ECONOMIC CRISIS AND GLOBAL SUPPLY CHAINS

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Abstract

This paper addresses the role assigned to global supply chains in the sharp fall in world trade associated with the economic crisis of 2008Q4 and 2009Q1. Using both simple accounting calculations and a simulation of a multi-region, multi-sector Computable General Equilibrium model, which explicitly models input-output relations within and between sectors, we ask whether the Spring 2009 Gross Domestic Product (GDP) forecasts, together with a twist in the composition of demand, a halt in the trend towards the reduction in trade costs and a collapse in the oil price, can lead to trade overshooting GDP. Firstly, we find that a large part of the fall in trade comes from a relative price effect. Secondly, the simulated fall in trade is in line with the fall in world GDP when the latter is aggregated using current exchange rates, which is the appropriate reference, rather than PPP weights, when comparing GDP to trade. Accordingly, our paper does not support the hypothesis of a systematic over-shooting of trade due to globalisation and the fragmentation of supply chains: additional factors such as the credit shortage must have played a role in the short run to explain the sharp fall in world trade.

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I- Introduction

The 2008 global crisis led to an abrupt fall in exports all over the world. During the last quarter of 2008, the value of exports decreased by 18 percent in Germany, 20 percent in the United States, 25 percent in France up to 32 percent in China. For the full year of 2009, world trade is expected to fall significantly despite more encouraging prospects from the second quarter on. Forecasts vary from -9 percent (World Trade Organisation - WTO - forecast of March 2009) to -9.7 percent (World Bank forecast of June 2009), -11 percent (International Monetary Fund - IMF - forecast of April 2009) up to -16.0 percent (Organisation for Economic Co-operation and Development - OECD - forecast of June 2009) whereas world output is expected to decline by "only" 1.3 (IMF, April 2009), 1.7 percent (World Bank, June 2009) or 2.2 percent (OECD, June 2009). Trade is hence expected to fall by more than GDP.

A significant drop in the relative price of traded goods, especially oil, compared to non-traded ones, could explain part of the global trade collapse, at least in nominal terms. Still, several explanations have been proposed for the collapse of the volume of trade that has been, according to Baldwin and Evenett (2009),"sudden, severe, synchronised". A first group of explanations relates to credit restrictions and the rise in perceived risks. The impact of economic crises on trade finance was already observed during the Asian crisis of 1997. Despite large exchange-rate depreciation, countries like Thailand saw their exports fall in the short run. Credit constraints are an important determinant of exports (Manova, 2008, Rajan and Zingales, 1998). During past banking crises, exports of those sectors most dependent on external financing were more affected (Iacovone and Zavacka, 2009). In 2008, there is some evidence that firms, especially in developing countries, suffered a fall in trade finance (see Auboin, 2009). This may have triggered export contraction, although direct evidence of this is lacking. Consequently, In the same way, the rise in exchange-rate volatility may have been

detrimental to trade.

A second group of explanations of trade contraction hinges on the rise of protectionism (Gamberoni and Newfarmer, 2009; Baldwin and Evenett, 2009). This includes the use of binding margins by some emerging countries, but also nationalist support to domestic industries (state aid, the Buy America Act, Chinese public procurement directives).

A third group of explanations points to transmission channels in the real economy. When considering the global economy (as opposed to the sole U.S. one), it can be observed that both industrial production and trade dived faster in 2008–2009 than during the Great depression (Eichengreen and O'Rourke, 2009). This is particularly true for those sectors most exposed to recession and credit shortage: capital goods and vehicles (Francois and Woerz, 2009). Importantly, this drop has been synchronised in the OECD, leading to a sharp drop in world trade (Araujo and Oliveira-Martins, 2009). The argument also underlines the fact that tradable sectors are more affected by the current crisis than non-tradable ones, while fiscal stimulus packages tend to be strongly oriented towards construction and infrastructure, which are non tradable.

Finally, the new patterns of the international division of labour may also have played a big role. Global supply chains, which characterise many sectors, often involve the same component being exchanged several times (and thus registered as 'trade' several times) before it is incorporated into the final product. Since GDP is recorded as a sum of value added, whereas exports are recorded as a sum of product values, a relatively low drop in world GDP could therefore be consistent with a much larger reduction in world trade. This is the argument which we seek to challenge in this paper.

Through simple accounting, we firstly show that fragmented supply chains are consistent with world trade reacting *proportionally* to a fall in world GDP, when relative prices are held constant. In order to generalise this result, a fully consistent framework taking into account actual inter-industrial relations within and across countries is needed. This is where a multi-

country, multi-sectoral computable general equilibrium (CGE) model is a useful tool. As a second step, we introduce in such model an exogenous scenario for GDP, investment and the oil price changes and we simulate the impact of this scenario on trade over 2009-2012. We do not explicitly simulate an increase in protectionist tensions such as a return to bound tariff rates for importers in position to do so, or any non-tariff protection elsewhere, but we impose a halt to the long-run trend of declining trade costs.

Our first conclusion is a warning that care should be taken in the use of nominal figures. Relative prices are essential to understanding the over-reaction of trade to GDP. Indeed, when using the same deflator for trade as for world GDP, we find that trade largely overshoots GDP during the crisis: in 2009, trade declines by –8.9 percent compared to the 2008 figure, for a 1.3 percent drop in world GDP. However, the fall in the oil price accounts for roughly 5 percentage points of this total. More generally, the percentage drop in the volume of world trade very much depends on the deflator used. Deflating each trade flow by its specific price (rather than by the same world GDP deflator) leads to smaller falls in world trade (–2.4%), since most of the observed decline in value is explained by the drop in prices.[1] The remaining gap between falls in GDP and trade can then be accounted for by aggregating country GDP growth rates at current exchange rates rather than those based on purchasing power parity (the convention used by the IMF). This gap indeed disappears when, like trade flows, GDPs are aggregated using current exchange rates: our 2.4% drop in world trade is similar to the 2.6% drop in world GDP (instead of 1.3% using the PPP aggregator).

The bottom line of this exercise is that a proper modelling of the fragmentation of supply chains hardly leads to any multiplier effect of trade over GDP. To obtain the double-digit figures recorded in 2008Q4 and 2009Q1, one firstly has to factor in short-run effects such as

1 Such finding at the world level is in line with the fact that nearly half of the decrease in nominal US imports from February 2008 to February 2009 was in industrial supplies and thus mainly driven by prices (Francois and Woerz, 2009).

inventory contraction, the reversal of expectations or the shortage of trade and consumption finance. These factors are to weigh on trade figures for the whole of 2009. Secondly, our simulations may underestimate the shift in demand away from durable goods. Our accelerator calibrated on past business cycles fails to reproduce the observed drop in investment. For instance, the calibrated 2009 drop in private investment in the US and Japan respectively, that we introduce are –17% and –16%, while the observed drops are –37% and –27% on a yearly basis at the end of the first quarter of 2009 (World Bank, 2009). Finally, our figures do not reproduce the collapse of the car industry, which was already suffered from over-capacities before the crisis and whose collapse has played a major role in global trade contraction (Francois and Woerz, 2009).

The remainder of the paper is organised as follows. Section II presents some simple accounting showing that the fragmentation of supply chains does not automatically imply that world trade will overshoot world GDP fluctuations. In Section III, we detail the methodology used to simulate the impact of the crisis on trade, relying on the CGE model MIRAGE. Section IV discusses results. In Section V, some robustness tests are presented. Section VI concludes.

II- Trade multiplier and the supply chain

The ratio of world exports of goods and services to world GDP increased from 12% in 1960 to 28% in 2006. One explanation of this trend is the fragmentation of supply chains: the same component being traded several times before being included in the final product (Hummels et al., 2001; Yi, 2003, Athukorala and Yamashita, 2008; Koopman et al., 2008). According to Tanaka (2009) or Yi (2009), due to this fragmentation, world trade should fall by more than world GDP during the crisis. The point we make here is that fragmentation does *not* imply that world trade will necessarily over-react to any shock on world GDP.

With simple accounting, it can be shown that world trade is to react *proportionally* to changes in GDP growth, provided (i) imported inputs remain a fixed proportion of output;

(ii) exported final products remain a fixed proportion of foreign income; and (iii) relative prices remain constant.

Our argument is accordingly systematising the "Barbie doll" example (O'Rourke, 2009): the actual value of world trade is a multiple of world production as a result of fragmentation, but the *change* in trade is proportional to the change in production: only a composition effect, where changes in trade marginally fall on the more fragmented sectors can generate a more than proportional reaction of trade to a drop in GDP. We will explore the second part of the argument in the next section and focus on the first part of it now.

Let us denote by X_i and Q_i^X the value of exports of final and intermediate goods respectively by country *i*. Similarly, we denote by M_i and Z_i^M the value of imports of final and intermediate goods for this country. Denoting value added, production and intermediate inputs by Y_i, Q_i and Z_i, respectively, we have:

$$Y_i = Q_i - Z_i \tag{1}$$

The question is whether the growth rates of total exports ($X_i + Q_i^X$) and total imports ($M_i + Z_i^M$) can differ from that of GDP (Y_i). We proceed in three steps by examining successively (i) trade in intermediate goods, (ii) trade in final goods, and (iii) total trade. In the following, we always assume fixed relative prices.

We first consider whether trade in intermediate goods necessarily overshoots changes in GDP. In the short term, imported and domestic inputs can be assumed to be complements rather than substitutes, and intermediate inputs can also be viewed as complements to labour and capital. Hence, we can assume a Leontief technology:

$$\frac{Z_i^M}{Z_i} = z_i^M \quad ; \quad \frac{Z_i}{Q_i} = z_i \tag{2}$$

Where z_i^M and z_i are constant, technical parameters. Substituting (2) into (1) yields:

$$Y_i = \frac{1 - z_i}{z_i^M z_i} Z_i^M \tag{3}$$

Using the usual Jones' notations, it follows that $\hat{Z}_i^M = \hat{Y}_i$*: the growth rate of imports of intermediate goods is the same as that of domestic GDP*. Denoting by a *j* subscript the partner country of *i*, the same line of reasoning leads to: $\hat{Q}_i^X = \hat{Y}_j$: *the growth rate of exports of intermediate goods is equal to GDP growth in the partner country*. It could be argued however that the fall in trade does not derive from intermediate goods, but from final goods. This is what we now examine.

Exports of final goods are generally considered to be a function of foreign income. Assuming constant relative prices, we have:

$$X_i = M_j = \eta_j \left(Y_j\right)^{\gamma_j} \tag{4}$$

where η_j, γ_j are positive parameters. When the trend of globalisation is correctly accounted for, the income elasticity of imports, γ_j, is generally estimated close to unity. It follows that $\hat{X}_i = \hat{M}_j = \hat{Y}_j$. Symmetrically, we have: $\hat{M}_i = \hat{X}_j = \hat{Y}_i$. Hence, *the growth rate of exports of final goods is equal to that of foreign GDP; and the growth rate of imports of final goods is equal to that of domestic GDP*.

From these two building blocks, it can be concluded that $\hat{T}_i^X = \hat{Y}_j$ and $\hat{T}_i^M = \hat{Y}_i$, where T_i^X, T_i^M represent total exports and imports, respectively. As a first approximation we can finally assume that GDP growth is the same in both countries ($\hat{Y}_i = \hat{Y}_j = \hat{Y}$). We finally have:

$$\hat{T}_i^X = \hat{T}_i^M = \hat{T}_j^X = \hat{T}_j^M = \hat{Y} \tag{5}$$

The growth rate of world trade is equal to the growth rate of world GDP. In the absence of further opening up of the economies, the volume of world trade must grow at the same rate as the volume of world GDP. For a given country, the growth rates of exports and imports can differ depending on the relative growth of domestic and foreign GDP, but during a world depression, this difference is of second order.

Note that this result relies on three assumptions: (i) constant technical coefficients; (ii) a

unitary income elasticity of imports; and (iii) constant relative prices. Actually, technologies are not Leontief, the short-term income elasticity of imports is not exactly equal to unity and relative prices change. But only a very peculiar combination of these elements would put our reasoning at risk.

In order to check whether the argument based on such simple accounting remains accurate when the three simplifying hypotheses (fixed technical coefficients, final exports proportional to foreign income, fixed relative prices) are abandoned, and when more than two countries trade, we subsequently simulate a CGE model.

III- Simulations in general equilibrium with inter-industry relations

Here we study the multiplier effect hypothesis of trade over GDP growth for the 2009–2012 period, within the world CGE model developed by the CEPII – *MIRAGE*.[2] There are considerable advantages to such approach. The trade-growth nexus very much depends on the respective openness and specialisation of the various regions in the world – two key features of a CGE. Also, the ability of the model to compute the actual prices of traded goods is key to our reasoning.

We fully take into account inter-industry relations between 25 sectors and 18 regions of the world economy, using the specific input-output tables for each modelled country.[3] Interestingly, we not only take into account inter-industry imports (e.g. the car industry importing glass); we also account for imports on the diagonal of the input-output table (e.g. the car industry importing car components), thanks to the Armington specification that allows intra-industry trade. Thus, all simplifying assumptions of the previous section are now relaxed, with the exception of the Leontief technology between intermediate goods and

2 Modelling International Relationships in Applied General Equilibrium (Decreux and Valin, 2007), see Appendix 1 for a short description.

3 A region can comprise a single country.

primary factors. Relative prices vary, which leads to substitution of inputs and possibly of countries of origin for intermediate consumption, and the income elasticity of imports is calibrated based on observed values.

Lastly and importantly, we are now in a position to address the second part of the argument suggested by O'Rourke – as to whether the drop in trade induced by the fall in GDP falls on sectors with the highest vertical disintegration of production. The ratio of value added to exports indeed varies a lot across sectors: it is high in primary products and agricultural products, and lower in manufacturing (Johnson and Noguera, 2009). According to Miroudot and Ragoussis (2008), fragmentation is highest in motor vehicles, radio, TV and communication equipment, and office machinery and computers. Hence, we may expect that a drop in trade falling mostly on manufactured products and OECD countries should be a multiple of the fall in GDP. Here again, using a CGE model is useful, since the differences in fragmentation across sectors are documented in the baseline, while the demand shock is disseminated in the economy according to input-output relations. Accordingly, the composition effect suggested by O'Rourke is fully taken into account in our CGE approach.

In order to conduct our exercise, three variables are made exogenous in the model: GDP growth, oil prices and investment. The first two variables are based on the IMF forecasts of April 2009. The third variable, which captures a shift in demand away from capital goods, is calibrated on past business cycles, as detailed below. In addition, the calibrated trend of globalisation that is included in the model to account for trade growing faster than GDP over the past is halted in our simulation after 2008. The objective is to check whether the demand shock (both global and in terms of composition), combined with a sharp decline in the price of energy and a pause in globalisation, suffices to generate a multiplier effect of trade (in volume) over GDP when all interactions in the world economy – including, in particular, global supply chains – are properly modelled.

Some important determinants, such as trade finance, inventory adjustments or expectations,

are missing in a real-economy model like *MIRAGE*. In particular, the estimated income elasticities used are long-term elasticities, while in the short term, demand may react weakly to relative-price changes in some sectors. Similarly, the micro-economic foundations of the model do not account for expectations, thus it fails to account for 'bubbles' and short-term over-adjustments. Lastly, we do not account for the over-capacity in the car industry that has been revealed by the crisis but pre-dated it. The lack of consumer finance may have also played a role in the drop of world car demand.

We would accordingly expect to only partially replicate the double-digit drops in trade recorded in 2008Q4 and 2009Q1, which will have lasting effects on 2009 figures. However, our objective is rather to measure the role of global supply chains in the observed "over-shooting" of trade compared to GDP, within a consistent framework.

Trade data and social accounting matrices

While interested in medium-term effects, this paper however relies on the most recent aggregated trade figures for all countries for which monthly or (at worst) quarterly data was available up to December 2008. As regards Social Accounting Matrices, the data we use (GTAP 7) is an update of the data used by Johnson and Noguera (2009) and thus is calibrated on 2004 instead of 2001. It is also more disaggregated: the world economy is decomposed into 57 sectors and 113 regions. The model, calibrated on 2004 data, comprises a dynamic baseline reproducing the evolution of the overall economy from 2004 to the end of 2008. From 2009 on, the model simulates the changes in trade flows that are compatible with the forecasted recession, the drop in investment and a halt in the reduction of trade costs. The demography is given, investment is exogenous (see Section 3.3) and the oil price is constrained to the most recent forecasts.

Assumptions on GDP

Our first driver of the decline in world trade is the drop in GDP. As already stressed, we are

interested in exploring whether the potential impact of this downturn can lead to a multiplier effect of world trade as a result of industrial fragmentation. As already mentioned, the *MIRAGE* model relies on the GTAP-7 database that uses 2004 data. From 2005 to 2008, IMF and ITC databases are used to update GDPs, investment and trade flows.[4] Total factor productivity as well as savings rates are recovered endogenously. From 2009, our scenario is implemented: IMF forecasts for GDP are introduced exogenously, and TFP is again assumed to be endogenous.[5]

The calibration of GDP growth rates in the model from 2008 onwards is based on the *World Economic Outlook* database, updated in April (IMF, 2009), and on Freedman et al. (2009). For 2009 and 2010, we take the April figures (IMF, 2009). For 2011 and 2012, we rely on Freedman et al. (2009), who analyse the combined effects of fiscal stimuli on world economic performance. Most importantly, they provide growth projections for the United States, the Euro area, Japan and the world as a whole up to 2015. We extrapolate their results to other regions (which make up 30% of the world economy). Our GDP assumptions are presented in Appendix 3, using a decomposition of the world economy in 18 countries or regions. Note that world GDP growth rates are a PPP-weighted average of regional growth rates, which implies that the world GDP growth rate is sustained by the resilience of countries with undervalued currencies (e.g. China) to the crisis.

Calibration of the demand shift

Our second channel of trade attrition is a sharp decline in investment. To model this mechanism, we consider that investment follows an exogenous path in our simulations.

4 Trade data between 2004 and 2008 comes from TradeMap, ITC (Geneva). For 2008, the most recent data is used, including monthly series when available. Then, we simulate trade flows from 2009 onwards.

5 A drop in TFP can be interpreted as a drop in the utilisation rate of production capacity. An alternative approach is to compute the drop in primary factors (at constant TFP) that would lead to the imposed

Investment growth rates in the various economies are calibrated based on an investment accelerator. Using the investment growth rate series between 1980 and 2007 (WEO database), we calibrate the investment accelerator (α) by region that minimises squared errors (ε_t^2) in:

$$\frac{\Delta I_t}{I_t} = \frac{\Delta I_{t-1}}{I_{t-1}} + \alpha\left(\frac{\Delta Y_t}{Y_t} - \frac{\Delta Y_{t-1}}{Y_{t-1}}\right) + \varepsilon_t \qquad (6)$$

Where I_t and Y_t correspond, respectively, to investment and GDP in year *t*, and Δ is the variation from one year to the next.

The investment accelerator by region represents the ratio of changes in investment compared to changes in GDP. We use these figures to define investment growth rates by region over the period 2009-2012. They are presented in Appendix 2. Exogenous investment growth rates are imposed in the simulations; to do so, savings rates become an endogenous variable.[6]

Assumptions on energy prices

The third channel of trade attrition is the price of oil. Accordingly, the third exogenous variable introduced in the model is the oil price. It is assumed to follow an exogenous path from 2004 to 2010. In 2007 and 2008, the annual percentage change in the oil price is respectively +10.7% and +36.4% according to IMF (2009c). For 2009, a sharp drop (–46.4%) was forecasted in April 2009 by the IMF, before a recovery in 2010 (+20.2%). Stocks of natural resources adjust proportionally in all producing countries to be consistent with such price path.

Globalisation trend

In order for *MIRAGE* to reproduce the observed growth rates of trade over the period 2004–

GDP growth. Such method has been used by Willenbockel and Robinson (2009).

[6] In *MIRAGE*, trade balances are assumed a constant percentage of world GDP.

2008, an iceberg cost of exporting has been introduced at the country level (on the top of the already present transport cost). Since exports grew faster than GDPs from 2004 to 2008, this additional cost progressively diminishes during this period, mimicking the globalisation of the world economy (e.g. the development of supply chains referred to above). It seems reasonable to assume a halt to this trend during times of crisis. This approach does not roll back liberalisation and could therefore be seen as rather conservative, since some commentators have claimed that there is a trend towards a "de-globalisation process" (e.g. The Economist, 2009). Although there is some anecdotal evidence of 'murky protectionism' arising from the crisis (Baldwin and Evenett, 2009), firm evidence of a trend towards protectionism is limited. What does appear to be a realistic assumption, however, is a freezing of trade liberalisation as national governments focus on their domestic economic imperatives. Accordingly, in the simulation we impose a halt to the decline in trade costs in 2009 to mimic this halt in globalisation.

Choice of the deflator

Finally, the measurement of changes in prices of world trade is an important issue. In its standard version, *MIRAGE* reports evolutions in real terms (i.e. corrected for inflation) and uses the world GDP deflator. Consequently, all nominal variables introduced as exogenous inputs in the model (trade flows over 2004-2008 and the oil price over 2004-2010) have been deflated by a world GDP deflator computed as an average between US and EU deflators, in dollars.[7]

When it comes to reporting trade impacts, the model can compute trade either as values deflated by world inflation, or as actual volumes, at constant prices. The first, standard approach may well be ill-suited to a context where the price of a commodity which accounts

7 In the simulation, the world deflator is generated by the model based on GDP deflators in the 18 countries or zones under scrutiny.

for some 10 percent of world trade (oil), is almost halved. Indeed, aggregate prices (the GDP deflator) will vary much less than the price of oil. Using the GDP deflator runs the risk of massively overstating the fall in oil export volumes, and by implication, magnifying the fall in total world trade. Accordingly, two systems of deflators are successively used to recover trade volumes: a uniform world GDP deflator (like in Section 2); a system of sector-specific trade prices (unlike in Section 2).

Not all unit values of trade are observable: for very recent periods, unit values are unavailable. Guesstimates on prices have to be made.[8] However, using sector-specific trade prices yields interesting results in terms of interpreting how dramatic the impact of the crisis on actual trade flows really is. Notice that relying on such prices is only possible when a complete model of the world economy, such as *MIRAGE*, is used, although such CGE models are devoted to simulation rather than forecast.

IV- Results

Here we present the simulation results for the world as a whole and for individual countries or regions, using the two systems of deflators successively.

World exports

Projections for the annual growth of world exports from 2009 onwards are presented in Table 1 using the two alternative deflators. According to our simulations, world exports, at constant world GDP price, would be expected to fall by 8.9 percent in 2009. In contrast, at constant trade prices, in other words taking into account changes in the true price of traded goods, the decline appears to be much more limited: –2.4 percent. Accordingly, the comparison of trade flows using the two alternative deflators shows that a large part of the world trade collapse seems to be due to a marked fall in the relative price of traded goods compared to non-traded ones, with a large share of that fall coming from oil. This fall in

8 For instance, the WTO Secretariat acknowledges that it relies on estimates when necessary.

trade still represents a 1.1 percentage point "overshooting" over the GDP decline forecast by the IMF (–1.3 percent). However when the world GDP decline is computed using the current exchange rates instead of the PPP weights, the 2009 decline introduced in *MIRAGE* is computed at –2.6%. Thus when appropriate benchmarks are used (trade and GDP aggregated at the world level using the same weights), there is no longer any multiplier effect on trade.

In 2010, the model anticipates an increase in world trade of 2.1 percent (0.7 percent at constant trade prices). Trade is forecast to pick up in 2011 and 2012, when exports are expected to increase by roughly 4 percent.

Such orders of magnitude suggest that our favoured channel of trade attrition, namely the collapse of investment, combined with a halt to the globalisation process, fails to replicate the observed steep drop in the volume of world trade flows, which substantially exceeded that of GDP during the last quarter of 2008 and the first quarter of 2009. Instead, the model finds a similar rate of contraction in trade and GDP when trade flows are deflated by actual prices and GDP figures are aggregated in the same way as trade flows. On the basis of this analysis, the over-shooting observed in late 2008 and early 2009 may be explained by credit restrictions or short term expectations or inventories, all of which are not modelled by *MIRAGE*.

Regional impacts

Table 1 also details the evolution of exports for selected countries.[9] Using the constant world-GDP deflator, EU exports are forecast to fall by 8.6 percent in 2009, almost as much as world exports (–8.9 percent), whereas GDP would decline by 4.0 percent in the EU,

[9] Indeed, simulations were performed using the fully-fledged decomposition of the world economy in the above-mentioned regions.

compared to only 1.3 percent for the world economy.[10] In the United States, in contrast to the EU, exports in 2009 are forecast to fall by more than the world average (–9.5 percent). Asian countries are particularly hit by the dramatic decline in global demand for advanced manufacturing products, such as motor vehicles, information technology and capital goods (Sommer, 2009). As a result, Japanese exports are found to fall by roughly 9 percent in 2009.[11] China suffers smaller export losses than most other countries (–1.7 percent in 2009), although this represents a 10.9 p.p. fall between export growth levels in 2008 (+9.2 percent) and 2009 (-1.7 percent). This 10.9 p.p. drop in the growth rate of Chinese exports is more limited than the world average (–16.1 p.p.), because China suffers less from the decline in its export prices than exporters of primary or agricultural products.

From 2010 onwards, trade recovery appears widespread, thanks to a rapid recovery in non-OECD countries, in particular Brazil, China and India (OECD, 2009). However, the increase in exports in 2011 and 2012 remains below the 2007–2008 figures, most probably because of the slow recovery of several major economies, coupled with the halt in globalisation.

When trade flows are deflated by the prices of traded products, accounting for the drop in the price of oil yields a much milder fall in the export volumes of oil-exporting regions (Russia, Middle East, North Africa). In contrast and more interestingly, for advanced countries, which mainly export manufactured products and services, the difference between results based on the two deflators is limited. For Japan and the United States, there is at most a one percentage point difference. For the EU, the difference is also limited: –7.2% using sectoral trade prices, versus –8.6% using the GDP deflator. Finally, for developing economies exporting agricultural products or manufactured products, the outcome is more mixed. For

10 Note that intra-EU trade, which represents roughly 60% of European trade, is excluded from these calculations.

11 The same applies to Korea and Taiwan, not reported here.

China, the drop in exports (–11.4 p.p.) is much larger than the world average (–7.7 p.p.) due to the sharp contraction in most of its markets. For India, the price adjustment effect comes on top of a sharp decline in volumes. For Brazil the price adjustment effect is very large and is a major determinant of changes in exports.

-- Table 1 about here --

Distinguishing between industry and services, we find that, at the world level, both types of exports are almost equivalently affected, with a 3.8% drop for industry and a 3.6% for services, at constant trade prices (Table 2). This can be explained by the fact that our assumption of a drop in world-wide investment concerns both categories of investment: equipment goods and construction services. The latter are less traded than the former but in our simulation, those that are traded experience a similar fall. However, the picture can vary significantly between countries, with the sharp drops in industrial exports for certain OECD countries such as Japan (–9.3%) or the United States (–8.8%) contrasting to the relative resilience of developing countries exports (e.g. China).

-- Table 2 about here --

V- Robustness analysis

The results presented in the previous section suggest that the observed and simulated sharp drop in world trade is partly explained by the decline in the relative price of traded goods compared to non-traded ones. When modelled in such a way that trade flows are deflated by sector-specific trade prices and world GDP is aggregated at current exchange rates, instead of PPPs, world trade no longer overshoots world GDP for 2009. However, our assumption of a halt to the globalisation process may appear too conservative. As it is difficult to calibrate a 'de-globalisation' process, in this section we simply seek to measure the contribution of this assumption to the results, by re-running the same exercise while prolonging the trend of globalisation from 2009 onwards.

A second issue which we seek to explore is the contribution of our expected fall in the oil

price to the results, which is crucial in the finding of a large fall in world trade in 2009. The oil price is introduced as an exogenous variable and its evolution may reflect short-run factors such as 'fire sales' of oil derivatives. We accordingly re-run the simulation with an endogenous oil price, keeping the resource constant.

The role of the halt in the globalisation trend

Let us start with the important assumption in our simulations regarding the halt imposed on the trend of globalisation. Note that globalisation has been modelled here as a downward trend in trade costs, that we assume to be interrupted in 2009. Given the claims of de-globalisation from certain commentators (The Economist, 2009), it is interesting to explore how much the assumption contributes to the overall drop in trade simulated within *MIRAGE*. To capture this, we reproduce the previous scenarios while extrapolating (rather than halting) the decline in trade costs after 2008. Although such a trend seems an unlikely prospect in the current economic climate, it helps us to better understand the exercise.

The results presented in the second row of Table 3 must be compared with the first row (which replicates the first row of Table 1). In 2009, extrapolating the globalisation trend limits the drop in world trade to –6.8% at world GDP prices. Therefore our assumption of a halt to the globalisation trend is found to account for 2.1 percentage points (roughly 25%) of the simulated decline in world trade at GDP prices. Hence, the fact that the general trend towards integration and market opening of recent years does not continue in the model has, in itself, an important impact on trade. Conversely, assuming linearity as a first approximation, a reversal of the trend ('de-globalisation') could add some 2 percentage points to the fall in world trade.

--Table 3 about here --

The role of the oil price

The price of energy in our simulation is exogenous. We accordingly made the resource

endogenous in order to reflect the IMF's forecasts. Since the price of energy has been seen to profoundly impact the results, it is worth comparing them with a simulation where the oil price is determined by the model (resources are set exogenous). The results of this exercise are shown in the third row of Table 3. They point to a much reduced fall in trade in 2009 due to the more limited fall in the oil price. Hence, the short term deviation of the oil price from its long term equilibrium level accounts for a large part of the simulated decrease of world trade in 2009. As soon as the oil price converges toward its equilibrium long term price, differences between the two scenarios disappear.

Conclusion

Beyond the correlated sharp decline in activity world-wide – a consequence of a global economy – there are several potential explanations for the fall in world trade during the 2008-2009 crisis. The most popular include the fact that investment has dried up; that tradable sectors are relatively more affected by the crisis; that a scarcity of trade finance has constrained imports; that the increase in exchange-rate volatility has impeded trade; that there has been a rise in protectionism. Lastly, a specific role has been attributed to the impact of the fragmentation of the production process and the related multiplier effect of trade over GDP.

In this paper we firstly present simple accounting calculations showing that the supply-chain argument does not automatically lead world trade to overshoot a drop in world GDP. We then use a multi-region, multi-sector CGE model to explicitly take into account inter-industry relations at the sectoral level to assess whether the GDP forecasts for 2009 and 2010, together with a change in the composition of demand detrimental to investment and a halt in the trend towards a reduction in trade costs, can together account for the sharp drop in world trade.

The order of magnitude for trade decline in 2009 simulated by the model is 8.9 percent when

trade flows are deflated by the price of the world GDP, compared with the 1.3 percent fall in world GDP. However, the simulated drop in the volume of world trade very much depends on the deflator used. To some extent, results are driven by the assumptions made about the price of oil, in line with observed changes and forecast prices. Using simulated trade prices instead of GDP prices, the drop in the volume of world trade is only –2.4 percent. Accordingly, the large drop forecast by international organisations for the whole year of 2009 partly covers a relative price effect, i.e. a fall in the price of traded goods (especially energy) compared to non-traded ones. Lastly, it is important to use the right GDP benchmark to assess impacts: the drop in world GDP is –1.3% in 2009 according to IMF forecasts, but –2.6% when aggregated using current exchange rates. Accordingly, our paper does not support the hypothesis of a systematic over-shooting of trade due to the fragmentation of supply chains.

We performed additional simulations, not reported here, in order to estimate the elasticity of world exports to world GDP, *ceteris paribus*, and found an elasticity of 0.98. This outcome is not specific to *MIRAGE*. Willenbockel and Robinson (2009) use a static CGE of the world economy, *GLOBE*, to assess the impact of the global depression on developing countries' exports. They rely on an assumption of a 5 percent drop of GDP in the OECD, imposed to the world economy as it was in 2004. This is a much sharper drop than the one modelled in our own exercise (recall that we assume a 1.3 percent drop for the world GDP in 2009, with –6.2 percent for Japan and –4.0 percent for the EU, but only –2.8 percent for the U.S.). With a 5 percent drop in the OECD's GDP, the OECD's exports drop by 4.7 to 5.6 percent depending on the region, while developing countries' exports at worst suffer a drop of 2 percent. These results are computed as changes in volumes, at constant trade prices. They do not indicate the presence of any trade multiplier.

In sum, the double-digit drop in global trade that has been observed in the last quarter of 2008 and first quarter of 2009 seems likely to be explained by other factors than the

fragmentation of supply chains: changes in inventory levels, consumer expectations and trade finance or the collapse of the car industry appear to be good candidates.[12] Such factors are typically not modelled in a world multi-sectoral CGE such as MIRAGE, which is mostly focused on longer term adjustments. The short-term nature of some of these determinants should prevent a durable drop in trade such as that observed in the 1930s, unless a similarly significant rise in protectionism to that observed in the latter period emerges. In spite of anecdotal evidence of 'murky protectionism' this still looks an unlikely prospect.

Acknowledgements Excellent research assistance by Sadibou Fall is gratefully acknowledged. We are indebted to Louise Curran and to the participants in the Paris, July 2 2009 workshop, for helpful remarks on a previous draft. This research has received financial support from European Commission, DG Trade, under contract No. SI2.528.018. The usual disclaimer applies.

12 Regarding trade finance, the OECD estimates that it explains up to a third of the drop in trade over 2008Q4 and 2009Q1 (cf. OECD (2009), Box 1.2).

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Table 1: Export growth at constant world GDP and trade prices for selected countries

	2007	*2008*	*2009*	*2010*	*2011*	*2012*
World	(6.0)	(7.2)	(-8.9)	(2.1)	(4.1)	(4.4)
	6.6	5.3	-2.4	0.7	3.7	3.7
USA	(4.2)	(5.0)	(-9.5)	(0.6)	(2.6)	(3.4)
	4.2	5,2	-8,6	0,0	2,1	3,0
Japan	(2.7)	(2.7)	(-9.2)	(1.6)	(4.0)	(4.6)
	2.7	3,9	-10,1	2,0	3,7	4,4
EU27	(7.0)	(6.7)	(-8.6)	(1.6)	(3.6)	(3.8)
	7.0	7,3	-7,2	1,1	3,1	3,3
China	(11.9)	(9.2)	(-1.7)	(4.9)	(7.9)	(7.8)
	11.9	12,0	0,6	6,5	9,5	9,2
India	(7.6)	(7.3)	(-8.2)	(7.2)	(8.4)	(8.3)
	7.6	8,2	-5,8	8,2	9,7	9,3
Brazil	(8.4)	(15.7)	(-9.7)	(2.8)	(4.1)	(4.1)
	8.4	15,0	-2,7	1,4	4,0	3,4

Note: Annual percentage change, constant GDP prices in brackets

Source: MIRAGE simulations.

Table 2: Exports growth by sector for selected countries, 2009 (constant trade prices)

	World	USA	Japan	EU	China	India	Brazil
Industry	-3.8	-8.8	-9.3	-6.7	1.9	-2.1	-5.6
Services	-3.6	-9.1	-16.1	-9.0	-6.7	-16.1	-3.1

Note: Annual percent change.

Source: MIRAGE simulations.

Table 3: World export growth, 2007-2012 at constant GDP price, under different sets of assumptions

	2007	*2008*	*2009*	*2010*	*2011*	*2012*
Reference scenario	6.0	7.2	-8.9	2.1	4.1	4.4
Prolonged trend in globalisation	6.0	7.2	-6.8	4.5	6.7	7.1
Oil price endogenous	6.0	7.2	-2.8	1.6	4.4	4.9

Note: Annual percent change.

Source: MIRAGE simulations.

Appendix 1: The MIRAGE model

In the *MIRAGE* model, the demand side is modelled in each region through a representative agent. Domestic products are assumed to benefit from a specific status for consumers, making them less substitutable for foreign products than foreign products are between each other. Secondly, manufactured products originated in developing and developed countries are assumed to belong to different price or quality ranges. Hence, the competition between products of different qualities is less intense than between products of similar quality. As regards the supply side of the model, producers use five factors: capital, skilled and unskilled labour, land, and natural resources. The structure of value-added is intended to take into account the well-documented relative complementarity of skill-capital. The production function assumes perfect complementarity between value-added and intermediate consumption (like the accounting of Section 2), but domestic and imported intermediate inputs are substitutes (unlike in Section 2). The sectoral composition of the intermediate consumption aggregate stems from a nested CES function. Constant returns to scale and perfect competition are assumed to prevail in agricultural sectors. In contrast, firms are assumed to face increasing returns to scale in industry and services. In those sectors, competition is imperfect and exports of final goods depend on relative prices (unlike in Section 2 where relative prices are set constant).

Capital is accumulated every year as the result of investments in the most profitable sectors, but it cannot change its sector affectation. The pace of regional (or country) investment is set exogenously here, while returns to capital determine the allocation of investment across sectors. The current account balance is assumed to be exogenous (and equal to its initial value in percentage of the world GDP), while real exchange rates are endogenous. This approach has a specific consequence when it comes to the simulated changes in exports and imports of individual countries. Depending on the initial surplus or deficit in the current account, the percentage change of exports and imports must be different in order to keep the

imposed constraint on the current account. The real exchange rate appreciates or depreciates accordingly.

Natural resources are considered to be perfectly immobile and may not be accumulated. Oil resources, as detailed below, are calibrated such that prices in *MIRAGE* match IMF forecasts. Both high and low-skilled labours are assumed to be perfectly mobile across sectors, whereas imperfect land mobility is modelled with a constant elasticity of transformation function. Production factors are assumed to be fully employed. All production factors are immobile internationally.

Appendix 2: Accelerator and investment growth by region

	2007	***2008***	***2009***	***2010***	***2011***	***2012***	Accelerator
				Estimates			
Australia/New Zealand	3.1	-2.8	-12.5	-6.5	2.8	0.6	2.9
China	13.7	8.9	5.9	7.1	11.4	10.5	1.2
India	10.0	7.6	4.2	5.5	9.2	8.2	1.2
Japan	1.9	-4.4	-16.2	-2.1	2.7	4.0	2.1
Korea/Taiwan	4.7	-2.8	-16.1	-3.8	2.9	1.4	2.0
Rest of Asia	7.0	5.3	-0.6	2.2	6.7	5.7	1.2
Canada	4.3	-5.6	-18.9	-2.5	6.4	2.9	4.5
USA	-4.5	-6.8	-17.0	-9.7	-4.5	-1.9	2.6
European Union	6.1	-1.6	-20.9	-6.9	0.0	1.1	3.8
Rest of Europe/Turkey	3.4	-3.5	-19.3	-7.1	3.0	0.7	2.9
Russia	20.0	14.8	-9.6	4.0	15.6	14.0	2.1
Brazil	9.0	6.9	-16.2	-3.6	4.8	2.1	3.6
Mexico	6.5	-0.3	-18.3	-1.4	6.6	3.8	3.6
Other Latin America	9.0	3.6	-16.9	-5.7	5.2	2.4	3.6
Middle East	16.6	15.9	9.4	11.3	17.1	15.7	1.9
North Africa	10.1	10.9	5.9	7.1	12.5	10.7	2.3
South Africa	8.5	3.5	-5.0	0.5	8.2	6.2	2.5
Rest of Africa	10.3	6.9	-2.6	2.6	10.4	8.5	

Note: Annual percent change at constant price.

Source: Own calculations based on data from the World Economic Outlook database.

Appendix 3: GDP growth by region

	2007	*2008*	*2009*	*2010*	*2011*	*2012*
				Forecasts		
Australia/New Zealand	4.0	1.9	-1.5	0.6	3.8	3.0
China	13.0	9.0	6.5	7.5	11.1	10.3
India	9.3	7.3	4.5	5.6	8.6	7.9
Japan	2.4	-0.6	-6.2	0.5	2.8	3.4
Korea/Taiwan	5.2	1.5	-5.1	1.0	4.4	3.6
Rest of Asia	6.3	4.9	0.0	2.3	6.0	5.3
Canada	2.7	0.5	-2.5	1.2	3.2	2.4
USA	2.0	1.1	-2.8	0.0	2.0	3.0
European Union	3.1	1.1	-4.0	-0.3	1.5	1.8
Rest of Europe/Turkey	4.4	1.8	-3.7	0.5	4.0	3.2
Russia	8.1	5.6	-6.0	0.5	6.0	5.2
Brazil	5.7	5.1	-1.3	2.2	4.5	3.8
Mexico	3.2	1.3	-3.7	1.0	3.2	2.5
Other Latin America	5.7	4.2	-1.5	1.6	4.6	3.9
Middle East	6.4	5.9	2.5	3.5	6.6	5.8
North Africa	5.2	5.3	3.2	3.7	6.0	5.3
South Africa	5.1	3.1	-0.3	1.9	4.9	4.2
Rest of Africa	6.9	5.5	1.7	3.8	6.9	6.1

Note: Annual percent change at constant price.

Source: IMF (2009c) and Freedman et al. (2009).