



Offshore production and business cycle dynamics with heterogeneous firms[☆]



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ABSTRACT

To examine the effect of offshoring through vertical FDI on the international transmission of business cycles, I propose a two-country model in which firms endogenously choose the location of their production plants over the business cycle. Firms face a sunk cost to enter the domestic market and an additional fixed cost to produce offshore. As such, the offshoring decision depends on the firm-specific productivity and on fluctuations in the relative cost of effective labor. The model generates a procyclical pattern of offshoring and dynamics along its extensive margin that are consistent with data from Mexico's maquiladora sector. The extensive margin enhances the procyclical response of the value added offshore to expansions in the home economy, as the number of offshoring firms mirrors the dynamics of firm entry at home. As a result, offshoring increases the comovement of output across economies, in line with the empirical evidence.

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1. Introduction

Firms often establish production affiliates at foreign locations to benefit from lower production costs, a process known in the international economics literature as offshoring through vertical foreign direct investment (FDI).² The offshoring output fluctuates over the business cycle, and thus affects the dynamics of output and trade for the home and foreign economies. Since offshoring through vertical

FDI contributes to the output of the foreign economy but is often affected by shocks originating in the home country, it has potential implications for the comovement of output between the two economies.³ Also, since the relocation of production is a firm-level decision, the offshoring output and trade are likely to be influenced by changes in the firms' production strategies in addition to other factors considered in the traditional literature, in which the location of production plants is usually fixed over time.⁴

To motivate the line of research proposed in this paper, I empirically document the business cycle fluctuations of offshoring through vertical FDI, including its extensive margin,⁵ using the relationship

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² Unlike offshoring through horizontal FDI, under which firms relocate production abroad to gain access to the local market, the type of offshoring that I model is motivated by cross-country differences in the cost of effective labor, as foreign affiliates produce goods that are shipped back to the country of origin. Helpman et al. (2004) model exports and horizontal FDI as alternative internationalization strategies for multinational firms. Contessi (2010) analyzes the trade-off between exporting and offshoring through horizontal FDI in a business cycle framework.

³ "Offshoring" refers to the activity of firms that relocate certain stages of production to foreign countries. In contrast, "outsourcing" refers to firms that purchase intermediates from unaffiliated suppliers either at home or abroad, rather than producing them in-house (see Helpman, 1984, 2006).

⁴ In the traditional literature, output comovement crucially depends on the elasticity of substitution between country-specific goods (Backus et al., 1994; Burstein et al., 2008).

⁵ The extensive margin refers to the number of firms, plants, or varieties operating in a sector. The intensive margin refers to the amount of output (or exports) per firm, plant, or variety. The model in this paper assumes a one-to-one correspondence between a firm, a plant, and a variety.

between U.S. manufacturing and Mexico's *maquiladora* sector as an example. The *maquiladora* sector in Mexico is an appropriate empirical setup to examine the cyclicity of offshoring through vertical FDI, as it consists of manufacturing plants that import inputs mostly from U.S. firms, process them, and export the resulting output back to the U.S. firms, thus accommodating the offshoring activities of the latter. The time series and correlations in Fig. 1 show that: (a) The offshoring value added in Mexico's *maquiladora* sector is procyclical with the U.S. manufacturing industrial production (IP); in fact, it is more procyclical than Mexico's total manufacturing IP. (b) Like the offshoring value added, the extensive margin of offshoring (proxied by the number of *maquiladora* plants) is also procyclical with the U.S. manufacturing IP. (c) Mexico's offshoring exports are more procyclical than Mexico's regular (non-offshoring) exports with the U.S. manufacturing IP. This evidence highlights the procyclical pattern of offshoring and its extensive margin and adds to empirical studies documenting that fluctuations in the extensive margin of offshoring can have substantial macroeconomic effects for the economies involved (Bergin et al., 2009; Kurz, 2006; Ramondo et al., 2016).⁶

Motivated by these observations, this paper proposes a model of offshoring through vertical FDI in which firms choose the location of their production plants endogenously over the business cycle. In turn, the model allows for adjustments of offshoring along its extensive margin (the number of firms) that can potentially affect aggregate variables and the comovement of output between economies. Thus, the paper aims not to merely replicate the empirical business cycle properties of offshoring, but to explore whether the firm-level decision to produce offshore can play a role in shaping the model implications for trade and output comovement.

The model of offshoring proposed in this paper consists of two economies (the North and the South), building on the dynamic stochastic general equilibrium framework in Ghironi and Melitz (2005, henceforth GM05). As in GM05, the key model ingredients include endogenous firm entry, firm heterogeneity in labor productivity, and an endogenous export decision for firms in each economy. To this framework, I add: (1) an endogenous offshoring decision by the Northern firms, which decide whether to produce domestically (in the North) or offshore (in the South) guided by the cost advantage of offshoring every period; (2) a steady-state asymmetry in the cost of effective labor⁷ across countries, which makes production cheaper in the South; and (3) a calibration that replicates the asymmetric size of the U.S. and Mexican economies, as well as the importance of offshoring for the latter. Thus, there are two types of exports in the Southern economy, namely the offshoring and the regular exports. The offshoring exports, which represent the focus of this paper, are initiated by the Northern offshoring firms that decide to produce in the South and ship the resulting output back to the North. In contrast, the regular exports are initiated by the Southern firms that export to the North, as in GM05.

In this framework, following entry in the North (subject to a sunk cost), firms can use either domestic or foreign labor in production for their home market. The use of foreign labor involves the

establishment of an offshore plant and allows firms to transfer their idiosyncratic productivity abroad, but is subject to fixed and trade costs every period. Thus, the decision to produce offshore is firm-specific: Despite the lower cost of effective labor offshore, only firms with idiosyncratic productivity levels above an endogenous cutoff can afford the fixed and trade costs associated with offshoring. As a result, the extensive margin of the Southern offshoring exports depends on the terms of labor (i.e., the ratio between the cost of effective labor in the South and the North expressed in the same currency), which reflects the cost advantage of producing in the South. In contrast, the extensive margin of the Southern regular exports depends on Northern demand, which drives the Southern firms' decision to export.

The model implications are as follows. First, the model generates a procyclical pattern of the offshoring value added and the number of offshoring firms. The result reflects the link between firm entry in the North, the appreciation of the terms of labor, and the Northern firms' decision to produce offshore. Second, the model generates a higher correlation between the Southern offshoring exports and Northern output than between the Southern regular exports and Northern output, as in the data. The result is driven by the extensive margin of offshoring enhancing the procyclical pattern of offshoring exports relative to that of regular exports. In contrast, when the extensive margins are shut down, there is no longer a distinction between the offshoring and regular exports.⁸ Third, the extensive margin is less consequential for the dynamics of regular exports than for those of the offshoring exports, which is consistent with Alessandria and Choi (2007) and Fattal Jaef and Lopez (2014). In contrast to offshoring exports, the impulse responses for the Southern regular exports are similar when their extensive margin is free to adjust or when it adjusts only slowly. Since both the extensive and intensive margins of regular exports are driven by changes in demand, keeping one margin fixed has little impact in the aggregate. Fourth, since the offshoring exports are more procyclical than the Southern regular exports with output in the North, a larger share of offshoring exports in the total Southern exports leads to more output comovement. Using alternative calibrations of the baseline model, increasing the share of offshoring in Southern exports (while keeping the share of exports in output constant) results in more output comovement between the North and the South. This result is consistent with the empirical evidence in Burstein et al. (2008, henceforth BKT08), which shows that country pairs with larger shares of offshoring exports in bilateral trade exhibit more output comovement. To illustrate the role of the extensive margin in driving my result, the positive link between offshoring and output comovement breaks down in the alternative case with fixed extensive margins: Since the Southern offshoring and regular exports behave similarly in this case, varying the share of offshoring exports in the total Southern exports has little effect on output comovement.

The model implications are robust under a number of alternative assumptions. First, in the presence of capital and endogenous labor supply, the model displays the same properties as in the baseline case, namely: (1) procyclical pattern of offshoring value added and its extensive margin; (2) higher correlation between the Southern offshoring exports and Northern output than between the Southern

⁶ For instance, the offshoring extensive margin accounts for about one-third to one-half of the adjustment in *maquiladora* employment (Bergin et al., 2009; Coronado, 2011). Although offshoring is undertaken by only a fraction of U.S. manufacturing firms, the offshoring firms are larger and more productive (Kurz, 2006). Since intrafirm trade is concentrated in a small group of large affiliates and large multinational corporations (Ramondo et al., 2016), firms' actions can plausibly affect aggregate variables. Also, since firms' decisions to export and/or import have non-trivial effects on firm-level characteristics (see Kurz and Senses, 2016, for employment volatility), they are likely to have macro-level effects in the economies where these multinational corporations operate.

⁷ The cost of effective labor is defined as the real wage normalized by aggregate productivity. Thus, the cross-country asymmetry in the cost of effective labor in steady state implies that offshoring takes place in one direction, from the North to the South.

⁸ To explore the role of the extensive margin of offshoring in shaping aggregate implications, I contrast the baseline model to a number of special cases. These include versions of the model in which firm entry, the offshoring and exporting cutoffs, or both firm entry and the cutoffs are held fixed. Thus, when both firm entry and the cutoffs are held fixed, the Southern offshoring and regular exports display the same correlations and impulse responses. In addition, when the extensive margin of offshoring becomes countercyclical, which happens when firm entry alone is held fixed, the countercyclical extensive margin weighs down on the Southern offshoring exports, which become less correlated with the Northern output than are the Southern regular exports.

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