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Investment composition and international business cycles ☆

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ABSTRACT

This paper studies a two country model with traded and nontraded sectors, in which sector-specific capital goods, as in practice, are produced by combining inputs from all sectors. The model also includes nontraded distribution services employed in retailing traded goods to consumers. The results show that the model with capital goods comprising multisectoral inputs outperforms the standard model in which sectoral output also serves as its capital. In particular, it substantially improves (a) the movements of trade balance and relative prices; (b) within country comovements of sectoral and aggregate quantities; (c) cross-country comovements of output vis-à-vis consumption. The results change only marginally when distribution services are removed from the model.

1. Introduction

International business cycle models typically make simplifying assumptions on the composition of capital goods. In the two country single good model introduced by Backus et al. (1992), consumption and capital by construction are identical goods. Even in its two goods extensions, for example in Backus et al. (1994) and Heathcote and Perri (2003), a country specific consumption good also serves as capital. In models that include a nontraded sector, such as Stockman and Tesar (1995) and Mendoza (1995), a sector's output serves as its own capital. Some others, for example Burstein et al. (2003), and more recently Corsetti et al. (2008), assume that capital is produced only by the traded sector, but is perfectly mobile across traded and nontraded sectors.[2]

In practice, capital goods are sector specific and composed of both traded and nontraded goods. Based on multi-country panel data on aggregate investments, Bems (2008) estimates that about 54%–62% expenditure is on nontraded goods, and the remaining 38%–46% is on traded goods. However, the shares depend on whether the investments are undertaken by industries in the traded sector (namely, Agriculture, Forestry, and Fishing; Mining and Quarrying; Manufacturing) or the remaining industries in the nontraded sector.[3] For example, from 1947 to 2004, the average US investment expenditure incurred by the traded sector is 69% on Equipment and Software (i.e., goods produced by the traded sector), and 31% on Structures (produced by the nontraded sector); the corresponding shares for the investment undertaken by the nontraded sector are 39% and 61%, respectively. Furthermore, investment on traded goods includes imports, 37% and 36%, respectively, for the traded and the nontraded sectors. Altogether, US investment expenditure shares in the traded sector on its exportables, imports, and nontraded goods are 43%, 26%, and 31% respectively, whereas in the nontraded sector these shares are 25%, 14%, and 61%.[4]

This paper imbeds the above investment composition into an otherwise standard two-country complete-market international business cycle model, as in Stockman and Tesar (1995), in which each country produces a distinct traded (exportable) good and a nontraded good, and consumption preferences are defined over exportable, importable, and nontraded goods. The motivation is the following: since investment

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[2] In a slightly different vein, Kehoe and Ruhl (2009) study sectoral reallocations and real exchange rate movements in a determinstic economy under sudden stops. In their model, both traded and nontraded goods combine to produce capital goods, which are perfectly mobile across sectors.

[3] The sectoral aggregation is based on International Standard Industrial Classification of All Economic Activities developed by United Nations Statistics Division. See Data Appendix for further details.

[4] After accounting for the relative sizes of the two sectors, input share estimates are broadly consistent with those reported by Bems (2008).

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is the most volatile aggregate in the national accounts, modeling its composition correctly within the business cycle framework will significantly impact model-generated moments. First, a sector's investment demand from other sectors is likely to align their output, employment, and investment movements, and thus explain their observed positive correlations in the data.[5] Second, as output is either invested or consumed, any movements in the former will mirror in the latter as well, and thus inhibit cross-country consumption comovements encountered in standard models.

The results substantiate these conjectures. Along many dimensions, the model with sector-specific investments composed of multisectoral inputs outperforms the model with sectoral output serving as its own capital. First, it brings the volatility of trade balance, terms of trade, relative price of nontraded goods, and real exchange rates closer to the data. Second, internal correlations of output with other aggregates, particularly the trade balance, are much improved. Within country correlations of sectoral aggregates come closer to the data. Finally, cross-country consumption correlation falls below that of output; that is, the *quantity anomaly* disappears.[6]

How do investments composed of multisectoral inputs improve model performance? Consider a positive supply shock in either the exportable or the nontraded sector in one of the countries. Relative to the model where this sector uses its own output for investment, it instead demands more of all the three inputs: nontraded, exportables, and imports. A higher demand for the other home good, as well as imports, has three direct effects. First, it raises their relative prices more. As a result, terms of trade, relative price of nontraded goods, and real exchange rates are relatively more volatile. Second, a higher import expenditure on investment leads to a higher trade variability and countercyclicality of the trade balance.[7] Third, within-country sectoral outputs, and, therefore, their employments and investments, are more aligned.

A key explanation for why the cross-country consumption correlation falls is that in the model calibrated to the data, investment in the aggregate requires about 18% imports, whereas overall consumption expenditure on imports is only about 10%. Thus, cross-country quantity comovements are less driven by the motive to share consumption than to meet investment demands. This is further reinforced by within country investment demands for cross-sectoral goods. To understand the underlying mechanism, first consider a positive productivity shock to country 1's exportable sector. When the exportable sector solely utilizes its own output for investment, a part of the output increase is absorbed by its own investment, while the remaining is shared across the two countries for consumption. Since changes in the consumption demand for nontraded goods in both countries are primarily driven by their increased consumption of traded goods, the two countries' compositional and aggregate consumption movements are symmetrically aligned. In contrast, when investments in the exportable sector utilize nontraded goods as well, country 1's increased investment demand for nontraded goods adversely impacts its nontraded consumption. However, movements in the nontraded consumption of country 2 continue to be caused primarily by the increase in its traded consumption. Cross-country consumption comovements are inhibited as a result.

Now consider a positive shock to the nontraded sector of country 1. With investment in the nontraded sector not absorbing its own output solely, more of it is left for consumption that, by its very nature, cannot be shared across countries. Moreover, the investment demand for imports by country 1 is obtained by cutting the exportable consumption of country 2. Cross-country consumption comovement is again inhibited. Thus, with reduced consumption comovement under either shock, the quantity anomaly disappears when investments comprise multisectoral goods.

The last result is of particular significance, because the anomaly has puzzled international macroeconomists for about two decades. Researchers have resorted to various strategies to resolve this puzzle, restricting asset trades and introducing nontraded goods in particular, since tradablity of goods and assets is at the heart of consumption sharing across countries.[8] These strategies have met with only partial success. Table 1 summarizes the relative success of the past studies in this respect.

Merely restricting asset trade does not help. Baxter and Crucini (1995) show that with trend-stationary shocks, a sole riskless bond is almost as good as complete markets in letting countries pool consumption intertemporally; in addition, one needs unit root shocks to hinder consumption sharing in the bond economy. Thus Kollman (1996), in a bond economy with highly persistent shocks, finds a lower cross-country consumption correlation than the previous studies. Kehoe and Perri (2002) endogenize credit constraints, and with Kollman's shocks, improve on the relative magnitudes of the output and consumption correlations. Heathcote and Perri (2002) completely eliminate asset trade, but the anomaly remains robust.

Stockman and Tesar (1995), while retaining market completeness, introduce nontraded goods to inhibit cross-country consumption comovement. With only technology shocks in the model, the cross-country consumption correlation exceeds that of the outputs. Then they rope in taste shocks, which lower the cross-country correlation of consumption. Yet, the quantity anomaly survives.

What helps is a consumption bias towards the exportable goods, relative to imported goods, and/or a low elasticity of substitution between the two (i.e., low trade elasticity). For example, home bias helps Heathcote and Perri (2003) in matching data correlations in a two country model with limited asset trade and unit root shocks. As for a low trade elasticity, Pakko (1997) argues that with a high *compositional* risk aversion relative to the *aggregate*, consumers care less about smoothing aggregate consumption than about stabilizing its composition. This inhibits cross-country consumption sharing. With a low trade elasticity as well as a home bias in consumption, Corsetti et al. (2008) study a two-country model with incomplete markets. The quantity anomaly disappears in their results.[9]

A contribution of this paper is to highlight that merely accounting for a realistic input output structure in the production of capital goods eliminates quantity anomaly from the workhorse two-sector international business cycle model, with fairly standard specification of preferences and technologies, and without restricting technology shocks or trade in assets.

Another point of departure that this paper undertakes from the standard models is in accounting for the role of distribution services.[10] While Stockman and Tesar (1995), due to data constraints, classify

[5] In a closed economy model, Hornstein and Praschnik (1997) show that the use of intermediate inputs in production helps to explain within country positive crosssectoral output and employment comovements. Their two sectors are durables and nondurables. Durables produce capital for use in both sectors, while nondurables produce consumption and intermediate inputs for durables' production.

[6] That cross-country consumption correlation substantially exceeds output correlation in an international business cycle model – at complete variance with the data – was first highlighted and dubbed as the "quantity anomaly" by Backus et al. (1992). Their model economy comprised two countries, a single consumption good, and complete financial markets.

[7] Engel and Wang (2011) report that in OECD countries, trade in durable goods accounts for about 70% of imports and exports. They disaggregate their model economy into a durable and nondurable sector, and assume that only the former is traded. Similar to the present work, their model generates higher export and import volatilities, and counter-cyclicality of trade balance that fits the data well.

[8] The anomaly has also been addressed by incorporating (a) multiple sectors with trade in intermediate inputs (see, for instance, Ambler et al. (2002), Kouparitsas (1997), and Huang and Liu (2004)), and (b) multiple countries (see, for instance, Yakhin (2005)).

[9] The main intent of their paper is to resolve Backus–Smith puzzle by showing that a low elasticity of substitution and home bias in consumption in a bond economy leads to wealth effects that require terms of trade appreciation in case of a positive output shock (and vice versa).

[10] In recent years, several international relative-price puzzles have been explained by explicitly modeling distribution services, i.e., the transportation, wholesaling, and retailing services, as nontraded component of traded consumption. See, for example, Burstein et al. (2003), Corsetti and Dedola (2005), and Corsetti et al. (2008).