Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development **30-Oct-2009**
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English text only

ECONOMICS DEPARTMENT

> **Cancels & replaces the same document of 29 October 2009**

UNDERSTANDING THE WORLD TRADE COLLAPSE

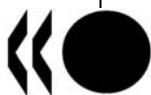**ECONOMICS DEPARTMENT WORKING PAPERS No.729**

by

Calista Cheung and Stéphanie Guichard

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ABSTRACT/RESUMÉ

Understanding the world trade collapse

The collapse in world trade volumes at the end of 2008 and beginning of 2009 was exceptional by historical standards. This paper shows that world demand (to which trade has become more responsive in recent decades) can explain most of the collapse in world trade, but that tight credit conditions have likely amplified the short-term trade response. Credit tightening likely accelerated the trade decline through trade finance constraints and its relatively larger impact on trade-intensive sectors. A portion of the trade decline remains unexplained, which may reflect a possible breakdown in global supply chains. Looking ahead, the pace of normalisation in financial conditions and the future evolution of global supply integration will affect the speed of recovery in trade and global output.

JEL classification codes: F10; F17; E0
Keywords: International trade; financial crisis; vertical supply; trade elasticity

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Comprendre l'effondrement du commerce mondial

L'effondrement du volume des échanges mondiaux à la fin de 2008 et au début de 2009 est exceptionnel dans une perspective historique. Ce document montre que l'essentiel de cet effondrement peut s'expliquer par une baisse de la demande mondiale (à laquelle le commerce est devenu plus réactif au cours des dernières décennies), mais que le resserrement des conditions de crédit a probablement joué un rôle important. La raréfaction du crédit a vraisemblablement accéléré la chute du commerce via son impact sur le financement des échanges et son impact relativement plus prononcé sur les secteurs les plus intenses en commerce. Une partie de la chute du commerce demeure inexpliquée, et pourrait refléter une rupture de chaînes d'approvisionnement mondiales. Pour l'avenir, le rythme de la normalisation dans les conditions financières et de l'évolution future de l'intégration de la production mondiale affectera la vitesse de la reprise du commerce et de la production mondiale.

Classification JEL : F10 ; F17 ; E0
Mots-clés : Commerce international ; crise financière ; intégration verticale ; élasticité du commerce

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UNDERSTANDING THE WORLD TRADE COLLAPSE

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Calista Cheung and Stéphanie Guichard[1]

1.   Introduction and main findings

1.   Having initially resisted the global economic slowdown, world trade volumes collapsed in the fourth quarter of 2008 and the first quarter of 2009 (Figure 1) at a faster pace than that observed during the Great Depression.[2,3] A striking feature of the current episode is the globally-synchronised nature of the collapse: trade contracted in almost all OECD countries, with half the economies experiencing declines greater than 20% (quarter-over-quarter, annualised). This degree of synchronisation is unprecedented in post-war history.

2.   This episode raises several questions regarding the reasons for the trade collapse and their role in the global recession. Understanding these issues is key to assessing the speed at which trade flows will recover. In particular, an important issue is whether trade was only a victim of the global crisis or contributed importantly to the synchronisation of the current recession. Another uncertainty is the role played by the global credit crunch and trade finance conditions in the trade collapse. This paper discusses the potential factors driving the recent drop in world trade, and assesses their contribution using an aggregate global trade equation developed for the purpose of assisting the OECD Economic Department's international trade projections for the *Economic Outlook* publication.[4]

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2.   All data used in charts and estimations in this paper are from the June 2009 *OECD Economic Outlook* No.85 database (EO85). Based on EO85, world trade volumes declined by 26% in 2008Q4 and by 32% in 2009Q1. Both world trade and GDP data have since been revised, and are normally subject to frequent and substantial revisions. World trade is defined as an average of world import and export volumes of goods and services.

3.   A comparison with the 2008-09 episode of trade contraction is available in Eichengreen and O'Rourke (2009). According to this analysis, the fall in the level of world trade 15 months after the start of the current crisis was almost double the decline observed over the similar period during the Great Depression. For details about the trade collapse during the Great Depression see Eichengreen and Irwin (2009).

4.   The world trade forecast remains based on a bottom-up approach in which import and export volumes are projected with the help of a system of country-specific trade equations detailed in Pain *et al.* (2005). The global trade equation has been developed as way to check the consistency of this bottom-up approach with the global activity forecast.

3.   The main findings are that the contraction in demand is the main factor behind the trade collapse, especially in a context where growth in vertical supply integration has changed the relationship between trade and income. In addition, financial conditions tightened dramatically in the second half of 2008 and likely played a role through both restricting trade finance and reducing demand in trade-intensive sectors that are most credit-dependent. Part of the world trade collapse remains difficult to explain, however, and may reflect a possible freeze or temporary breakdown in global supply chains. Looking forward, the speed of normalisation in financial conditions and the future evolution of global production chains will also affect the strength of the trade and global output recovery.

4.   The rest of this paper is organised as follows: section 2 discusses various potential factors that may have contributed to the 2008-09 drop in world trade. Section 3 sets up the basic world trade equation, and examines the increase in long-run income elasticity of trade over the past decades. Section 4 assesses the significance of vertical supply integration, financial conditions, and global synchronisation of the recession, section 5 compares the out-of-sample forecast performance among the various equations, and section 6 concludes.

Figure 1. World trade level and growth

$ billions 2005

Quarter-on-quarter annualised
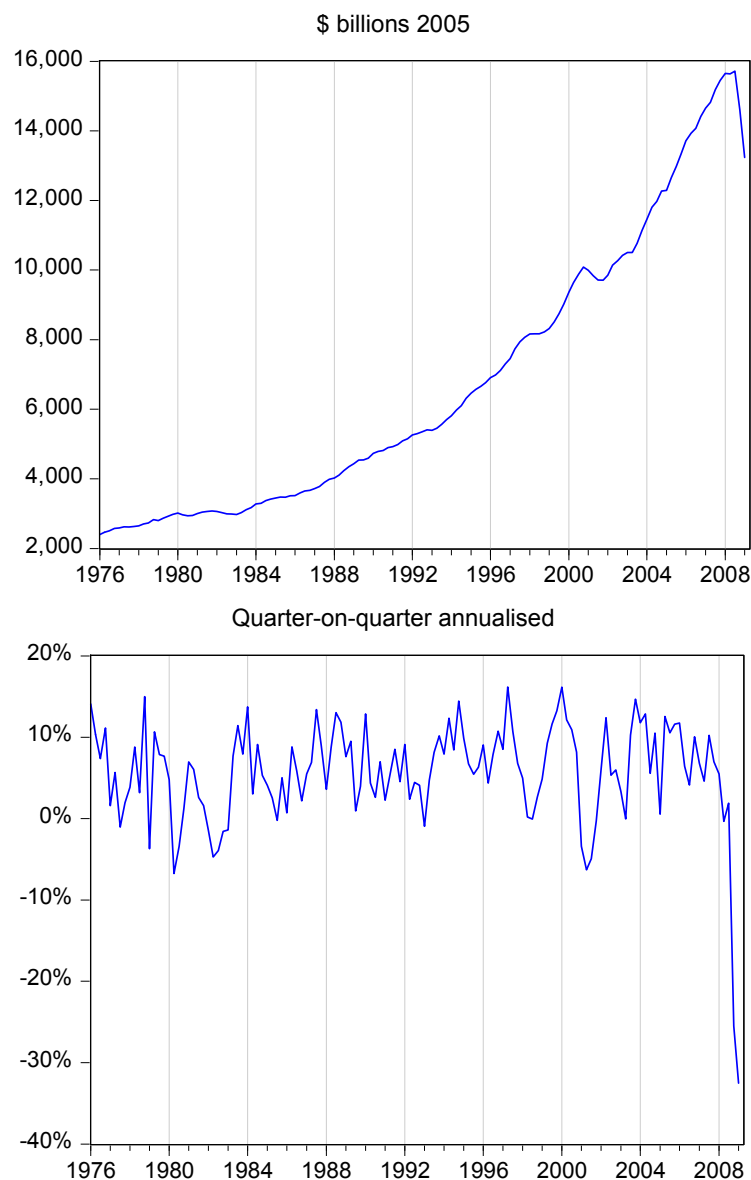
2.   Factors driving recent trade developments

5.   There is no consensus on what were the main drivers of the trade collapse in 2008Q4-2009Q1. While demand was a key factor, the disproportionately large drop in world trade suggests that additional factors played a role. The most common explanations cited include an increase in the elasticity of world trade to income, the role of supply chains, the tightening in credit conditions. Increased protectionism is also mentioned but does not seem to have played a major role.

2.1   *Global demand, higher world trade elasticities and globalisation*

6.   A considerable drop in world demand over the 2008Q4-2009Q1 period was a major factor driving the slump in world trade. World output volumes retreated by over 3% (quarter-over-quarter annualised) in 2008Q4, and by over 4% the following quarter. The bulk of the decline was driven by OECD economies -- real GDP for the OECD area as a whole receded by about 8% each quarter (annualised), with domestic demand in particular shrinking by about 6-8%. The contraction in world trade volumes was more than eight times larger than the reduction in world output over this period. This *apparent* trade response (which is a simple ratio of growth rates) is distinct from the notion of an *estimated* income elasticity, which measures the independent effect of changes in output on trade after accounting for other explanatory variables. Nonetheless, the magnitude of the *apparent* trade response over these quarters exceeds historical *estimated* income elasticities by a sizable margin, which raises the question of whether the income elasticity has increased recently. Although this is an empirical question, there are several potential explanations for why trade appears to have become more responsive to income.

7.   While the upward trending share of world trade in world output (shown in Figure 2) indicates a long-run income elasticity larger than 1, the change in slope towards the late 1980s suggests this elasticity may have increased around that time. This is consistent with the findings of Irwin (2002) and Freund (2009) -- the former estimates that the long-run elasticity of world trade to world income has increased to 3.4 since 1985, from around 1 over the 1974-1985 period.

Figure 2. Rising share of world trade in world output
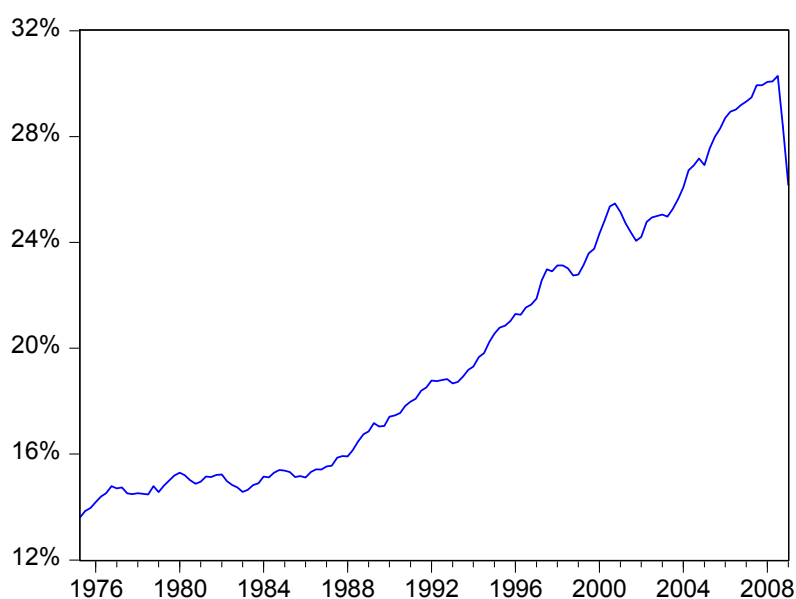
Source: OECD
*Volumes of World trade in goods and services as ratio of real world GDP (OECD+BRICs)

Figure 3. Trade costs declined in the 1990s[1]

--- Average MFN Tariff Rate on Non-Agricultural Non-Fuel Goods: US, EU, Japan, Canada (left)
--- Average Real Cost per tonne of Transported Merchandise (right)*
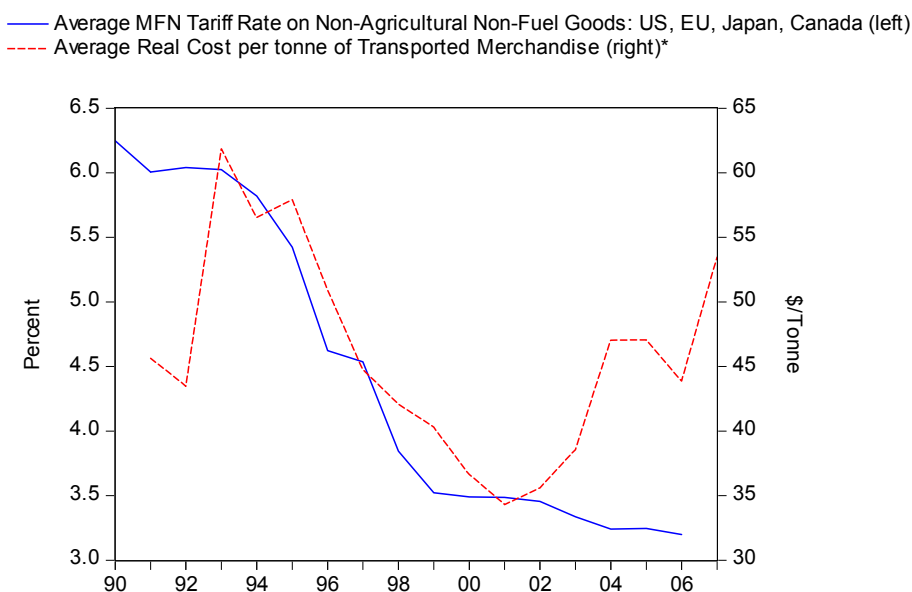
1.   See Korinek, J. (2009) for details on the Maritime Transport Cost Database.
*   Average of OECD and developing country export and import costs, deflated by world import prices (2005=1).
Source: UNCTAD TRAINS database, OECD Maritime Transport Cost Database.

8.   One potential reason for the apparent increased responsiveness of world trade to world income is that trade costs have declined since the mid-1990s (see Figure 3), as trade liberalisation has lowered tariffs and non-tariff trade barriers, and as transportation technologies have improved. Clemens and Williamson (2002) estimate that average worldwide import tariffs have dropped from 8.6% to 3.2% between 1960 and 1995, while Anderson and van Wincoop (2004) find that lower tariffs and other trade barriers explain the majority of the decline in trade costs. However, empirical evidence that trade costs have affected trade flows is mixed. On the one hand, Jacks, Meissner, and Novy (2008) find that lower trade costs (including tariffs and transportation costs) explain about a third of trade growth between 1950 and 2000. On the other hand, Jacks and Pendakur (2008) find little evidence that maritime transport innovations have contributed importantly to developments in global trade, explaining instead that lower shipping costs were endogenous technological responses to the heightened trading potential of the world. Furthermore, the evolution of real shipping costs since the mid-1990s varies considerably by region. As shown in Golub and Tomasik (2008) and Boulhol *et al* (2008), the real maritime transport cost of goods shipped from Europe and North America declined between 1995 and 2000, but rose for goods shipped from Japan, Australia, and New Zealand. To the extent that this divergence reflects bottlenecks arising from booming trade in Asia, it would suggest that changes in transport costs have responded endogenously to trade patterns. Since 2001, average real shipping costs have increased on average (Figure 3), possibly related to rising fuel prices.

9.   The globalisation of production processes, which has been facilitated by improvements in transportation technologies and lower trade barriers, has likely contributed importantly to any potential increase in trade elasticities over time. The international fragmentation of production implies that the export of one manufactured good now involves multiple border crossings of intermediate goods with incremental value added at each production stage. Since trade flows are measured in gross terms while GDP is measured in value-added, the change in trade flows is a multiple of the change in demand for the final exported good (Yi, 2009). Vertical supply integration (VSI) has risen and accounts for one-third of total trade growth in the last 20-30 years, as estimated by Hummels *et al.* (2001). While global production

chains have grown especially in Asia since the early 1990s (see Amador and Cabral, 2009), Miroudot and Ragoussis (2009) also find that vertical trade now represents over 30% of trade flows among OECD economies, accession countries and enhanced engagement countries. Furthermore, Yi (2003) proposes that the emergence of international supply chains can both magnify and generate non-linear trade responses to global shocks.

10.   Figure 4 illustrates that the share of world trade in world income has evolved roughly in line with world VSI, as measured in Amador and Cabral (2009). This proxy is constructed from input-output data based on an extension of the methodology of Hummels *et al.* (2001), and identifies vertical trade as the "excess" imports of an intermediate good for a given country with above-average exports of a related good. Growth in VSI began to gather pace in the early to mid-1990s, followed by a pause in the late 1990s, and an even sharper acceleration since the early 2000s. While the growth in VSI over the 1990s may be related to the simultaneous decline in trade costs over that period (Figure 3), the acceleration since 2000 appears to be driven more by increasing integration of production processes in Asia, as this region accounts for 60% of total vertical trade in the 2001-05 period (Amador and Cabral, 2009).

11.   These developments may have contributed to the apparent impact of the demand contraction on trade flows at the end of 2008, and to the synchronisation of the trade collapse. In particular, the OECD countries that experienced larger-than-average trade declines were for the most part those for which vertical trade constitutes more than one-quarter of total trade (Germany, Finland, Korea, Spain, Mexico, Hungary, Portugal, Czech Republic and Belgium), as shown in Figure 5, or else those whose shares of vertical trade have increased the most since the mid-1990s (Japan and Turkey).[5] Outside the OECD, supply chains have propagated the crisis to countries most engaged in vertical specialisation. Nonetheless, whether *estimated* income elasticities have changed after accounting for these factors remains unclear, and will be explored in section 3.

Figure 4. Vertical Supply Integration has accelerated
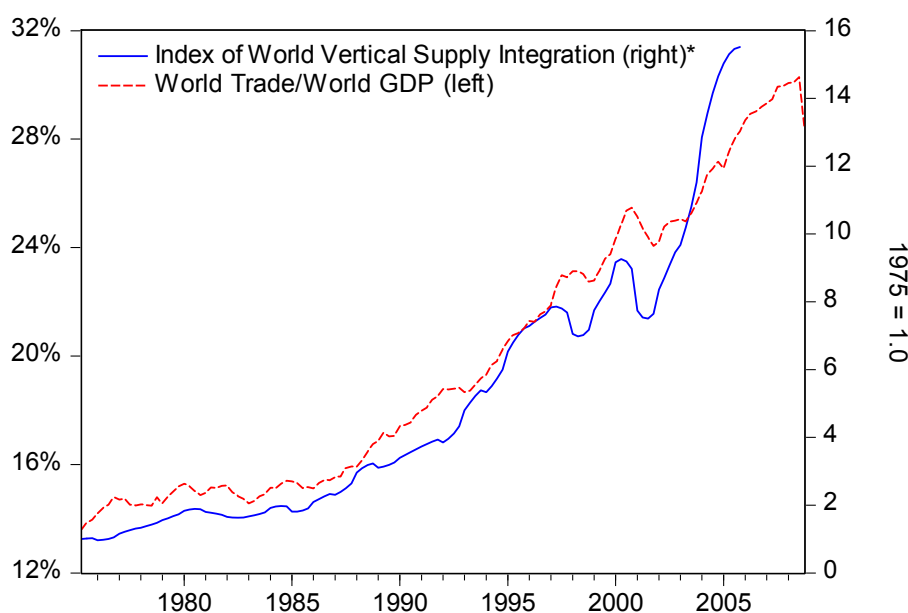
*Source: Amador and Cabral (2009)

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5.   Information on estimated shares of vertical trade in total trade is obtained from Miroudot and Ragoussis (2009).

Figure 5. Share of vertical specialisation in trade

The latest year available
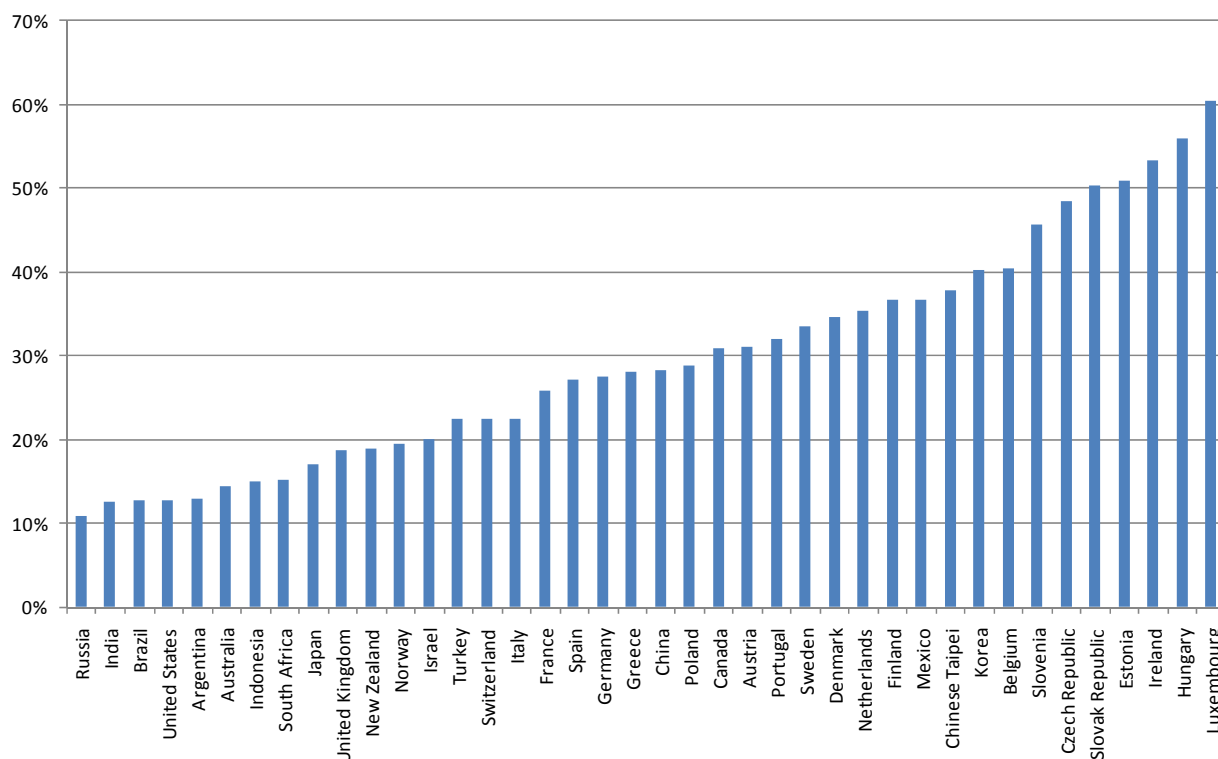
Source: Miroudot and Ragoussis (2009).

2.2   Other possible factors

12.   Even if the trade elasticity to demand has increased over time, the very large apparent elasticities implied by trade movements in 2008Q4-2009Q1 suggest that this episode is special and that factors other than demand have likely played a role in the trade collapse.

2.2.1   Trade finance and the global credit crunch

13.   Anecdotal evidence and surveys suggest that following the global credit crunch, trade finance conditions tightened in late 2008 resulting in reduced availability and much higher cost.[6] The impact is heterogeneous, affecting some countries, products or companies more than others (*e.g.* Humphrey, 2009 on Africa). Part of the international response to the global crisis has indeed involved support to trade financing, including the expansion of: 1) trade facilitation programmes run by regional development banks and the International Finance Corporation; and 2) credit and guarantee programmes run by export credit agencies.[7] It is, however, difficult to quantify the trade finance squeeze in the absence of time series on trade finance.

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6.   See for instance the 2009 International Chamber of Commerce Global survey (ICC, 2009); the IMF *Survey of Private Sector Trade Credit Development*; and surveys mentioned in Chauffour and Farole (2009).

7.   Details of the measures can be found in Chauffour and Farole (2009).

14.   More indirectly, the financial crisis may have magnified the apparent trade response to contracting demand through its larger impact on trade-intensive sectors. The credit-sensitive sectors affected the worst by the financial crisis have been those with the most globally-fragmented production processes and that represent a larger share of world trade than world output: motor vehicles and investment goods. In the fourth quarter of 2008, average OECD real investment in machinery and equipment declined by about 23%, while real consumption of durables fell about 15% (Figure 6). Meanwhile, trade in services seems to have fallen less than trade in goods.[8] Furthermore, the combination of the credit crunch and abrupt drop in demand against the setting of high energy prices may have disrupted supply chains and amplified the fall in world trade, although this cannot be confirmed due to the lack of VSI data over the recent period. However, it would likely be difficult to disentangle such an effect on trade from that of the trade finance squeeze given their interconnected nature.

Figure 6. Decline in demand for capital and durable goods has likely affected trade more than output
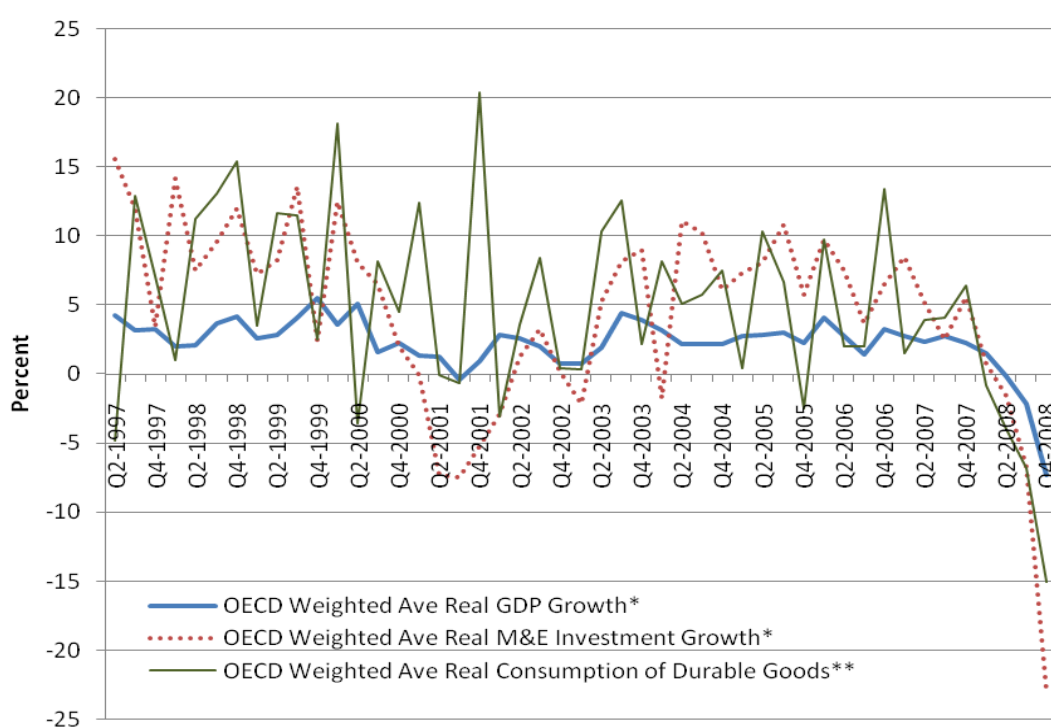
* OECD excluding Hungary, Iceland, Ireland, Poland, Switzerland, Turkey, weighted by 2008 PPP GDP shares
** OECD excluding Australia, Greece, Hungary, Iceland, Ireland, Korea, Luxembourg, Norway, Poland, Portugal, Sweden, Switzerland, Turkey, UK, weighted by 2008 PPP GDP shares

2.2.2   Protectionism

15.   Trade barriers normally escalate during economic downturns. During the Great Depression, an estimated 55% of the trade decline was due to higher trade barriers, and 45% from lower income (Irwin, 2002). Trade-restricting or distorting policies have increased since the start of the financial crisis -- the WTO (2009) reports an expansion in tariff and new non-tariff measures, anti-dumping actions, and

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8.   This is indicated by the larger reductions observed in merchandise trade volumes relative to goods and services (although the two measures are not fully comparable). While the two measures declined by similar magnitudes in 2008Q4, in 2009Q1 merchandise trade volumes decreased by 40% compared with 32% for world trade of goods and services. For more detailed analysis on trade of services see Borchert and Mattoo (2009) and Araújo and Martins (2009).

measures within various countries' stimulus packages that favour domestic goods and services.[9] Trade protections have indeed taken new forms, notably in advanced economies where subsidies and implicit protection measures were included in stimulus packages (including support to the automobile producers and financial institutions). So far, however, according to the World Bank and the WTO, protectionism does not seem to have played a significant role in the trade collapse, and increases in measures such as anti-dumping initiation have been less than predicted by historical relationships.[10] Bown (2009) finds, for instance, that for most economies the new protectionism measures account for only 0.2% to 0.8% of the fall in imports from pre-crisis levels. Although several factors limit the risk of a repetition of the 1930s' escalation of protectionism, including international trade co-operation, economic interdependency, and stronger exports lobbies, additional trade barriers could weigh on the recovery.

2.2.3   *Synchronised recession effect*

16.   A globally-synchronised economic downturn could accelerate the adjustment in trade flows relative to localised recessions, since trade would respond simultaneously across many countries. As a result, even though expected long-run income elasticities would not change, the initial trade response could be larger than usual. Indeed, findings from the IMF (2009b) suggest that global recessions tend to be characterised by weaker export activity than regular recessions. Freund (2009) further reasons that global slowdowns may curb trade more than usual because of: i) a sharper drawdown of firms' inventories; ii) greater protectionist policies; iii) a larger decline in trade of goods, which make up the bulk of world trade, relative to services, which account for a greater share of world GDP; iv) a breakdown of vertical supply chains as demand falls; and v) a preference to source more from domestic suppliers during downturns because of trust or financing problems.

3.   The basic global trade equation

3.1   *Overview*

17.   The framework for analysing recent developments in world trade begins with the following basic error-correction model (ECM) equation.

$$\Delta WT_t = \alpha_0 + \sum_{i=1}^{m} \beta_{1i} \Delta WT_{t-i} + \sum_{j=0}^{n} \beta_{2j} \Delta GDP_{t-j} + \lambda v_{t-1} + \varepsilon_t \qquad [1]$$

$$WT_t = \chi GDP_t + v_t \qquad [2]$$

where WT_t denotes the logged level of world trade volumes, defined as the average of total world import volumes and world export volumes. This basic equation [1] rests on the assumption that movements in world trade are characterised by dynamic adjustments, at the speed of λ, to some long-run equilibrium level that is dependent on the logged level of real world income, GDP_t, and v_t is the deviation from this equilibrium as defined by the cointegrating equation [2].

18.   The existence of cointegration between world trade and world income is tested using Engle-Granger tests on the residuals from estimates of equation [2]. Given the potential endogeneity problems between world trade and world output, these estimations are performed using the dynamic least squares

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9.   See also Evenett (2009) for detailed information on measures taken during the current global downturn that are likely to affect foreign commerce.

10.   See World Bank Global Monitoring Report (2009) and WTO (2009).

methodology of Saikkonen (1991) to correct for any endogeneity and serial correlation in the cointegrating equation:

$$WT_t = \chi GDP_t + \sum_{j=-k}^{k} \varphi_j \Delta GDP_{t-j} + \omega_t$$

19.   World real income is proxied by two series: one series is constructed as a weighted aggregate of output in OECD countries plus Brazil, Russia, India, and China, and a second series that only includes OECD countries. The OECD GDP series accounts for more than 80% of output in the first aggregate, is available on a more timely basis, and is more reliable on a quarterly basis. It was therefore retained in the remainder of the paper as the preferred explanatory variable.

3.2   *The long-run relationship between world trade and world income*

20.   Preliminary tests over the longest available samples (1975q2-2008q4) between world trade and either world GDP or OECD GDP cannot reject the null of no cointegration.[11] This is consistent with the evidence of changes in the long-run elasticity of world trade to world income found in Irwin (2002) and Freund (2009). To assess whether shifts may have occurred in the relationship, Gregory-Hansen (1996a, 1996b) tests were then conducted on the null hypothesis of no cointegration allowing for a possible structural break.

21.   Test results suggest that the elasticity of world trade to income has increased over time. The first two columns of Table 1 show results from the Gregory-Hansen tests for cointegration between world trade and both real world GDP and real OECD GDP. The results suggest a break may have occurred in the equilibrium relationship between world trade and world GDP in 1989Q4, although the null hypothesis of no cointegration cannot be rejected. This break date appears to coincide reasonably well with the period when the share of trade in world output began to trend more steeply (Figure 2).[12] The depiction of the coefficients in bold in the second regime indicate that they are significantly different from estimates over the first regime. Replacing world GDP with OECD GDP does strengthen the support for cointegration somewhat, providing further reason to favour this measure for subsequent estimations.[13] A break was found in 1986Q3, after which the estimated elasticity of trade to income appears to have almost doubled from about 1.3 to 2.5.[14] These elasticity estimates over the second regime remain lower than those found in Irwin (2002) and Freund (2009), although part of the discrepancy reflects the difference in sample periods

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11.   Alternative tests for cointegration were also performed including non-OECD GDP separately from OECD GDP, and also replacing OECD GDP with OECD domestic demand or OECD investment -- all generated inferior results to those using OECD GDP.

12.   Since the Gregory-Hansen methodology allows for only one possible shift, this test is meant primarily to provide empirical support for an increase in the long-run income elasticity of trade over the history of the series. The test was also conducted over the sample of the second regime (1988Q3-2008Q4), with no evidence found for a second structural shift. Based on lack of visual signs of a subsequent regime shift, tests allowing for multiple structural breaks in the cointegrating equation (for example, see Kejriwal and Perron, 2009) were not pursued.

13.   The apparently stronger relationship between world trade and OECD GDP relative to world GDP may reflect that a considerable portion of output growth outside of the OECD (particularly China) in recent years has been export-oriented, with final demand originating in OECD countries. See Asian Development Bank (2007).

14.   Tests including a time trend in the estimations caused the long-run coefficient on GDP to become negative, and were therefore not pursued further.

used.[15] As discussed in section 2.1, declining trade costs or barriers may explain the variation in income elasticity over time. However, the lack of long time series data on trade tariffs or non-tariff barriers (the series constructed from UNCTAD data shown in Figure 2 begins in 1989 did not permit a formal testing of this hypothesis over this sample period).[16]

Table 1. Cointegrating equation with regime shift

Dependent variable: Δ (WT)	(A) *GDP* = World GDP	(B) *GDP* = OECD GDP	(C) *GDP* = OECD GDP
Regime 1:	1975Q2–1989Q3	1975Q2-1986Q2	1975Q2-1988Q2
Constant *GDP$_t$* *IVSI$_t$*	-12.27*** 1.35***	-10.93*** 1.32***	-8.55*** 1.21*** 0.06***
Regime 2:	1989Q4-2008Q4	1986Q3-2008Q4	1988Q3-2005Q4
Constant *GDP$_t$* *IVSI$_t$*	**-25.86*** 1.79***	**-47.37*** 2.51***	**-39.18*** 2.20*** 0.09***
ADF t-statistic[†]	3.86	4.19	5.78**

1. *,**,*** denotes statistical significance at the 10%, 5%, and 1% levels, respectively.
2. Figures depicted in bold indicate that the coefficient in the second regime is statistically different from that in the first regime at 1% significance level.
3. [†] Gregory and Hansen (1996) critical values used to determine significance.

22.   Growth in vertical supply integration (VSI), which may itself be partly a reflection of declining trade costs or barriers, is another potential explanation for the larger apparent long-run response of trade to changes in income over time. To assess the role of VSI in driving world trade movements, a quarterly index ($IVSI_t$) is constructed through interpolation of the Amador and Cabral (2009) measure, which is an annual series ending in 2005, and included in the cointegrating equation of the form:

$$WT_t = \chi GDP_t + \eta IVSI_t + v_t \qquad \qquad [2a]$$

where growth in VSI is assumed to affect world trade independently of changes in world income. An alternative equation is also tested which allows for the possibility that rising VSI may influence trade by raising its estimated elasticity with respect to income:

$$WT_t = \mu + \chi GDP_t + \eta IVSI_t + \kappa(IVSIc_t * GDPc_t) + v_t \qquad \qquad [2b]$$

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15.   Freund (2009) estimates are based on a simple regression of real world trade growth on real world GDP growth, and therefore do not distinguish between short-run and long-run elasticities. Irwin (2002) estimates an autoregressive distributed lag (ARDL) equation for the level of world exports and finds that the long-run elasticity with respect to income has increased from 1.0 over the 1974-1985 interval to 3.4 over the 1985-2000 period. As a robustness check, ARDL equations were estimated for the equations presented in this paper, with no significant differences in the estimated long-run elasticities or cointegration results relative to those presented.

16.   World oil prices were also tested and found to have no significant impact on world trade.

where $IVSIc_t$ and $GDPc_t$ represent deviations of $IVSI$ and income from their respective means, and κ represents the additional elasticity to income resulting from the growth of vertical supply chains.[17]

23. Estimates from Gregory-Hansen tests suggest that vertical supply integration has significantly affected long-run levels of world trade; results from estimation of equation [2a] over 1975Q2-2005Q4 are shown in the third column of Table 1. Estimations of equation [2b] produced coefficients of the incorrect sign on the VSI variable and are thus not reported. Incorporating the VSI measure significantly strengthens the evidence of cointegration to the 5% significance level, with the same break date found at 1988Q3.

24. While VSI is found to significantly influence trade, its quantitative impact is relatively small, suggesting that every 10% increase in vertical trade has added less than 1% to the long-run level of world trade. Whereas the effect of VSI does not change significantly between the two regimes, the estimated trade elasticity to income continues to rise significantly from 1.2 to 2.1 after the break point (as compared to rising from 1.3 to 2.5 when VSI is not included). These results suggest that factors not embodied in the VSI proxy have contributed to increasing the trade elasticity to income. This could reflect the limits of the VSI series,[18] or the decline in trade costs over the 1990s, which is not taken into account in the analysis.[19] Further analyses presented in the appendix suggest that the higher long-run income elasticity of trade since the late 1980s is more likely related to increasing VSI.

3.3 The basic global equation

25. Based on evidence of a structural shift towards the end of the 1980s, estimations of the full ECM equation were then performed restricting the sample to the second regime. For ease of comparison, the sample period begins in 1990Q2, based on the earliest available observation for one of the financial conditions variables that are introduced in the next section. The ending point of 2007Q4 was chosen to ensure that statistical significance of the regressors was not distorted by the financial crisis period.

26. In order to extend the $IVSI$ variable beyond 2005, forecasted values were used based on a simple $AR(q)$ model.[20] As depicted in Figure 7, these forecasted values follow reasonably well the trend in world trade relative to world income up until mid-2008. Ending the sample before the financial crisis avoids having to estimate how VSI evolved during the crisis and make any assumption on the possible disruption in supply chains. Nonetheless, the arbitrary nature of this assumption obviously limits the usefulness of this variable for practical application, and identifying a suitable proxy that is updated on a more timely basis remains a challenge.[21] The estimation results do not appear distorted by the assumed values for $IVSI$

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17. The variables are centred in order to reduce possible multicollinearity arising from the introduction of the interaction term (see Freidrich, 1982, Cronbach, 1987 and Iverson, 1991).

18. This VSI measure is merely a proxy that may not adequately capture the extent to which global production linkages have grown. As described by Amador and Cabral (2009), the proxy likely underestimates true vertical trade, since it only recognises imports of intermediates in "excess" of some international threshold. Furthermore, it includes only imports of intermediate inputs that are used to produce export goods, thus excluding those used for goods sold domestically.

19. Another possible explanation is the shift in composition of trade over time from agricultural goods and raw materials towards more income-elastic manufactures. Although it was expected that such an effect would be reflected in a higher coefficient on the interaction term of equation [2b], this was not supported by the estimation results.

20. An alternative series was generated whereby values beyond 2005 were held constant at the latest available data point. Using this series did not generate significant differences in any of the results reported in this paper.

21. Variables considered to proxy growth in VSI at the world level include the share of intermediate goods in total trade, the share of manufactures in OECD trade as a ratio to its share in OECD GDP, as well as

beyond 2005, as shown by the similarity of results for estimations ending in 2005Q4 that are reported for comparison in the Appendix.

Figure 7. Assumed values for index of Vertical Supply Integration beyond 2005

— Index of World VSI with Forecasted Values beyond 2005* (right)
--- World Trade/World GDP (left)
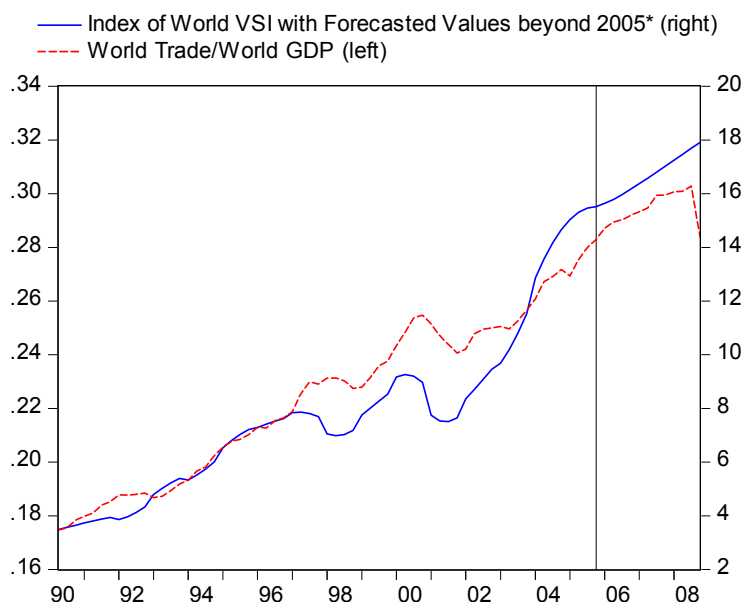
Source: Amador and Cabral (2009)

27.   Results from estimations of the basic equation [1] and the basic equation with VSI effects over this 1990Q2-2007Q4 sample period are shown in the first two columns of Table 2. The short-run dynamics include the contemporaneous and lagged change in GDP_t.[22] Engle-Granger (1987) residual-based tests now suggest that the null hypothesis of no cointegration is just short of being rejected at the 10% level for the basic equation, and can be rejected at the 1% level when VSI effects are incorporated (second column).[23] The basic equation (A) suggests elasticities with respect to income of about 2.5 in the long run, and 3.0 in the short-run (after two quarters). Relative to the basic equation, incorporating the VSI proxy in the long-run equilibrium improves the adjusted R^2 considerably. Including the VSI variable lowers the long-run income elasticity from 2.5 to 2.0, suggesting that VSI implicitly adds 0.5 to the *apparent* long-run response of trade to changes in income. These estimations produce lower short-run trade elasticities with respect to

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growth in manufacturing FDI flows. It was found that trade in intermediate goods has actually declined as a share of total trade, as documented by Hummels *et al.* (2001), and therefore does not capture the evolution of VSI. Movements in the share of manufactures in OECD trade relative to its share in OECD GDP, obtained from the OECD *STAN* database, have also followed a different pattern from the VSI measure, and are not sufficiently timely given their publication lag of one to two years. This latter limitation also applied to FDI data.

22.   One lag of the ΔGDP variable is included, since coefficients on additional lags were found insignificant.

23.   Ericsson and Mackinnon (2002) critical values are used. For all equations in this paper estimations were also performed using the dynamic least squares method of Saikkonen (1991) to correct for possible endogeneity and serial correlation in the cointegrating equation. In most cases these did not result in significantly different estimates of the long-run parameters, and therefore results based on one-step non-linear estimations are reported. In the short-run dynamics, Hausman (1978) tests did not find any endogeneity problems associated with the contemporaneous OECD GDP variable.

GDP, and also imply considerably faster adjustment to long-run equilibrium levels relative to the basic equation. When the sample is cut off at 2005 the results do not change significantly (see Appendix).

28.   In order to capture the larger trade effects from reduced demand for capital and durable goods in recent quarters, tests were also performed replacing growth in OECD GDP with growth in OECD non-residential investment in the short-run dynamics. In general these variations produced inferior equation fit, and the results are reported in the Appendix.

4.   Expanding the general framework

29.   This section expands the basic equation to assess the role of financial conditions and the globalised recession in driving the recent trade collapse.

4.1   Assessing the role of financial conditions

30.   To assess the possible role of trade finance constraints in driving world trade movements, the next step was to expand the equation by including variables that reflect the state of global financial conditions. In the absence of reliable data on trade finance or even global financial conditions, three proxies were used. The first series is the percentage of banks reporting a tightening in credit on commercial and industrial loans to large and medium sized firms, minus the percentage reporting a loosening, taken from the US *FRB Senior Loan Officer Opinion Survey*. This variable is meant to represent changes in global credit availability, whereby an increase in the series signifies a tightening of conditions. In order to capture the increase in the cost of credit, the second proxy used is the US high yield spread on ten-year government bonds. In addition, a "financial stress" variable was constructed which uses information from both credit availability and spread variables. This variable is meant to capture changes in both availability and cost of credit, while also assigning a larger weight to financial crisis episodes, when both levels of credit tightening and spreads are high.[24]

31.   Using data that represent only the US economy is a clear limit of this analysis where global indicators would have been preferable. This choice is justified by both the strong international correlation of bonds spreads and the absence of long history on credit availability surveys outside the United States. Nonetheless, these proxies for trade finance conditions may underestimate the impact on trade if financial crises tend to restrict trade finance relatively more than other forms of credit. This may occur, for example, if international trade is more vulnerable to counterparty risk.

32.   Changes in credit availability are expected to influence world trade growth over the short run, and so the variable is included in the short-term dynamics of the basic equation.[25] Including the credit availability variable raises the fit of the equation considerably relative to the basic equation, as demonstrated by results in the third column of Table 2, and gives the expected result that a tightening in credit availability significantly lowers world trade growth in the short term. The magnitude of the effect is relatively small, implying that a 10% balance of firms tightening credit would remove 0.2 percentage points (about 0.7 percentage points annualised) from world trade growth in the short run. Nonetheless, this

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24.   This variable is constructed by interacting the credit availability variable with the spread variable. This term is found to be stationary based on ADF tests. When the credit availability variable and the spread variable were included in the equation together or separately with the interaction term, neither of them were significant, even after centring the interacted variables. The interaction term was therefore included on its own.

25.   The credit availability variable is found to be stationary based on ADF tests that reject the presence of a unit root at the 10% significance level, and is therefore included in level terms in the equation.

suggests that in 2008Q4 credit constraints would have lowered world trade growth by almost 6 percentage points annualised, accounting for almost 20% of the trade decline.

Table 2. Estimations results 1990Q2-2007Q4

Dependent Variable: Δ (*WT*$_t$)	(A) Basic Equation	(B) Equation with VSI	(C) Equation + credit availability	(D) Equation + financial stress	(E) Equation with VSI + financial stress
Constant	-5.07***	-10.64***	-8.51***	-8.50***	-11.96***
	(-2.8)	(-5.5)	(-4.6)	(-4.5)	(-5.9)
ECM adjustment parameter (λ)¥	-0.10	-0.33***	-0.17***	-0.17***	-0.34***
	(-2.8)	(6.1)	(-4.6)	(-4.4)	(-6.5)
GDP$_{t-1}$	2.54***	2.01***	2.54***	2.54***	2.05***
	(36.6)	(26.0)	(67.9)	(67.9)	(23.0)
IVSI$_{t-1}$		0.17***			0.15***
		(7.0)			(5.4)
Δ*GDP$_t$*	1.82***	1.23***	1.43***	1.39***	1.18***
	(4.2)	(4.0)	(3.8)	(3.6)	(3.7)
Δ *GDP$_{t-1}$*	1.22***	0.83**	1.17***	1.14***	0.84**
	(3.4)	(2.6)	(3.7)	(3.6)	(2.6)
Credit standards			-0.02***		
			(-3.5)		
Financial stress				-0.24***	-0.05
				(-3.1)	(-0.61)
Adj R²	0.504	0.654	0.569	0.558	0.645
S.E. of regression	0.008	0.007	0.007	0.008	0.007

1. t-statistics in parentheses.
2. ,**, *** denotes significance at the 10%, 5%, and 1% level respectively, based on Newey-West HAC standard errors.
3. ¥ Ericsson and Mackinnon (2002) critical values used to determine significance.

33. The fourth column of Table 2 displays the results when the basic equation is augmented with the financial stress variable. This variable has a statistically significant coefficient of the correct sign, and implies that credit conditions in 2008Q4 removed about 13 percentage points off world trade growth, explaining about 45% of the collapse. However, including this variable does not improve the fit of the equation relative to the version that accounts only for credit availability. When included separately, the spreads variable was not significant, and when included on its own produced even worse equation fit, and the results are therefore not reported. Simple tests for threshold effects were conducted to investigate whether financial conditions bear a non-linear relationship with trade, with varying effects when credit is constrained relative to normal times. These provided no strong evidence of a non-linear impact of financial conditions on trade, and the results are shown in the Appendix (Table A4).

34. Including the financial conditions variables strengthens the evidence of cointegration relative to the basic equation, with the t-statistics on the ECM term now able to reject the null hypothesis of no cointegration at the 1% significance level. When VSI effects are included (fifth column of Table 2), however, neither of the financial conditions variables remains significant. This may reflect the interconnected nature of the credit boom leading up to the financial crisis. Since the crisis had the largest impact on sectors most highly integrated into global supply chains, by the same token the preceding credit boom may have facilitated the expansion of vertical supply linkages, making their impacts on trade difficult to separate. In this regard, when the VSI variable is excluded, the estimated impact of financial conditions variables likely incorporates the effect arising from the demand composition of the downturn, which was concentrated in credit-sensitive sectors that are most trade-intensive.

4.2 Impact of synchronised recession

35.   Although the presence of a global recession would not be expected to change long-run income elasticities, it could hasten the adjustment of trade to demand and thereby augment the initial trade response. To assess the importance of the global shock in driving recent trade weakness, a variable was created to try to capture the presence of globally-synchronised recessions. This was constructed using real GDP data on all OECD countries, along with Brazil, Russia, India, China, and the OECD accession countries (Estonia, Chile, Israel, and Slovenia), for a total of up to 38 countries. The methodology chosen to identify recessions differs from that of the IMF (2009b), which is based on the Burns and Mitchell (1946) approach to dating turning points that identifies recessions as the entire period between peak to trough in real GDP. Since in practice it is difficult to identify peaks and troughs in real-time, a simplified method is chosen whereby recessions are defined simply as two consecutive quarters of contraction in real GDP. A globally-synchronised recession is then defined as occurring when more than 30% of the countries face recession -- this identifies three episodes between 1990 and 2008: 1991Q1-1991Q3, 1992Q3-1994Q1, and 2008Q2-2008Q4.[26] Figure 8 depicts the percentage of countries in recession based on this identification method compared with that using the IMF (2009b) method.

Figure 8. Percentage of countries in recession
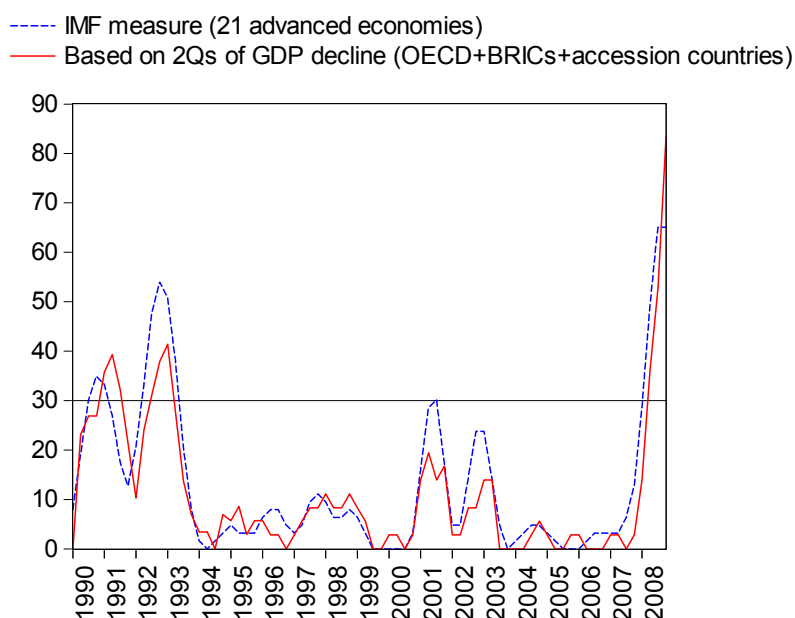
Source: IMF (2009b), OECD calculations

36.   A dummy variable is then constructed which takes the value of 1 when there is a globally-synchronised recession -- this variable is then interacted with ΔGDP_t in the short-term dynamics of the equation.[27] The results, shown in Table 3, are somewhat mixed on whether global recessions add any significant impact on global trade over and above that during normal times. Results in the first column of Table 3 suggest no additional impact from global recessions when the credit availability variable is included in the basic equation (and similarly when including the financial stress variable). However, when VSI effects are incorporated (second column of Table 3), incidences of global recessions are found to raise significantly the short-run income elasticity of trade (Figure 9). This suggests that the trade response to

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26.   Using the IMF (2009b) method would have additionally identified the 2001 episode as a globally-synchronised recession. However, including this episode did not affect the estimations results significantly.

27.   The dummy variable is also included individually but was found to be insignificant.

income changes tends to overshoot its long-run income elasticity much more during times of global recession. However, financial conditions variables become insignificant when the effects of VSI are included. Results for estimations ending in 2005 (Table A3) do not vary significantly.

Table 3. Estimations results 1990Q2-2007Q4

Dependent Variable: $\Delta\,(WT_t)$	(F) Equation + credit availability + synchronisation	(G) Equation with VSI + credit availability + synchronisation	(H) Equation with VSI + synchronisation
Constant	-8.50***	-12.27***	-12.27***
	(-4.6)	(-5.9)	(-6.05)
ECM adjustment parameter (λ)$^{¥}$	-0.17***	-0.35***	-0.35***
	(-4.6)	(-6.7)	(-6.5)
GDP_{t-1}	2.54***	2.02***	2.03***
	(72.5)	(23.4)	(28.8)
$IVSI_{t-1}$		0.16***	0.16***
		(6.0)	(7.3)
ΔGDP_t	1.43***	1.19***	1.18***
	(3.7)	(3.6)	(3.7)
ΔGDP_t *Sync dummy	0.27	1.30**	1.28**
	(0.3)	(2.3)	(2.3)
$\Delta\,GDP_{t-1}$	1.19***	0.92***	0.92***
	(3.6)	(3.1)	(3.1)
US credit standards	-0.02***	0.00	
	(-3.5)	(0.09)	
Adj R^2	0.563	0.652	0.657
S.E. of regression	0.007	0.007	0.007

1.   t-statistics in parentheses.
2.   *, **, *** denotes significance at the 10%, 5%, and 1% level respectively, based on Newey-West HAC standard errors.
3. $^{¥}$Ericsson and Mackinnon (2002) critical values used to determine significance.

Figure 9. Impact of a 1 percentage point contraction of OECD GDP on world trade with and without a synchronised recession
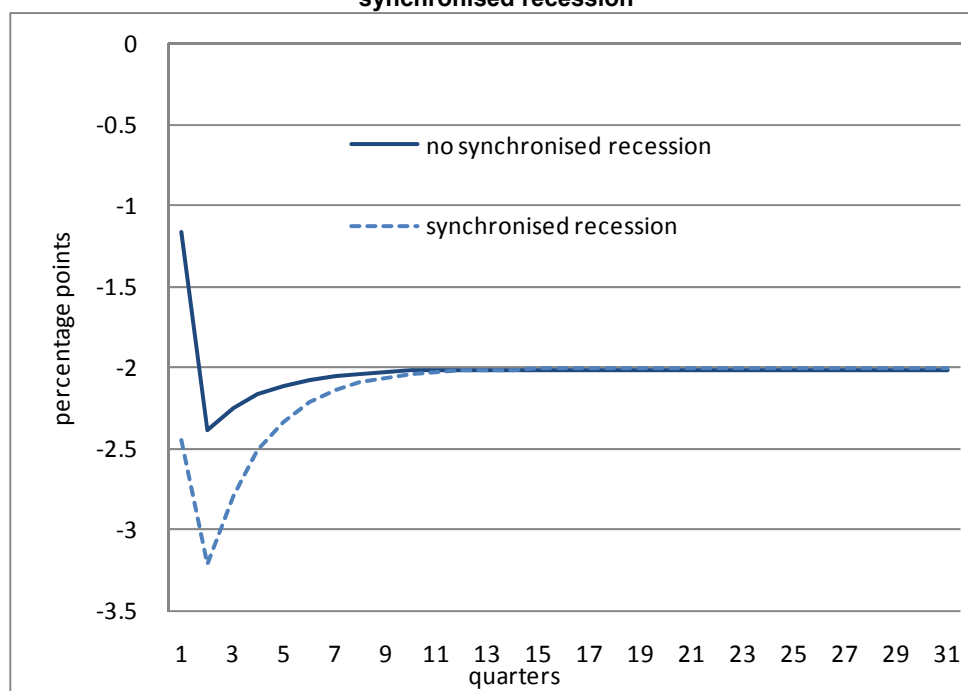
Source: OECD calculation based on equation (H).

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5.   Out-of-sample forecast comparisons

37.   In order to evaluate the relative usefulness of each factor for both explaining the recent collapse in world trade, and for predicting future world trade movements, the accuracy of out-of-sample forecasts from each of the equations is compared. Since the OECD *Economic Outlook* world trade projections cover a two-year horizon, out-of-sample forecasts are evaluated for horizons of one quarter ahead, four quarters ahead, and eight quarters ahead. Because one of the main objectives is to understand the recent trade collapse, dynamic forecasts for the 2008Q4 period are produced and compared based on equation estimations ending in 2008Q3 (for one quarter ahead), 2007Q4 (for four quarters ahead), and 2006Q4 (for eight quarters ahead). This procedure is then repeated to generate out-of-sample forecasts for the 2009Q1 period.

38.   Rather than forecasting the independent variables over the forecast horizon, actual observations for all variables (except world trade) are used to construct the forecasts, so that the source of any error can be attributed entirely to the predictive ability of the equation. Forecasts from each equation are evaluated against those from both the basic equation and a naïve AR(q) benchmark equation, based on root mean square forecast errors (RMSFEs) as well as the size of the point forecast errors in 2008Q4 and 2009Q1.

39.   Table 4 shows that none of the equations are able to fully predict the world trade contraction in 2008Q4 and 2009Q1, regardless of the forecast horizon used. The RMSFEs for all equations are largest for the one-quarter-ahead forecasts, and smallest for eight-quarter-ahead forecasts. This is because for all equations, the forecast error was largest in 2008Q4 -- and the weight of this quarter declines when averaging over four and eight quarters of forecast errors.

40.   As expected, the naïve benchmark performs the worst by a substantial margin. Whereas some of the equations performed worse than the basic equation, equation (D), which incorporates the financial stress variable, appears to generate the most accurate forecasts over all horizons based on the RMSFEs. This suggests that although including the financial stress variable did not improve the in-sample fit of the equation relative to including only the credit availability measure, it is more appropriate for explaining the current episode.[28]

41.   Comparing the various point forecasts for the 2008Q4 and 2009Q1 period in Table 4, it is unusual that for 2008Q4, most of the equation forecasts made one quarter ahead had considerably larger errors than forecasts produced four and eight quarters in advance. This result is peculiar since forecast errors would normally be expected to accumulate and increase with the forecast horizon. Indeed, forecast errors for 2009Q1 exhibit the usual properties with one-quarter-ahead forecasts being most accurate. This suggests that incorporating information on activity in the most recent quarters worsened the forecast accuracy in 2008Q4, although it is not clear why.[29]

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28.   Indeed, the in-sample fit of the equation including the financial stress variable is superior to that including only the credit availability measure when the sample is extended to the crisis period.

29.   Examination of the estimation results reveals that the short-run parameter estimates on both GDP changes and the financial conditions variables decrease when the sample period is extended from 2007Q4 to 2008Q3. Although the changes are not statistically significant, the lower implied impact of financial conditions over these quarters may reflect that trade growth responded minimally to the sharp tightening in financial conditions over those quarters. It is therefore possible that the sudden collapse in trade in 2008Q4 was a lagged response to an accumulated tightening of financial conditions. However, including various lags of the financial conditions variables did not improve the predictive power of the equations. Furthermore, forecasts exploiting threshold effects of credit constraints (equations Ci and Cii in Table A3) were no more accurate, suggesting no evidence of non-linear trade responses.

42.   At the one-quarter-ahead horizon, the basic equation is able to predict 60% of the decline in world trade in 2008Q4 and 80% of the decrease in 2009Q1. Since this equation exploits only the relationship between world trade and output, this suggests that most of the recent trade collapse can be explained by world demand. Over all forecast horizons, incorporating both credit availability and cost generated the most accurate predictions for world trade in 2008Q4 and 2009Q1. At the one-quarter-ahead horizon, equation (D) was able to predict almost 80% of the decline in world trade in both 2008Q4 and 2009Q1. Meanwhile for 2009Q1, adding the effects of the global recession generated a superior forecast (equation (F)), explaining 90% of the drop in world trade that quarter. The poor performance of the basic equation including VSI effects likely reflects the possibly erroneous assumption that VSI continued to grow over the 2008Q4 and 2009Q1 periods, despite the collapse in world trade. This gives rise to the possibility that a freeze or breakdown in vertical trade has occurred over these quarters.

Table 4. Out-of-sample forecast evaluation

Forecast Horizon: quarters ahead	RMSFEs			2008Q4 forecast error (as % total decline)			2009Q1 forecast error (as % total decline)		
	1Q	4Q	8Q	1Q	4Q	8Q	1Q	4Q	8Q
(A) Basic Equation	0.083	0.057	0.045	-40	-35	-34	-19	-26	-25
(B) Basic Equation with VSI	0.137	0.088	0.068	-59	-59	-59	-38	-47	-48
(C) Basic equation + credit availability	0.090	0.063	0.051	-40	-34	-34	-23	-29	-30
(D) Basic equation + financial stress	0.062	0.046	0.037	-22	-11	-10	-21	-21	-21
(E) Basic equation with VSI + financial stress	0.130	0.081	0.063	-57	-51	-52	-34	-45	-45
(F) Basic equation + credit availability + synchronised recession	0.088	0.056	0.048	-47	-27	-30	-10	-23	-27
(G) Basic equation with VSI + credit availability + synchronised recession	0.079	0.050	0.043	-37	-25	-29	-18	-26	-30
(H) Basic equation with VSI + synchronised recession	0.081	0.050	0.043	-39	-25	-28	-18	-27	-29
(9) AR(*q*)	0.254	0.198	0.150	-113	-126	-127	-66	-121	-121

Figure 10. One-quarter-ahead forecasts for 2008Q4 and 2009Q1

Quarter-over-quarter growth, annualised
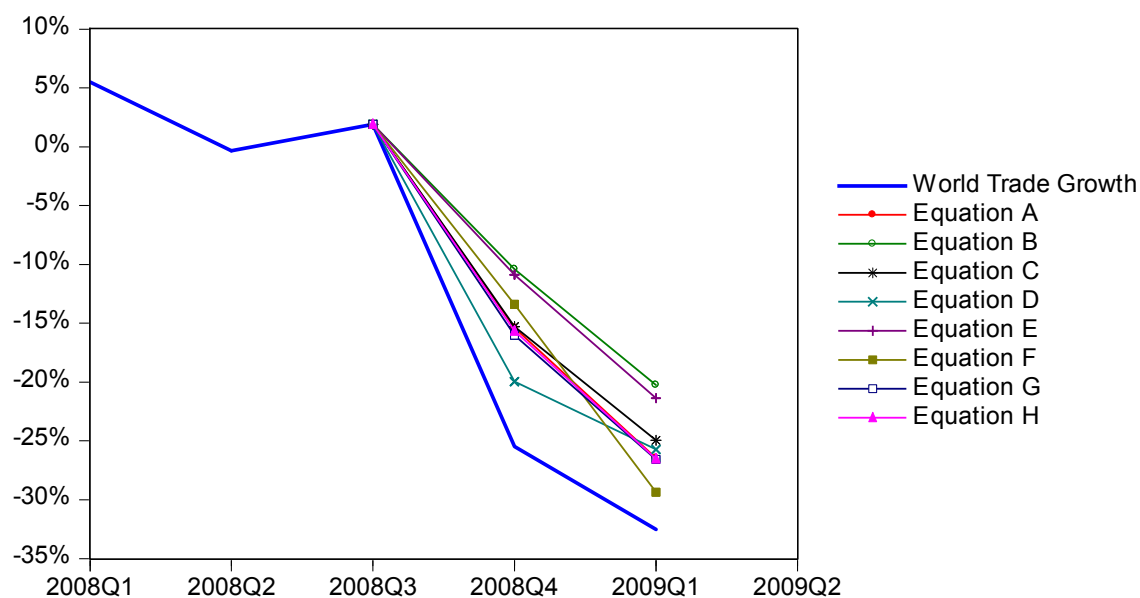
Figure 11. Four-quarter-ahead forecasts for 2008Q4 and 2009Q1

Quarter-over-quarter growth, annualised
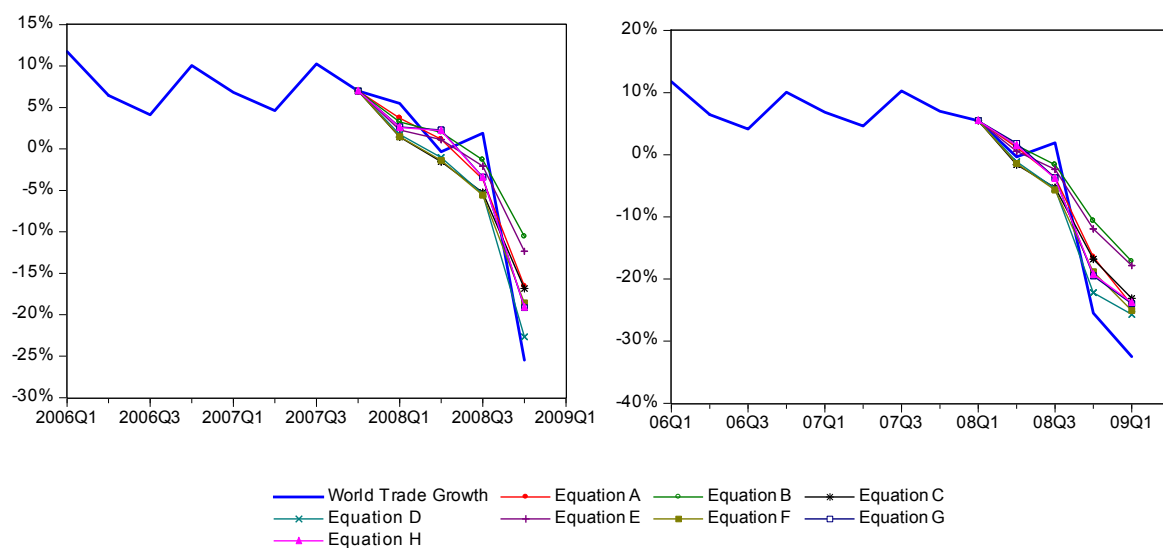
Figure 12. Eight-quarter-ahead forecasts for 2008Q4 and 2009Q1

Auarter-over-quarter growth, annualised

6. Conclusion

43. The collapse in world trade volumes in the fourth quarter of 2008 and the first quarter of 2009 were exceptional by historical standards. This paper uses an aggregate global trade equation to assess the various potential factors driving recen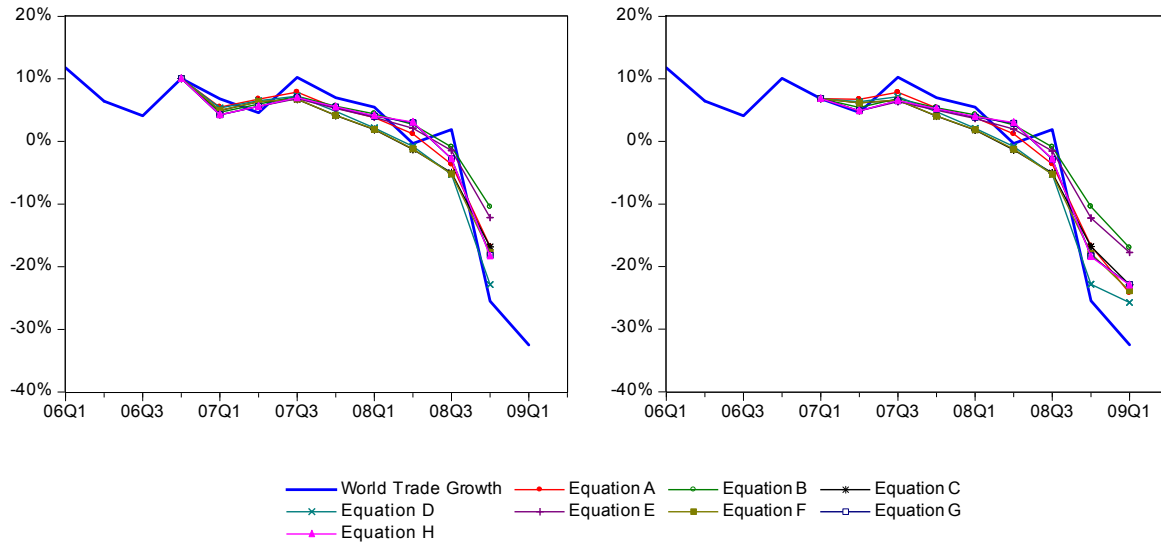t trade developments, and finds that most of the collapse can be explained by world demand. Although the estimated long-run income elasticity of trade has almost doubled since the late 1980s, possibly as a result of growth in vertical supply integration, there is no evidence that this elasticity has changed more recently. Instead, tight credit conditions have likely amplified the short-term trade response, reflecting the effects of both trade finance constraints and the composition of the demand contraction, which was oriented towards credit-sensitive sectors that are most trade-intensive. The global synchronisation of the recession likely accelerated the transmission of shocks through trade links, boosting the short-run trade response further. A portion of the trade decline in the fourth quarter of 2008 and the first quarter of 2009 remains unexplained (about 10%-20%), which may reflect a breakdown in global supply chains over those quarters, although this cannot be confirmed. The lack of timely data on vertical supply integration is a challenge that precludes a precise assessment of its evolution over the recent period, and limits its usefulness for forecasting purposes. Furthermore, the interconnected nature of all of these events prevents a clear distinction between their relative contributions to the trade collapse. Looking ahead, the pace of normalisation in financial conditions and the future evolution of global supply integration will affect the speed of recovery in trade and global output.

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APPENDIX

44.   This appendix presents some additional results and analyses. First it assesses the role played by transportation costs and vertical supply in raising the estimated long-run income elasticity of world trade. Second, it presents further empirical results from tests for non-linear effects of financial crises on world trade growth, and composition effects of demand. Third, it presents estimation results for all equations in the main paper with a sample period ending in 2005 as robustness checks.

Further investigation of factors raising the long-run income elasticity of world trade

45.   In order to investigate which factors may have contributed to driving up the long-run income elasticity of trade since the late 1980s, experiments were conducted restricting the long-run coefficient of the GDP_t variable in the cointegrating equation [2b] (of the main text) to equal the parameter estimate derived before the structural break. A positive and statistically significant coefficient on the interaction term in equation [2b] would then suggest that growth in VSI has contributed to driving the long-run income elasticity of trade higher after the break date. To assess the influence of declining trade costs over the 1990s, the cointegrating equation [2b] was also augmented with the tariff and real shipping cost indicator variables depicted in Figure 3. Since both measures are annual series, quarterly values were interpolated.

46.   Results from this experiment are displayed in Table A1. The income variable used is OECD GDP -- results using world GDP are not reported based on worse fit and lack of cointegration. The short-run dynamics include the contemporaneous and lagged change in GDP_t. Hausman (1978) tests were conducted and found no problems of endogeneity associated with contemporaneous OECD GDP variable. The $TRCOST_t$ variable represents the log of the real maritime transport cost variable, which tended to produce better results than the tariff measure, and the sample period was 1991Q2-2005Q4, based on the earliest observation available for this series.

47.   Over the 1991Q1-2005Q4 sample, restricting the long-run income elasticity to remain at 1.21 (its value before the structural break) results in a significantly larger estimated effect from VSI, as shown in the first column of Table A1, although the interaction term remains insignificant. Although the real shipping cost variable is found to have a negative and highly significant effect on trade in the long-run, the null hypothesis of no cointegration is just short of being rejected at the 10% level. When no value is imposed on the long-run income elasticity, the null hypothesis of no cointegration can then be rejected at the 1% significance level as shown in the second column of Table A1. The unrestricted long-run income elasticity goes to 1.9 and the impact of VSI is halved. This result supports the notion that the higher long-run income elasticity of trade since the late 1980s likely reflects the impact of rising VSI. Real shipping costs are no longer significant once the interaction term is removed (third column of Table A1), and dynamic least squares estimates which correct for endogeneity confirm the insignificance of this variable. Based on the superior equation fit and stronger cointegration results, the interaction term and transport cost variable are removed and long-run income elasticity is left unrestricted for comparison with other equations in the main paper.

Table A1. Investigating the increase in long-run income elasticity

Dependent Variable: Δ (*WT_t*)	Restricted 1991Q2-2005Q4	Unrestricted 1991Q2-2005Q4	Unrestricted 1991Q2-2005Q4
Constant	-2.55***	-14.31***	-12.85***
	(3.1)	*(-5.0)*	*(-6.0)*
ECM adjustment parameter (λ)¥	-0.22	-0.47***	0.50***
	(-3.1)	*(-5.5)*	*(6.0)*
GDP_{t-1}	1.21	1.88***	1.72***
		(16.4)	*(6.5)*
IVSI_{t-1}	0.37***	0.18***	0.22***
	(27.4)	*(6.0)*	*(3.4)*
GDPc_{t-1} *IVSIc_{t-1}	0.18	0.04	
	(1.5)	*(0.97)*	
TRCOST_{t-1}	-0.17***	-0.05**	-0.09
	(-5.7)	*(-2.1)*	*(-1.4)*
Δ***GDP_t***	1.23***	1.08***	0.94***
	(3.1)	*(2.9)*	*(2.8)*
Δ ***GDP_{t-1}***	0.99**	1.13***	0.84**
	(2.5)	*(3.7)*	*(2.6)*
Adj R²	0.634	0.725	0.721
S.E. of regression	0.007	0.006	0.006

1.　　 t-statistics in parentheses.
2.　　 *, **, *** denotes significance at the 10%, 5%, and 1% level respectively, based on Newey-West HAC standard errors.
3.　　 ¥ Ericsson and Mackinnon (2002) critical values used to determine significance.

Testing for non-linear effects of financial crises and incorporating composition effects of demand

48.　　　It is possible that financial conditions bear a non-linear relationship with trade, with varying effects when credit is constrained relative to normal times. In order to investigate this possibility, simple tests are conducted for threshold effects. In the first scenario, differential effects are permitted when the credit availability variable is greater than zero (the percentage of firms tightening exceeds the percentage loosening). The results, reported in the first column of Table A2, do suggest that credit availability significantly affects trade growth in the short-term only when credit is constrained, although the magnitude of this effect is not different from that found in equation (C) in Table 3. The overall equation fit is also worse than that of equation (C). In the second scenario, the threshold of the credit availability variable is set at 20, to see whether the impact is larger when credit is tightened more severely. Doing so identifies three episodes of substantial credit constraint over the sample: 1990, 1998, and 2000-02. The results suggest a slightly larger impact on trade when the degree of credit constraint is higher, as displayed in the second column of Table A2. However, the overall fit of this equation also fails to improve upon that of equation (C), and there appears to be no strong evidence of a non-linear effect of financial conditions on trade.[30] Out-of-sample forecasts (Table A3) also fail to improve upon the performance of equation (C).

49.　　　The financial crisis had a disproportionately large effect on demand for capital and durable goods, which comprise a larger share of world trade than world output. In order to capture the possible effect of these developments on trade, tests were performed modifying equation (D) by replacing growth in OECD GDP with growth in OECD non-residential investment (Δ*INV_t*) in the short-run dynamics.

30.　　　Using the absolute value of credit availability with a threshold was also tried to isolate the impact of periods of important credit tightening or loosening but the results were not different to the ones presented here.

Equation (D) was selected as a benchmark based on its superior out-of-sample forecasts. The series for OECD consumption of durable goods was not used because of insufficient country coverage prior to 1995; however, this series rebounded sharply in 2009Q1 suggesting little influence on the further contraction in trade that quarter. The results are shown in the fifth column of Table A2, and do not improve upon the fit of equation (D) for estimations ending in 2007Q4, and out-of-sample forecasts (Table A3) are found to produce larger errors in 2008Q4 and 2009Q1 relative to equation (D).

Table A2. Tests for threshold financial crisis effects and demand composition effects

Dependent Variable: Δ (WT_t)	(Ci) Theshold = 0 1990Q2-2007Q4	(Cii) Theshold = 20 1990Q2-2007Q4	(Ci) Theshold = 0 1990Q2-2005Q4	C(ii) Threshold = 20 1990Q2-2005Q4	D(i) 1990Q2-2007Q4
Constant	-8.57*** (-4.3)	-8.67 (-4.5)	-9.7*** (-3.9)	-9.91*** (-4.0)	-14.00*** (-5.0)
ECM adjustment parameter (λ)[¥]	-0.18*** (-4.3)	-0.17*** (-4.5)	0.20*** (-3.8)	-0.21*** (-3.9)	-0.29*** (-5.0)
GDP_{t-1}	2.54*** (69.4)	2.53 (72.2)	2.50*** (63.6)	2.51*** (66.8)	2.53*** (93.6)
ΔGDP_t	1.42*** (3.8)	1.39*** (3.6)	1.37*** (3.4)	1.34*** (3.3)	
ΔGDP_{t-1}	1.17*** (3.6)	1.18*** (3.8)	1.30*** (4.1)	1.29*** (4.2)	
ΔINV_t					0.28*** (3.1)
Δ INV_{t-1}					0.26*** (2.9)
Credit standards (< threshold)	-0.02 (-1.3)	-0.01 (-1.5)	-0.03** (-2.3)	-0.02** (-2.6)	
Credit standards (> threshold)	-0.02** (-2.4)	-0.03*** (-3.2)	-0.02** (-2.1)	-0.02*** (-3.0)	
Financial stress					-0.30*** (-3.7)
Adj R[2]	0.562	0.566	0.603	0.601	0.451
S.E. of regression	0.007	0.007	0.007	0.007	0.008

1. t-statistics in parentheses.
2. ₊, **, *** denotes significance at the 10%, 5%, and 1% level respectively, based on Newey-West HAC standard errors.
3. [¥] Ericsson and Mackinnon (2002) critical values used to determine significance.

Table A3. Out-of-sample forecasts

Forecast Horizon: quarters ahead	RMSFEs			2008Q4 forecast error (as % total decline)			2009Q1 forecast error (as % total decline)		
	1Q	4Q	8Q	1Q	4Q	8Q	1Q	4Q	8Q
(Ci) Basic equation + credit availability (threshold = 0)	0.090	0.063	0.063	-40	-34	34	-23	-29	-30
(Cii) Basic equation + credit availability (threshold = 20)	0.090	0.063	0.051	-40	-33	-34	-23	-29	-30
(Di) Basic equation with OECD investment, financial stress	0.094	0.057	0.045	-36	-31	-31	-30	-33	-32

Robustness checks

50.   This section presents the results corresponding to Tables 3 and 4 with estimations ending in 2005Q4 to verify that extending the VSI measure over 2006 and 2007 did not change the results.

Table A4. Estimations 1990Q2-2005Q4

Dependent Variable: Δ (WT_t)	(A) Basic Equation	(B) Equation with VSI	(C) Equation + credit availability	(D) Equation + financial stress	(E) Equation with VSI + financial stress
Constant	-5.71**	-12.17***	9.91***	-9.47***	-14.12***
	(-2.4)	*(-5.0)*	*(-4.0)*	*(-3.8)*	*(-5.7)*
ECM adjustment parameter (λ)¥	-0.12	-0.36***	-0.21**	-0.20**	-0.39***
	(-2.3)	*(-5.9)*	*(-3.9)*	*(-3.7)*	*(-6.5)*
GDP_{t-1}	2.50***	2.03***	2.51***	2.51***	2.07***
	(30.1)	*(27.7)*	*(64.5)*	*(59.6)*	*(28.0)*
$IVSI_{t-1}$		0.15***			0.14***
		(6.3)			*(5.7)*
ΔGDP_t	1.76***	1.17***	1.34***	1.31***	1.10***
	(3.9)	*(3.7)*	*(3.4)*	*(3.1)*	*(3.3)*
ΔGDP_{t-1}	1.34***	0.94***	1.29***	1.27***	0.94***
	(3.7)	*(2.9)*	*(4.2)*	*(4.1)*	*(3.0)*
US credit standards			-0.02***		
			(-3.7)		
US financial stress				-0.25***	-0.05
				(-3.1)	*(-0.62)*
Adj R^2	0.527	0.687	0.608	0.588	0.685
S.E. of regression	0.008	0.007	0.007	0.008	0.007

1.   t-statistics in parentheses.
2.   *, **, *** denotes significance at the 10%, 5%, and 1% level respectively, based on Newey-West HAC standard errors.
3.   ¥ Ericsson and Mackinnon (2002) critical values used to determine significance.

Table A5. Estimations results 1990Q2-2005Q4

Dependent Variable: Δ (WT_t)	(6) Equation + credit availability + synchronisation	(7) Equation with VSI + credit availability + synchronisation	(8) Equation with VSI + synchronisation
Constant	-9.87***	-14.29***	-14.27***
	(-4.1)	(-5.6)	(-5.5)
ECM adjustment parameter (λ)¥	-0.21**	-0.40***	-0.40***
	(-3.9)	(-6.3)	(-6.4)
GDP_{t-1}	2.51***	2.06***	2.05***
	(68.8)	(28.1)	(30.7)
$IVSI_{t-1}$		0.14***	0.15***
		(6.0)	(6.7)
ΔGDP_t	1.34***	1.09***	1.10***
	(3.4)	(3.3)	(3.5)
ΔGDP_t *Sync dummy	0.16	1.10*	1.16**
	(0.2)	(2.0)	(2.2)
ΔGDP_{t-1}	1.31***	1.02***	1.01***
	(4.1)	(3.6)	(3.5)
Credit standards	-0.02***	-0.00	
	(-3.6)	(0.3)	
Adj R^2	0.601	0.690	0.695
S.E. of regression	0.007	0.007	0.007

1.   t-statistics in parentheses.
2.   *, **, *** denotes significance at the 10%, 5%, and 1% level respectively, based on Newey-West HAC standard errors.
3.   ¥ Ericsson and Mackinnon (2002) critical values used to determine significance.

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