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Value-added trade and business cycle synchronization☆

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ABSTRACT

Ever since Frankel and Rose's (1998) seminal paper, the literature on trade and business cycle synchronization has relied on gross trade data, with weak results in recent papers that carefully address omitted variable bias. This paper re-examines this relationship using new value-added trade data for 63 advanced and emerging economies during 1995–2013. In a panel framework, we identify a significantly positive impact of bilateral (value-added) trade intensity on business cycle synchronization—controlling for global common shocks, country-pair heterogeneity and other covariates—that is absent when gross trade data are used. There is also some evidence that the impact of value-added trade on synchronization increases with the degree of (value-added) intra-industry trade. We provide a theoretical rationale for the role of value-added trade for synchronization using a simple international business cycle model that features cross-country input linkages in production.

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1. Introduction

The relationship between trade integration and business cycle synchronization (BCS) has been subject to extensive research, motivated in good part by the optimum currency area literature (OCA) that was pioneered by Mundell (1961) and McKinnon (1963) and given new impetus by Frankel and Rose (1997, 1998). A wide range of empirical papers (e.g., Frankel and Rose, 1997, 1998; Baxter and Kouparitsas, 2005; Imbs, 2004; Inklaar et al., 2008) have found that country pairs that trade more with each other experience higher business cycle synchronization. While these previous studies have adopted a variety of empirical techniques, they have typically not controlled for country-pair factors and common global shocks that could potentially drive the trade-BCS relationship and lead to omitted variable bias. Indeed Kalemli-Ozcan et al. (2013b) and Abiad et al. (2013) find the relationship between trade integration and BCS to be insignificant when such controls are added in a panel setup.¹ Recent literature has therefore cast serious doubt on the positive impact of trade integration on BCS found in earlier studies using alternative empirical frameworks.

Our paper argues that the measurement of bilateral trade intensity is important for evaluating the trade-BCS relationship. Gross trade data, which have been commonly used in the literature, can misrepresent trade linkages across countries given the growing importance of

supply-chain networks across the globe. Once such supply-chain linkages are accounted for and trade integration is measured using *valued added* rather than *gross* trade data—using newly constructed annual data extending the OECD-WTO Trade in Value Added (TiVA) dataset—a positive, highly significant and robust effect of trade intensity on BCS is restored for a sample of 63 countries spanning the last two decades. IV estimates are larger than OLS estimates, suggesting that OLS attenuation bias induced by measurement error—which remains even when valued added trade data are used, as these rely on detailed information on trade flows and input–output matrices—is sizeable. The effect of trade is economically significant: our baseline estimates imply that the increase in (value added) trade intensity observed over the period 1995–2013 has accounted for an increase of close to 0.1 in the correlation of annual growth rates for the median country pair. There is also some evidence that the impact of value-added trade on synchronization increases with the degree of (value-added) intra-industry trade.

The reason why valued-added trade captures the bilateral trade linkages between two countries better than gross trade does is simple (see the detailed discussion in Johnson, 2014a): it is the value added exported by country A to country B, not the gross value of these exports, that contributes to overall value added and therefore to GDP in country A. In a world of growing supply chains and intermediate goods trade (Koopman et al., 2014), countries increasingly specialize in adding value at particular stages of production, and intermediate inputs, passing through these different stages, typically cross borders multiple times. In such a world, gross exports do no longer capture how much value added country A sells to country B, for several reasons. Let us consider for example country A's GDP response to demand shocks originating in country B. First, for each dollar of gross exports from country A to country B, the value added generated in country A is *less than or equal to*

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¹ Earlier studies that accounted for country-pair heterogeneity also found weaker or no effects of overall trade intensity on BCS (Calderon et al., 2007; Shin and Wang, 2004).

one dollar since imported intermediate goods are used in the production of exported goods; the larger the imported foreign content of exports, the more gross exports *overstate* the actual exposure of country A to shocks in country B, all else equal. Second, countries A and B may engage in bilateral intermediate goods trade under which the same good crosses the same border multiple times at different stages of production; here again, gross exports from country A to country B will *overestimate* the value-added exposure of A to B. Third, and crucially, country A may indirectly export value added to country B without shipping any gross exports, for instance if it exports intermediate goods to a third country C that uses them to produce a final consumption good that is then exported by C to B; in this case, direct gross exports from A to B will *under-estimate* the value added that A exports (indirectly) to B. Focusing on value-added trade addresses these issues because it: i) nets out bilateral trade in intermediate goods—unlike gross trade data which count products multiple times when they cross borders repeatedly for processing purposes; and ii) includes indirect trade linkages via third countries—such as value added exported indirectly by A to B via intermediate inputs exported by A to C that are then used to produce a good exported by C to B.

The iPhone supply chain provides a simple illustration of the importance of the “third country effect” and the broader case for using value-added trade data. Although China exports the product to the US, its domestic firms add only a small fraction of the overall value added, mainly by assembling components sourced from other countries (Xing and Detert, 2010). As a result, China’s gross iPhone exports to the US vastly exceed the value added by Chinese producers, and therefore vastly overstate the potential GDP growth impact of demand shocks coming from the US. By contrast, Korea does not export any iPhone to the US. Yet, compared to China, Korea reaps a far bigger share of the total value added from iPhone trade with the US, but it does so indirectly through exports of components to China. In Korea’s case, gross trade with the US vastly under-estimates the potential GDP impact of shocks to US iPhone demand—indeed gross trade is zero.

Conventional international real business cycle models (IRBC) in the tradition of Backus et al. (1992) do not make a distinction between value-added and gross trade. Traded goods cross borders only once as they are exported either as final consumption goods or as intermediate inputs to produce final goods that are immediately consumed by the importing country. In such models, trade induces cross-country comovement if home-produced and foreign-produced goods are highly complementary.² Recently, Johnson (2014b) builds a new type of IRBC model with input–output linkages across sectors within and across countries, introducing another channel through which trade propagates shocks across borders and lead to BCS. Specifically, higher productivity in the home country lowers production costs, and thereby raises production not only in its direct export markets but also in a sequence of countries that indirectly import intermediate inputs from the home country. We present a simplified static version of Johnson (2014b) and show that in our simple model value-added, rather than gross trade, matters for shock propagation and BCS.

Our paper contributes to the burgeoning literature that emphasizes the importance of distinguishing between value-added trade and gross trade in international trade and macroeconomics. Bems (2014), for instance, argues that calibrating a misspecified value-added trade model to gross trade data can generate misleading predictions regarding how relative prices respond to external rebalancing. As supply-side linkages fundamentally alter how relative price changes affect international competitiveness, Bems and Johnson (2012) show that

² A positive shock in the home country increases its GDP but decreases its export price relative to that of foreign products. The resulting improvement in the terms of trade of the foreign country triggers a positive supply response of production factors, and thereby an increase in GDP. This effect is larger when home-produced goods and foreign-produced goods are more complementary (either as final consumption goods or as intermediate inputs in final production).

value-added trade weights are the correct weights to attach to each trading partner’s final demand when computing real effective exchange rates. This paper adds another dimension to the discussion: we show that BCS bears a robust relationship with value-added trade, while the link with gross trade—which until now has been the focus of both empirical and theoretical literature—is statistically insignificant.

Our paper also adds to an active theoretical and empirical literature on the role of intermediate goods trade for BCS. Theoretically, in a calibrated multi-country multi-sector dynamic IRBC model featuring vertical trade, Johnson (2014b) finds that such a model generates strong positive output comovement but more limited value-added comovement across countries, even with strong complementarity among inputs. This finding is not inconsistent with ours. We do not study the distinction between cross-country output vs. value-added comovement; instead, we show that value-added trade has a statistically and economically significant effect on cross-country GDP comovement, providing empirical confirmation for the claim made by Johnson (2014a). More importantly, Johnson (2014b) is about the inability of the standard IRBC to generate a strong change in bilateral output correlations in response to changes in (gross) trade intensities, a longstanding issue in a literature that has sought to evaluate the performance of IRBC models through the lens of what was thought to be a strong relationship between gross trade and BCS following the seminal papers of Frankel and Rose (e.g. Kose and Yi, 2006; Burstein et al., 2008). Our paper is about the importance of the proper measurement of trade linkages in evaluating the empirical trade-BCS relationship.

On the empirical front, using gross trade data at the sector level, Di Giovanni and Levchenko (2010) find a larger positive impact of (gross) trade on comovement between sector pairs that use each other as intermediate inputs. This suggests that vertical trade along the supply chain is likely to generate more comovement than final goods trade. Our paper does not focus on the *type* of trade (intermediate versus final), but rather on how the overall *intensity* of bilateral trade should be computed when thinking about the role of trade for BCS. On this issue, we find that the domestic value added embodied in exports (of final and intermediate goods together) matters, while the overall value of bilateral gross trade does not. It may still be the case that trade in intermediate goods generates greater comovement than trade in final goods—indeed our tentative finding that intra-industry trade generates greater comovement than inter-industry trade is consistent with this view, although the two issues are conceptually distinct.

The rest of the paper is structured as follows. Section 2 presents a simple model illustrating that propagation of shocks across borders is driven by value-added trade more than by gross trade. Section 3 describes the data. Section 4 provides OLS and IV estimates of the impact of trade on BCS using both gross and value added trade data. As a robustness check, Section 5 re-estimates our main regressions using the original OECD-WTO TiVA data as well as an alternative measure of BCS. Section 6 extends the analysis by exploring whether the impact of trade integration on BCS differed during the global financial crisis. Section 7 concludes.

2. An illustrative model

This section presents a simple three-country model to show that the propagation of shocks across countries depends on the value added traded between them. Indeed, as shown below in a special example, even when there is no direct gross trade between two countries, shocks still propagate between them via their trade with the third country, an illustration of the “third country effect” mentioned in the introduction.

We start by noting that in typical IRBC models in the tradition of Backus et al. (1992), goods are exported either as final consumption goods or as intermediate inputs to produce final goods that are immediately consumed by the importing country. Therefore, trade is written

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