what causes changes in invoicing decisions over time. I wanted to identify factors which could help explain short term yearly changes of levels of invoicing. I also wanted to examine what happened to dollar

invoicing shares in high growth versus low growth periods. Do periods of high growth coincide with higher shares of invoicing and vice versa? Does newer growth in sectors tend to be invoiced in dollars? I considered the possibility of a relationship between sector growth rates and shares of dollar invoicing. Goldberg and Tille (2008) do not find strong evidence for links between home country aggregate demand volatility and vehicle currency invoicing choices. I do not examine home country demand volatility but focus on sector growth rates to examine how exporters change their invoicing decisions in high growth versus low growth years. I ran the following regression –

$$D_{it} = \alpha + \beta g_{it} + \gamma x_{it} + \epsilon_{it}$$

The subscript  $i$  refers to a sector while  $t$  refers to a particular year since I was dealing with panel data. The variable  $D_{it}$  refers to the change in share of non-EU UK exports invoiced in the dollar. For example, if the fraction of exports in Machinery and Transport equipment invoiced in the dollar changes from 0.35 in 2013 to 0.40 in 2014,  $D_{machinery,2014} = 0.05$ . The variable  $g_{it}$  refers to the percent growth rate in total non-EU export volume for sector  $i$  in year  $t$ . The variable  $x_{it}$  serves as a control and denotes the change in share of total non-EU UK exports to the United States. For example, if the fraction of exports in Machinery and Transport equipment to the US changes from 0.30 in 2013 to 0.27 in 2014,  $x_{machinery,2014} = 0.03$ . The purpose of including this variable was to look beyond changing exports to the United States as a mover for dollar invoicing shares. In the absence of any vehicle currency invoicing there would be a fixed relationship between  $D_{it}$  and  $x_{it}$ . The aim of this regression is to only establish correlation between shares of dollar invoicing and sector growth rates. I do not aim to prove any claims of causality. Establishing a positive correlation helps understand the growth dynamics of sectors and also shows that dollar invoicing is here to stay, since its share increases in high growth years. Table 1 and 2 outline the results including all sectors, and only differentiated sectors excluding Beverages and Tobacco and unclassified



Commodities and Transactions respectively. These two sectors were excluded from the second regression because of their high volatility and unconventional trends compared to other sectors.

Table 1: Output for all sectors

	<i>Dependent variable:</i>	
	Change in share of exports invoiced in USD for all sectors	
Sector Growth Rate	0.00003 (0.00003)	t = 0.757
Change in share of exports to US	0.199 (0.159)	t = 1.256
Constant	0.013** (0.006)	t = 2.255
Observations	90	
R <sup>2</sup>	0.019	
Adjusted R <sup>2</sup>	-0.003	
Residual Std. Error	0.054 (df = 87)	
F Statistic	0.847 (df = 2; 87)	
<i>Note:</i>	*p<0.1; **p<0.05; ***p<0.01	

Table 2: Output for Differentiated sectors

	<i>Dependent variable:</i>	
	Change in share of exports invoiced in USD for differentiated sectors	
Sector Growth Rate	0.001** (0.0005)	t = 2.345
Change in share of exports to US	-0.032 (0.127)	t = -0.254
Constant	0.012** (0.005)	t = 2.469
Observations	28	
R <sup>2</sup>	0.188	
Adjusted R <sup>2</sup>	0.123	
Residual Std. Error	0.024 (df = 25)	
F Statistic	2.887* (df = 2; 25)	
<i>Note:</i>	*p<0.1; **p<0.05; ***p<0.01	

As can be seen in Table 1, when using data from all sectors there is no significant relationship between changes in dollar invoicing shares and sector growth rates. However, when I subset for the differentiated sectors, the results are significant ( $p < 0.05$ ) as can be seen in Table 2. The constants for both regressions are similar and imply that on average, in a given sector and year, the share of dollar invoicing increases by 1.3 percentage points. The

coefficient (0.0011) of the sector growth rate seems small but it does have a meaningful interpretation. It suggests that a 10% sector growth rate in a given year is associated with an increase in share of exports invoiced in the dollar by 1.1 percentage points. The coefficients for the added control of share of US exports are not significant in any regression, which can be expected due to the high level of dollar invoicing in non-US trades. Share of exports to the United States should not and do not accurately predict changes in dollar invoicing shares.

## **VI. Discussion**

It is clear that dollar invoicing levels are increasing across all United Kingdom export sectors, including differentiated ones. The biggest and arguably one of the most differentiated export sectors in the United Kingdom of Machinery and Transport equipment has shown steepest rises in dollar invoicing levels. The link between positive sector growth rates and shares of exports invoiced in the dollar also reveal that dollar invoicing in the United Kingdom is here to stay as long as growth is positive, even though differentiated sectors are becoming increasingly important.

These trends bring into question Goldberg and Tille's (2008) findings and hypothesis that vehicle currency invoicing may decline as trade becomes increasingly among differentiated sectors. Hence the question arises, why have differentiated export sectors in the United Kingdom seen increasing levels of dollar invoicing? It seems that some other postulated factors influencing invoicing decisions are taking precedence over sector type, which has presumed to be the most important factor since Goldberg and Tille (2008). Though, it is difficult to estimate exactly what these factors may be due to lack of data availability, I emphasize one main mechanism, which has been suggested in prior research.

Firms which manufacture differentiated goods import inputs that tend to be reference priced and dollar invoiced. Hence, prior increases in dollar invoicing levels in reference

priced sectors have caused present-day increases in dollar invoicing levels in differentiated sectors. Gopinath, Gourinchas et. al (2016) highlight the importance of strategic complementarities when firms decide which currency to price exports in. Invoicing imported inputs and exports in the same currency allows firms to stabilize and better predict incoming revenue flows. Firms with higher imported inputs also have a higher demand for safe dollar deposits. Gopinath and Stein (2018) expand on how firms that import inputs in dollars with sticky import prices will prefer dollar deposits since these are the safest claims in real terms. While this logic applies more to emerging markets, a similar phenomenon could be taking place with United Kingdom exporters. They import reference-priced, sticky goods that are invoiced in dollars, thereby increasing their demand for dollar deposits and thus, invoice their exports in dollars. Amiti, Itskhoki and Konings (2020) recently found similar results for Belgian firms. Larger firms that import inputs in dollars tend to export in dollars. Thus, it is possible that despite the fact there is less incentive to herd prices in differentiated sectors, the herding incentives and high dollar invoicing levels in reference priced sectors, eventually spillover into higher dollar invoicing shares in differentiated export sectors.

It is also possible that trends seen in this data are more specific to the pound-dollar relationship. Some of the dollar invoicing levels did increase post the Brexit referendum (see Figure 2 in years post 2016). The pound has been more volatile since the vote which may play a factor in influencing firm invoicing decisions. This is in contrast to the “exorbitant privilege” of the dollar as suggested by Gopinath, Gourinchas et. al (2016), which is only increasing due to the dollar’s dominant position in international banking. This also suggests that though any vehicle currency would satisfy some theoretical models such as those put forward by Goldberg and Tille (2008), inertia of invoicing trends and the unique position of the dollar itself also play a role in cementing a vehicle currency. Despite United States’

decreasing share of world trade, the dollar could still be the vehicle currency for years to come.

## **VII. Conclusion**

In summary, dollar invoicing shares in UK exports have increased in most sectors over the past decade. Differentiated goods sectors, particularly machinery and manufactured goods sectors have shown some of the largest increases in dollar invoicing. In 2019, many of these differentiated sectors show levels of dollar invoicing that are at par if not higher than those seen in reference priced and less differentiated sectors. High growth rates in these differentiated sectors are also associated with higher shares of dollar invoicing, suggesting that newer trade contracts also tend to be invoiced in the dollar.

It seems that growth in dollar invoicing shares in non-differentiated sectors prior to 2010 is now being reflected in growth in dollar invoicing shares in differentiated sectors. Many of these differentiated sectors are characterized by large firms that are import intensive. Since these inputs are usually reference priced, it is beneficial for firms to export in the same currency to regulate revenue flows and hold safe dollar deposits. The decline in levels of pound invoicing might reflect a drop in trust of pound deposits due to recent volatility, while the dollar's 'exorbitant privilege' keeps on increasing. This also implies that it is an uphill task for the rmb to establish itself as a dominant, international currency due to the inertia and pervasiveness that come with using the dollar in most trade transactions. It remains to be seen that if the growth of differentiated trade sectors and decline of United States' share of world trade do not spell the downfall of dollar invoicing then what will?

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