International Trade in Open Economy Macroeconomics*

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Abstract

This paper surveys the main ingredients and results of a research program at the intersection of international trade and open economy macroeconomics that has been developing since the early 2000s. The program bridges an artificial gap between fields by incorporating Krugman-Melitz trade microfoundations and producer dynamics in the benchmark, dynamic macro model under uncertainty. I review the main features and results of this integrated framework. I summarize the results of extensions used to study the determinants and consequences of foreign direct investment, labor market and other macro effects of trade integration, monetary policy, and other questions. I then discuss directions for future research and offer suggestions for further readings.

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1 Introduction

Modern international macroeconomic theory builds on micro-level specifications of the behavior of households and firms. The assumption that the latter have some monopoly power—usually in the form of monopolistic competition among a continuum of producers—is widely used to motivate price-setting and, in turn, as a stepping stone to introduce imperfect price adjustment, and thus a role for monetary policy, in models.[1] However, that is as far as the majority of open economy macro models go in specifying the micro-level behavior of producers. The most common assumption is that the economy is populated by a constant, exogenously given number of firms and products.

By contrast, international trade analysis has long acknowledged the role of producer entry decisions into domestic and foreign markets in shaping trade patterns and affecting consumer welfare.[2] Since the early 2000s, a large literature has developed that studies the consequences of firm heterogeneity for trade, aggregate productivity, and welfare.[3] While the typical approach of international macro analysis is to address questions of interest in dynamic models under uncertainty, trade models usually restrict attention to steady-state outcomes in the absence of aggregate uncertainty. Open economy macroeconomics allows for and often focuses on the dynamics of external imbalances; international trade models usually assume balanced trade.

This separation between the two fields is artificial, and it prevents each of them from addressing many interesting questions, or from reaching more reliable, empirically relevant conclusions on questions they do address. But the gap between the two fields can be easily bridged once one recognizes the de-facto convergence of their microfoundations.

Replacing the assumption of a fixed, exogenous number of firms in the benchmark New Keynesian open economy framework with the assumption of endogenous market entry subject to entry costs, and allowing for heterogeneous productivity across firms, yields an open economy macro framework that encompasses the current workhorse model of international trade—essentially, extending the latter in the direction of dynamics and general equilibrium under aggregate uncertainty. This paper reviews the key ingredients and main results of a research program that builds on this insight and has been developing since the early 2000s.

I will argue that the development of an integrated international trade and macro framework

[1] Obstfeld and Rogoff's (1995) seminal article pioneered this approach to international macro modeling.

[2] The pervasive evidence of intra-industry trade motivated Krugman's (1979, 1980) studies of trade under monopolistic competition and of the implications of product variety for gains from trade.

[3] Eaton and Kortum (2002) and Melitz (2003) began this literature on models of international trade with heterogeneous firms. See Melitz and Redding (2014) for a survey.

has made it possible to shed new light on classic questions in international macroeconomics and to address new questions. Although I will focus on theoretical developments, the introduction of deeper trade foundations into open macro models, combined with the increased availability of micro-level data, has made it possible better to confront the models with empirical evidence. In turn, this has resulted in analysis of key policy questions that is more reliable and nuanced than in traditional New Keynesian models without micro-level producer dynamics.

The fast growing literature at the intersection of open economy macroeconomics and international trade has addressed questions that range from the effect of productivity on international relative prices (Ghironi and Melitz, 2005) to the role of offshoring in business cycle synchronization across countries (Contessi, 2006, 2015; Zlate, 2016), from the consequences of trade for aggregate volatility (di Giovanni and Levchenko, 2012) to the role of differences in labor market institutions in shaping dynamics after trade integration (Cacciatore, 2014), from the effects of structural reforms (Cacciatore et al., 2016, 2017) to the interaction of trade and monetary policy (Cacciatore and Ghironi, 2012), and many more. I survey these developments below. I focus on models that assume monopolistically competitive producers and use versions of the Krugman-Melitz framework for their trade microfoundation. I then briefly summarize promising directions for future research.

Important questions for future study in joint trade-and-macro analyses have been raised by the establishment of global value chains across multiple borders, by the importance of financial market imperfections and failures underscored by the global crisis of 2007-08, by the observation of increasing market power of large firms and the consequences that firm-specific shocks can have for the aggregate economy in such environment, by concerns about the distributional consequences of trade and macro policies, and by the looming threat of protectionism in response to these events and concerns.

The rest of the paper is organized as follows. Section 2 presents a canonical model of international trade and macroeconomic dynamics with monopolistic competition and heterogeneous firms, and it summarizes the key new insights that the model delivers. Section 3 discusses how the model was modified in subsequent literature to study the dynamics of foreign direct investment and its role in international business cycle synchronization. Section 4 focuses on labor market imperfections and unemployment, and it summarizes the new insights that this version of the framework yields on the effects of trade integration. Section 5 addresses the incorporation of nominal rigidity and a role for monetary policy, and it presents the insights that this type of framework delivers on policy. Section 6 suggests directions for future research. Section 7 concludes and offers suggestions

for further reading.

2 A Canonical Model of International Trade and Macroeconomic Dynamics

Ghironi, and Melitz (2005) provide a canonical model of international trade and macroeconomic dynamics with monopolistic competition and heterogeneous firms.[4] The model assumes that the world consists of two countries (Home and Foreign) populated by representative households that derive utility from consuming a Dixit-Stiglitz (1977) continuous bundle of domestic and imported goods. In each country, households have access to only a subset of the goods they would ideally like to consume, because market entry by firms is costly and this limits the number of products that are available to households in each period. There is an unbounded mass of potential entrants. Prior to entry, these are all identical and face a sunk entry cost of $f_{E,t}$ units of effective labor. Upon entry, firms draw firm-specific productivity levels from a continuous distribution (assumed Pareto to solve the model). This firm-specific productivity remains fixed thereafter, but production (which uses only labor in linear fashion) is subject to aggregate, country-specific productivity shocks. Given Home real wage w_t in units of consumption, the unit production cost of a firm with firm-specific productivity z is thus $w_t/(zZ_t)$, where Z_t is the aggregate productivity shock. Given the sunk entry cost $f_{E,t}$ in units of effective labor, firm entry into the domestic market requires the sunk payment of $(w_t/Z_t)f_{E,t}$ units of consumption.

Trade is subject to iceberg and fixed costs. Exporting requires the payment of $f_{X,t}$ units of effective labor, or $(w_t/Z_t)f_{X,t}$ units of consumption. The existence of this fixed cost implies that only firms that have drawn a sufficiently high firm-specific productivity z will export.[5] Given firm z's export profit $d_{X,t}(z)$ in period t, the condition $d_{X,t}(z_{X,t}) = 0$ defines the cutoff productivity for exporting: Firms with productivity above $z_{X,t}$ export; those with productivity below the cutoff serve only their domestic market. This implies that the composition of the household's consumption bundle changes in each period depending on economic conditions and the decisions of firms regarding domestic and export market entry. All goods are *tradable* in the model; in equilibrium, some of them are endogenously *non-traded* in each period. The non-traded set changes as the profitability of exporting fluctuates in response to domestic and foreign aggregate shocks.

[4] As explained in Ghironi and Melitz (2005), producers in our model are best interpreted as production lines within multi-product firms whose boundaries we leave unspecified by virtue of continuity. I will refer to producers as firms below for consistency with the language convention of the New Keynesian macro literature.

[5] *Ceteris paribus*, firms with higher productivity have lower marginal costs, charge lower prices, and have larger profits.

The model assumes a time-to-build requirement, such that firms that enter the domestic economy in period t will only begin producing and generating profits in period $t+1$: Firms spend the first period of their life "setting up shop." Every firm, regardless of productivity, is subject to exogenous risk of firm destruction at the end of each period. This happens with probability $\delta \in (0,1)$ and can happen also to new entrants—some of which, therefore, exit the economy without actually ever producing and generating profits.

Defining appropriate market-share-weighted productivity averages for firms serving their domestic market and for exporters as in Melitz (2003) makes it possible to solve the model by focusing on corresponding average prices and quantities, and the numbers of firms that operate in each market. Given average productivity for domestic sale $\tilde{z}_D$ and average export productivity $\tilde{z}_{X,t}$, in essence the model behaves as if the Home economy is populated by $N_{D,t}$ firms with productivity $\tilde{z}_D$ that serve the domestic market and $N_{X,t}$ exporters with productivity $\tilde{z}_{X,t}$ that sell output also in the other country.

The average firm makes profit in period t equal to $\tilde{d}_t \equiv \tilde{d}_{D,l} + [1 - G(z_{X,t})]\,\tilde{d}_{X,l} = d_{D,l}\left(\tilde{z}_D\right) + [1 - G(z_{X,t})]\,d_{X,l}\left(\tilde{z}_{X,t}\right)$, where $G(z)$ is the distribution of possible firm-specific productivity draws. Prospective entrants are forward looking and compute the rational expectation of the stream of profits that they will generate post-entry. This is given by:

$$\tilde{v}_t \equiv E_t \sum_{s=t+1}^{\infty} \left[\beta\left(1-\delta\right)\right]^{s-t} \left(\frac{C_s}{C_t}\right)^{-\gamma} \tilde{d}_s.$$

Profits are discounted with the Home household's stochastic discount factor, adjusted for the probability of exogenous firm destruction, reflecting the assumption that firms are fully owned domestically and all profits are distributed to households as dividends ($\beta \in (0,1)$ is the familiar discount factor parameter and $\gamma > 0$ is the constant coefficient of relative risk aversion). Entry occurs up to the point where $\tilde{v}_t$ (the expected value of a firm) is equal to the sunk entry cost $(w_t/Z_t)f_{E,t}$, yielding the entry condition $\tilde{v}_t = (w_t/Z_t)f_{E,t}$. The assumptions on firm destruction and the timing of entry and production imply that the law of motion for the number of Home producing firms is given by $N_{D,t} = (1-\delta)\left(N_{D,t-1} + N_{E,t-1}\right)$, where $N_{E,t-1}$ is the number of firms that entered the Home economy at $t-1$.[6]

Households hold bonds and shares in a mutual fund of all the producing, domestic firms. The mutual fund pays dividend $\tilde{d}_t$ in each period and shares in it are traded at price $\tilde{v}_t$. The Euler

[6] This highlights that the number of firms in the model behaves in pre-determined fashion like the capital stock of familiar real business cycle models.

equation for share holdings is:

$$\tilde{v}_t = \beta\left(1-\delta\right) E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\left(\tilde{v}_{t+1}+\tilde{d}_{t+1}\right)\right].$$

Notice that forward iteration of this equation and transversality yield the expression of the value of the firm that prospective entrants compute in deciding domestic entry. Firms finance their entry costs by issuing shares in the stock market. The Euler equation for holdings of shares in the mutual fund of all Home firms provides the general equilibrium link between firm entry decisions and the optimizing behavior of the representative household: In this model economy, investment takes the form of creation of new firms, financed by households with their savings. The price of investment is $\tilde{v}_t$, determined by the Euler equation above.

Under balanced trade (or financial autarky), aggregate accounting implies that the standard equality between aggregate demand—the sum of consumption and investment (the price of shares times the number of new entrants)—and income (labor income and dividend income): $C_t + \tilde{v}_t N_{E,t} = w_t L + N_{D,t}\tilde{d}_t$, where L is the amount of labor employed by the economy and inelastically supplied by the representative household. The price of shares determines the allocation of resources between consumption of existing products and creation of new ones.

When bonds are traded internationally, equilibrium aggregate accounting yields a standard law of motion for net foreign assets as a function of interest income from the net asset holdings with which the country enters the period and of the trade balance during the period. The trade balance reflects variation of exports and imports along both the extensive margin (the numbers of exported and imported products) and the intensive margin (the quantity of a given exported or imported product).

New Perspective on the Harrod-Balassa-Samuelson Effect

Ghironi and Melitz (2005) show that the model performs at least as well as—if not better than—the familiar international real business cycle (IRBC) framework at replicating standard domestic and international business cycle moments for the U.S. economy. Ghironi and Melitz (2007) illustrate the success of the model at replicating and explaining several features of gross and net U.S. trade flows. More importantly, the model makes it possible to offer a new perspective on the Harrod-Balassa-Samuelson (HBS) evidence that richer, more developed economies have higher average prices and an appreciated real exchange rate.

The textbook treatment of this evidence relies on the assumption of faster productivity growth in the tradable sector than in the non-tradable one. This causes the relative price of non-traded goods to increase and the real exchange rate to appreciate.[7] However, as discussed already by Rogoff (1996), while the evidence that richer countries have higher average prices is pervasive, the evidence that productivity in the traded sector always rises faster than in non-tradable production is not as pervasive. This poses a challenge for the standard theory because, if one assumes an equal increase in productivity across traded and non-traded sectors, the real exchange rate does not move.

In the GM model, the real exchange rate of the Home countries appreciates (i.e., the Home country's consumer price index—CPI—rises relative to Foreign) even if there is a completely aggregate exogenous productivity increase that is equal across all uses of labor in the economy—whether this labor is employed by firms that are serving only the domestic economy or also exporting, or whether labor is absorbed by creation of new firms or the fixed costs of trade.[8]

The intuition is simple. Focus first on the long-run effect of a permanent increase in home productivity. This will necessarily imply that the cost of Home effective labor must rise relative to Foreign. Because the Home economy has become more productive, disproportionately more new entrants find it optimal to locate themselves at Home than in Foreign. But remember that firms in each country are exiting at exogenous rate δ in each period. If no firms found it optimal to enter Foreign in the new long run equilibrium, eventually there would be no Foreign firms left to keep Foreign labor employed. To prevent this from happening, the cost of Home effective labor must necessarily rise relative to Foreign, so that some prospective entrants will still find it optimal to set up shop in Foreign. In the presence of non-traded goods, an increase in the cost of Home labor relative to Foreign translates into appreciation of Home's real exchange rate. Moreover, the fact that Home effective labor becomes relatively more expensive implies that the fixed cost of exporting becomes a higher (lower) hurdle for Home (Foreign) firms. The result is that lower-productivity Home firms drop out of the export market, while some lower-productivity Foreign firms begin exporting to Home. But lower-productivity firms are those that charge relatively higher prices. Hence, average import prices fall in Foreign and rise at Home, which further contributes to an increase in Home's CPI relative for Foreign. Finally, changes in firm decisions with respect to

[7] See Obstfeld and Rogoff (1996).

[8] The original GM setup specifies the exogenous productivity shock Z_t as affecting all uses of labor in the economy precisely because one of the goals of the paper was to study the consequences of completely aggregate productivity shocks in the new model.

export status imply that the composition of the Home consumption basket (relative to Foreign) shifts in the direction of relatively higher-price non-traded goods—a third channel through which Home's CPI rises relative to Foreign and the real exchange rate appreciates.

As explained in detail in GM, firm creation (entry) into the domestic versus Foreign economy is crucial for the results of the model. Absent entry, the real exchange rate would depreciate following a domestic productivity increase (the reason is that there would be an excess demand of Foreign effective labor that requires Foreign effective labor to become more expensive—this happens in the short run also with entry: It is precisely entry that reverses this over time and pushes prices in the direction of long-run real exchange rate appreciation). Thus, the GM model provides a new interpretation of the HBS effect in response to completely aggregate productivity increases that complements that complements the traditional assumption of systematic differential in exogenous productivity dynamics across sectors.

3 Foreign Direct Investment and International Business Cycles

The era of globalization that began between the late 1980s and the early 1990s witnessed a large increase in flows of foreign direct investment (FDI). Firms engaged in FDI to be able to serve foreign markets by producing locally (horizontal FDI), which allowed them to economize on trade costs and/or "jump tariffs," or they engaged in FDI to take advantage of lower production costs abroad by offshoring production (vertical FDI) and then importing output for sale to domestic consumers. This phenomenon led to the establishment of so-called global value chains (GVCs) with different stages of production taking place in different countries, with parts crossing multiple borders, before final products would finally be sold to consumers.

Naturally, international macroeconomists became interested in how the establishment of such trade networks affected the propagation of shocks across countries and the tradeoffs facing policy-makers. Initially, this took the form of simply modifying standard business cycle models to account for trade in intermediate goods (for instance, Burstein, Kurz, and Tesar, 2008) and investigating the extent to which this would ameliorate the so-called trade-comovement puzzle (i.e., the failure of standard models to replicate the observation that increased trade integration is associated with more correlated business cycles; see Kose and Yi, 2001, 2006).[9] In the policy context, trade in

[9]Kalemli-Ozcan, Papaioannou, and Peydro (2013) challenged the evidence that trade is associated with business cycle correlation (first documented by Frankel and Rose, 1998, and Clark and van Wincoop, 2001) by pointing out that the relation becomes insignificant once one controls for financial integration. Duval et al. (2016) found that the relation between trade and comovement returns significant even controlling for financial integration when one

intermediates was incorporated in analyses of openness and optimal monetary policy such as, for instance, Lombardo and Ravenna (2014). But some scholars began making headway into how the endogenous decision of firms to engage in FDI that trade theorists had begun exploring (see. among others, Helpman, Melitz, and Yeaple, 2004) is shaped by and contributes to shaping international macro dynamics.

Contessi (2006) built on Helpman, Melitz, and Yeaple's (2004, HMY below) analysis of trade versus horizontal FDI to study the interaction of firm entry decisions, productivity, and the international business cycle. Contessi (2015) showed that a structural model of endogenous, horizontal FDI and firm heterogeneity can shed light on conflicting empirical results on the relation between FDI and host-country growth. Contessi's model is essentially a version of GM in which the export decision is replaced by an endogenous decision to produce abroad in order to serve the foreign market.

Zlate (2016) developed a version of the GM model in which firms endogenously decide whether to produce abroad in order to take advantage of lower input costs and then import the output back for sale to domestic consumers. The model is designed so that this vertical FDI happens only in one direction (North to South) and it is intended to capture the phenomenon of U.S. firms locating production in Mexico in order ultimately to serve U.S. consumers. However, the micro-level structure of the model makes it possible to accomplish this outcome by virtue of a realistic, rather than ad hoc, assumption: Zlate plausibly assumes that costs of business creation (the domestic entry costs of the GM model) are higher in the South than in the North. This results in the fact that, on average, the North economy is populated by a larger number of firms. But this puts upward pressure on labor demand and the effective cost of labor in the North, resulting in a steady-state wage differential that induces Northern firms to find it optimal to locate production in the South but not vice versa. There is ample evidence of the plausibility of Zlate's assumption.

An expansionary shock in the North then propagates to the South also through the decision of some Northern firms to relocate production: As periods of economic expansion are associated with more creation of new firms, they are also eventually associated with rising labor costs in the North. Over time, this causes an increase in the number of Northern firms offshoring production to the South. In turn, this results in expanded demand for Southern labor, with a positive effect on Southern wages and a dampened effect of the shock on the cross-country labor cost differential relative to the basic GM framework.

considers the trade in value added implied by GVCs.

Zlate (2016) shows that his model succeeds at explaining and replicating standard features of the U.S.-Mexico business cycle and, in addition, a variety of facts that relate to the cyclicality of U.S.-driven firm activity in Mexico. He also shows that increased trade integration results in stronger business cycle correlation between his model-U.S. and Mexico. Moreover, his results and the mechanisms he focuses on have implications for the international relative price, HBS dynamics highlighted in GM: To the extent that a richer country invests in a one at relatively lower development, the implied upward pressure on wages in the developing partner implies a narrowing of the real exchange rate appreciation associated with the productivity gap between the two countries.[10]

GVCs required a rethinking of international trade analysis, with the development of models of task trade (Grossman and Rossi-Hansberg, 2008), theories of ownership rights allocation and GVC organization (Antràs and Chor, 2013), and the analysis of trade in value added (Johnson and Noguera, 2012). Many other contributions on the topic have appeared and are continuing to appear in the trade literature, some with clear connection to macro.[11] Yet, our understanding of how GVCs interact with macroeconomic dynamics is still very limited.[12] For instance, the extent to which GVCs modify the effects of exchange rate movements on the macroeconomy—and thus the notion of external competitiveness—is an area of research that is still in its infancy and that is likely to keep us busy for significant time. Importantly, we need better understanding of these phenomena regardless of the direction in which trade will evolve in the future: Whether or not the GVC phenomenon becomes more pervasive, we will need better models to guide policy than those available so far.

4 Trade, Unemployment, and Labor Market Institutions

The effects of increased trade integration on labor markets have become a central topic in international trade research since the entry of China in the WTO appeared to have caused large employment losses in the manufacturing sectors of the U.S. and several other industrial economists.

[10] Other contributions to the literature include, among others, Fillat and Garetto (2015), Russ (2007), and Ramondo and Rappoport (2010). Russ shows how integrating HMY horizontal FDI in a New Keynesian model can help us understand conflicting evidence on the effects of exchange rate volatility on FDI. Fillat-Garetto and Ramondo-Rappoport focus on the implications of FDI decisions for returns and risk sharing.

[11] For example, Cuñat and Zymek (2017) show that accounting for GVCs leads to downward revision in estimated productivity differences across countries.

[12] di Giovanni, Levchenko, and Mejean (2017) is a significant step forward on the empirical front by exploring the micro-level determinants of business cycle comovement generated by input trade in the production networks of French firms.

Autor, Dorn, and Hanson's (2016) work on the "China shock" deservedly received a lot of attention. Several scholars in the trade field wrote theories of the effects of trade on labor markets capable of explaining several features of the data. Helpman and Itskhoki (2010, HI) and Helpman, Itskhoki, and Redding (2010, 2013—HIR1 and HIR2, respectively) incorporated labor market rigidities in the form of the search-and-matching frictions studied by Diamond (1982a,b) and Mortensen and Pissarides (1994)—DMP—below and showed that trade, although beneficial in terms of welfare, can have unfavorable consequences for unemployment. They also showed that labor market institutions (proxied also by the size of frictions) matter for domestic and spillover effects. Coşar, Guner, and Tybout (2016) studied how reductions in trade frictions, tariffs, and firing costs affect firm dynamics, job turnover, and wage distributions in a model estimated with Colombian micro-level data. They showed that Colombia's integration in the world economy had a positive effect on GDP, but this came at the cost of higher unemployment, greater wage inequality, and higher firm-level volatility. An important conclusion from HI, HIR, and others is that institutional features of labor markets are among the determinants of trade patterns across countries

These studies and many others in the trade literature assume balanced trade and focus on long-run outcomes.[13] Cacciatore (2014) extends the GM model to incorporate DMP search-and-matching frictions and studies the consequences of trade integration for labor market (and other macro) outcomes in a fully dynamic model under uncertainty. The framework allows him to evaluate the effects of trade integration on impact, along the transition dynamics to the new long-run position, and the long-run effects of trade. Differences in labor market rigidities across model-countries—such as differences in costs of job creation and destruction, and in unemployment benefits—proxy for different labor market institutions, and this makes it possible to explore the extent to which a symmetric policy change (symmetric trade integration) can result in current account imbalances implied by integration of asymmetric countries. Moreover, inclusion of business cycle shocks in the model (in the form of technology shocks) allows Cacciatore to study how trade integration alters the pattern of business cycle fluctuations.

Cacciatore calibrates the more rigid economy in his model to Europe's Economic and Monetary Union (EMU) and the flexible economy to the United States. He shows that trade is beneficial for welfare by inducing higher productivity (a familiar property of the Melitz, 2003, model, consistent with much evidence), but, as observed in the data, unemployment can temporarily rise when trade

[13] Helpman and Itskhoki (2015) introduces dynamics in the model of HI, but it does not addresses how trade integration affects business cycles.

barriers are lowered. In the environment of his model, labor market rigidities reduce the gains from trade, but they can mitigate short-run employment losses by discouraging firms that face stiffer competition from firing workers. Cacciatore shows that trade integration can cause unemployment to increase in the short run as stronger foreign competition discourages domestic business creation and induces firms to shed low-productivity workers. In the long run, the less productive firms shrink, and the most productive ones expand, and average firm productivity rises. This increases the average return to job matches, with beneficial effects for aggregate employment, output, and consumption. In the more rigid economy (Europe), higher labor market frictions simultaneously reduce incentives to create and destroy jobs. Lower job destruction is beneficial for employment in the short run, but smaller job creation implies that production expands by less over time. Importantly, the more flexible economy (the U.S.) attracts foreign investment and it runs a current account deficit along part of the transition dynamics due to the larger return to product creation.[14] In the long tun, the model-U.S. benefits more from the trade expansion than the model-Europe.

With respect to the business cycle implications of increased trade, the model correctly predicts that business cycle synchronization increases with stronger trade linkages, as documented by Frankel and Rose (1998) and Clark and van Wincoop (2001). Put differently, the Cacciatore-GM model provides an answer to the trade-comovement puzzle mentioned above. Different from Zlate's (2016) FDI-based mechanism, Cacciatore's hinges on the interaction of product and labor market dynamics: The time consuming nature of the job matching process combines with the presence of sunk entry costs in product markets. This dampens the cross-country resource shifting motive at the heart of the failure of basic international real business cycle models, allowing the demand effects from easier trade to generate a plausible comovement increase in the aftermath of trade integration.[15]

[14] This result casts doubts on the blanket statement that is sometimes made that trade policy has no effect on the current account. Trade policy will affect the current account any time policy decisions affect intertemporal incentives to save and invest. See Barattieri (2014) for another example.

[15] The mechanisms leading to increased business cycle synchronization do not depend on country-specific labor market features. Nevertheless, comovement is further strengthened if asymmetries in labor markets become less pronounced. This result has implications for the discussion of optimum currency area criteria in Frankel and Rose (1998). Frankel and Rose argued that lack of business cycle synchronization should not necessarily be a concern when considering adoption of a common currency because increased trade would result endogenously in increased comovement. Cacciatore shows that this effect is stronger if trade integration is preceded by harmonization of labor market structures.

5 Nominal Rigidity, Monetary Policy, and Structural Reforms

Cacciatore and Ghironi (2012) extend the Cacciatore-GM model to incorporate price stickiness and to re-examine the implications of the extended framework for the classic question of the optimal conduct of monetary policy in open economies. The New Keynesian literature usually explored the question by studying how incentives to coordinate policies across countries or to choose one or another exchange rate regime would depend on the degree of openness of the economy as captured by the size of home bias parameters in consumer preferences or foreign input shares in the production function.[16] However, to the extent that trade integration is the outcome of decisions about trade policy, this approach risks confounding things that should be invariant to policy (parameters of preferences and technology) with policy itself. Incorporation of an explicit trade microfoundation in the model makes it possible to avoid this problem by modeling trade policy changes (and their impact on the market entry and exit decisions of producers) explicitly.

We assume that firms produce bundles of products (or product features) with different levels of product- (or product-feature) -specific efficiency. The presence of fixed costs implies that only the products (or features) produced at sufficiently high efficiency are included in the export bundle. Prices are set at the level of the bundles for domestic and export sale subject to adjustment costs as in Rotemberg (1982). Bundle-level price setting makes it possible to preserve the aggregation properties of the Melitz (2003) trade model in the presence of these price adjustment costs. Similar adjustment costs are in place for wages.

The model thus extended yields several results. First, optimal, cooperative monetary policy in an environment of low trade integration requires non-negligible deviations from zero inflation on average and over the business cycle. Policy uses inflation to narrow inefficiency wedges relative to the efficient allocation both in steady state and over the business cycle. In the presence of labor market frictions, inflation redistributes bargaining power from workers to firms, inducing these to create more jobs and bringing the aggregate employment outcome closer to efficiency. Over the business cycle, policy trades off wage stability and price stability, resulting in inflation that is allowed to vary in response to shocks.[17] However, the optimal inflation target is lower if trade integration increases. The reason is that, as noted above, trade integration redistributes market share toward the larger, more efficient producers. This implies that average firm productivity rises

[16] See Cacciatore and Ghironi (2012) for references.

[17] This replicates a result originally obtained by Erceg, Henderson, and Levin (2000) in a standard closed-economy New Keynesian model with sticky prices and wages.

and so does the average value of job matches to firms. In turn, this induces firms to create more jobs, bringing the economy closer to the efficient outcome. There is thus less need of positive inflation to erode markups and perform the task of increasing welfare.

Second, the model replicates the evidence that increased trade integration endogenously results in stronger business cycle comovement across countries. Benigno and Benigno (2003) showed in a standard two-country New Keynesian model that central banks have no incentive to coordinate policies across countries if their business cycles are perfectly correlated. In their model, this is the result of assumptions about exogenous shocks. In our model, for given stochastic processes of shocks, business cycles become more correlated because of trade integration (for the reasons discussed above). But a result similar to that in Benigno and Benigno's paper emerges: The welfare gain from coordinating policies across countries relative to country-level, non-cooperative, optimal policies is smaller if trade integration is higher. We thus provide a microfoundation for the Benigno-Benigno result: Removal of trade barriers causes cycles to become more correlated and lowers the gain from policy coordination relative to optimized, non-cooperative policies. Importantly, however, we show that gains from cooperation are much higher when countries are strongly integrated if the optimal, cooperative outcome is compared to historical central bank behavior. Central banks sticking to their historical behavior in an environment of high trade integration do not adjust for the much larger inefficient spillover effects of their policies. Cooperation (or non-cooperative, but optimized policy) are much preferable.[18]

Bergin and Corsetti (2015) provide another example of analysis of monetary policy in a model with producer-level trade dynamics. They use a two-country version of Bilbiie, Ghironi, and Melitz (2012), which abstracts from producer heterogeneity and endogenous export entry decisions, but still incorporates the key ingredients of Krugman's trade theory. Bergin and Corsetti's framework reconciles policy prescriptions that have been at the center of open-economy New Keynesian analysis since Corsetti and Pesenti (2001) with the traditional incentive of monetary policy to boost competitiveness. Corsetti and Pesenti showed that central banks of open economies may have an incentive to contract monetary policy to deliver higher welfare via terms of trade appreciation. However, this prescription flies in the face of decades of policymaking based on the idea that depreciation can be beneficial by boosting export competitiveness. The Bergin-Corsetti model features two productive sectors in each country: a perfectly competitive one and a monopolistically compet-

[18] The paper considers also the comparison between fixed and floating exchange rates. See also Cooke (2014, 2016) for analyses of monetary policy in models with Melitz-type dynamics of heterogeneous producers.

itive one (where producer entry dynamics take place). In this environment, optimal policy induces firms with market power to set lower markups on average, it boosts the competitiveness of these firms, and it generates increased business creation in the differentiated production sector (interpreted as manufacturing). However, the terms of trade need not depreciate as upward pressure on labor costs from increased producer entry (the same force highlighted by GM) may prevent that from happening.[19]

Cacciatore, Fiori, and Ghironi (2016, CFG) and Cacciatore et al. (2016a,b) used international macro models with Krugman-type trade, endogenous flexible-price markups, and DMP labor market frictions to study the effects of reforms intended to increase the flexibility of product and labor markets (so-called "structural reforms") and their interaction with monetary policy and macroeconomic conditions at the time of reform implementation. CFG showed that optimal monetary policy is expansionary in response to reforms in order to smooth transition costs and front-load long-run gains. Cacciatore et al. (2016a) showed that transition costs can be exacerbated if reforms are implemented during recessions (especially in the case of labor market reforms) or at times when the economy cannot borrow from abroad (product market reforms), Finally, Cacciatore et al. (2016b) showed that the zero lower bound (ZLB) on policy interest rates is in itself no reason to postpone reforms: Product market reforms have inflationary effects that can be especially beneficial at the ZLB and deflationary effects of labor market reforms are very small for plausible parameterizations of the model. These results stand in contrast to those that one obtains from using basic versions of the New Keynesian model without explicit modeling of product and labor market dynamics.[20] They underscore once again the importance of including micro-level producer dynamics in macro models.

6 Directions for Future Research

I discuss several promising directions for future research in Ghironi (2017). I focus only the key points here.

I mentioned in Section 3 the establishment of global value chains across multiple borders as an important area where more research at the intersection of trade and macro is needed. So is the role of financial market imperfections. Much work on this topic has been done in macro since the crisis of 2007-08 and considerable work has been done also in trade after Amiti and Weinstein (2011) and

[19] In the trade field, Bergin and Corsetti's results are most related to those in Ossa (2011).
[20] See, for instance, Eggertsson, Ferrero, and Raffo (2014).

Chor and Manova (2012) showed the importance of financial market frictions in the so-called Great Trade Collapse that accompanied the crisis. Manova (2013) is the benchmark version of the Melitz (2003) model extended to incorporate financial frictions—showing that these lead to a reduction in the number of exporters relative to the setup without financial frictions. Yet, we still lack a combined analysis of financial market imperfection, trade, and macro dynamics.[21]

The study of how trade affects labor market outcomes must be extended to incorporate distributional consequences and the effects of uninsurable employment risk. The models in HI and HIR1 and HIR2 feature two sectors and allow the authors to study how trade affects income inequality across workers in different sectors. But this is done in the long-run environment of those papers. Autor, Dorn, and Hanson (2016) have made it clear that, often, the devil is in the transition dynamics (or, in the specific case, lack thereof). Dynamic models of trade and inequality, and of how slow adjustment of labor markets to trade can exacerbate problems, are needed. Similarly, for the connection between trade and uninsurable income risk.

di Giovanni and Levchenko (2012) showed that trade integration can result in higher aggregate volatility by redistributing market share toward larger firms in an environment of granularity (Gabaix, 2011) in which firm-specific shocks have aggregate consequences. More research is needed on the role of large firms in trade and macro dynamics, including on understanding markups and how they are affected by trade.[22]

Finally, the macroeconomic consequences of protectionism and the interaction of trade policy with other types of policy have been receiving increasing attention in ongoing research and are likely to remain an important topic for some time.

7 Conclusions and Suggestions for Further Reading

This paper surveyed the key ingredients and results of a research program that merges international trade and international macroeconomic theory in an integrated framework. The integration of trade into open economy macro theory makes it possible to obtain new insights on classic questions and to address new questions. The issues raised by events in the world economy suggest that there is much that this integrated approach can contribute as it continues to develop in future research.

Space constraints and my own taste and work clearly influenced the choice of material covered

[21] Some exceptions exist: Cacciatore, Ghironi, and Stebunovs (2015) incorporate Krugman-type trade in a model of the consequences of monopoly power in banking. Rodríguez-López (2016) studies how crises in the provision of liquid assets can have large, negative effects on trade. But much more is needed.

[22] On this topic, see de Blas and Russ (2015).

in this short survey. I focused mostly on work that assumes monopolistic competition and builds on Krugman's (1979, 1980) international trade theory, extended by Melitz (2003) to introduce heterogeneity. But there are different approaches to the integration of international trade theory and open economy macroeconomics that have been pursued in the literature and that have produced important, interesting results—Dornbusch, Fischer, and Samuelson's (1977) integration of Ricardian trade theory and open macro dynamics should be in any reading list in this area and so should later work that builds on that seminal paper (see, for instance, Naknoi, 2008). Similarly, reading lists should include work that combines Heckscher-Ohlin theory with macro dynamics (an excellent example is Cuñat and Maffezzoli, 2004) and other approaches. An extensive reading list is available in the syllabus of my graduate course in International Trade and Macroeconomics, which can be currently found online at http://faculty.washington.edu/ghiro/ITMSyllabus.pdf. Should I leave the University of Washington, readers who are interested in the syllabus will always be able to locate it easily by using their preferred search engine to locate my new webpage and exploring my teaching materials.

References

[1] Amity, M., and D. E. Weinstein (2011): "Exports and Financial Shocks," *Quarterly Journal of Economics* 126: 1841-1877.

[2] Antràs, P., and D. Chor (2013): "Organizing the Global Value Chain," *Econometrica* 81: 2127-2204.

[3] Autor, D. H., D. Dorn, and G. H. Hanson (2016): "The China Shock: Learning from Labor Market Adjustment to Large Changes in Trade," NBER Working Paper 21906.

[4] Barattieri, A. (2014): "Comparative Advantage, Service Trade, and Global Imbalances," *Journal of International Economics* 92: 1-13.

[5] Bergin, P. R., and G. Corsetti (2016): "Beyond Competitive Devaluations: The Monetary Dimensions of Comparative Advantage," *mimeo*, University of California, Davis and Cambridge University.

[6] Bilbiie, F., F. Ghironi, and M. J. Melitz (2012): "Endogenous Entry, Product Variety, and Business Cycles," *Journal of Political Economy* 120: 304 –345.

[7] Burstein, A., C. Kurz, and L. Tesar (2008): "Trade, Production Sharing, and the International Transmission of Business Cycles," *Journal of Monetary Economics* 55: 775-795.

[8] Cacciatore, M. (2014): "International Trade and Macroeconomic Dynamics with Labor Market Frictions," *Journal of International Economics* 93: 17-30.

[9] Cacciatore, M., R. Duval, G. Fiori, and F. Ghironi (2016a): "Market Reforms in the Time of Imbalance," *Journal of Economic Dynamics and Control* 72: 69-93.

[10] Cacciatore, M., R. Duval, G. Fiori, and F. Ghironi (2016b): "Market Reforms at the Zero Lower Bound," *mimeo*, HEC Montréal, International Monetary Fund, North Carolina State University, and University of Washington.

[11] Cacciatore, M., G. Fiori, and F. Ghironi (2016): "Market Deregulation and Optimal Monetary Policy in a Monetary Union," *Journal of International Economics* 99: 120-137.

[12] Cacciatore, M., and F. Ghironi (2012): "Trade, Unemployment, and Monetary Policy," *mimeo*, HEC Montréal and University of Washington.

[13] Cacciatore, M., F. Ghironi, and V. Stebunovs (2015): "The Domestic and International Effects of Interstate U.S. Banking," *Journal of International Economics* 95: 171-187

[14] Chor, D., and K. Manova (2012): "Off the Cliff and Back: Credit Conditions and International Trade during the Global Financial Crisis," *Journal of International Economics* 87: 117-133.

[15] Clark, T. E., and E. van Wincoop (2001): "Borders and Business Cycles," *Journal of International Economics* 55: 59-85.

[16] Contessi, S. (2006): "International Macroeconomic Dynamics, Endogenous Tradedness and FDI with Heterogeneous Firms," *mimeo*, Federal Reserve Bank of St. Louis.

[17] Contessi, S. (2015): "Multinational Firms' Entry and Productivity: Some Aggregate Implications of Firm Level Heterogeneity, *Journal of Economic Dynamics and Control* 61: 61-80.

[18] Cooke, D. (2014): "Monetary Shocks, Exchange Rates, and the Extensive Margin of Exports," *Journal of International Money and Finance* 41: 128-145.

[19] Cooke, D. (2016): "Optimal Monetary Policy with Endogenous Export Participation," *Review of Economic Dynamics* 21: 72-88.

[20] Corsetti, G., and P. Pesenti (2001): "Welfare and Macroeconomic Interdependence," *Quarterly Journal of Economics* 116: 421-446.

[21] Coşar, A. K., N. Guner, and J. Tybout (2016): "Firm Dynamics, Job Turnover, and Wage Distributions in an Open Economy," *American Economic Review* 106: 625-663.

[22] Cuñat, A., and M. Maffezzoli (2004): "Heckscher-Ohlin Business Cycles," *Review of Economic Dynamics* 7: 555-585.

[23] Cuñat, A, and R Zymek (2017): "International Value-Added Linkages in Development Accounting", Edinburgh School of Economics, University of Edinburgh, Discussion Papers 281.

[24] de Blas, B., and K. N. Russ (2015): "Understanding Markups in the Open Economy," *American Economic Journal: Macroeconomics* 7: 157-180.

[25] Diamond, P. A. (1982a): "Wage Determination and Efficiency in Search Equilibrium," *Review of Economic Studies* 49: 217-227.

[26] Diamond, P. A. (1982b): "Aggregate Demand Management in Search Equilibrium," *Journal of Political Economy* 90: 881-894.

[27] di Giovanni, J., and A. A. Levchenko (2012): "Country Size, International Trade, and Aggregate Fluctuations in Granular Economies," *Journal of Political Economy* 120: 1083-1132.

[28] di Giovanni, J., A. A. Levchenko, and I. Mejean (2017): "The Micro Origins of International Business Cycle Comovement," *American Economic Review*, forthcoming.

[29] Dixit, A. K., and J. E. Stiglitz (1977): "Monopolistic Competition and Optimum Product Diversity," *American Economic Review* 67: 297-308.

[30] Dornbusch, R., S. Fischer, and P. A. Samuelson (1977): "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods," *American Economic Review* 67: 823-839.

[31] Duval, R., N. Li, R. Saraf, and D. Seneviratne (2016): "Value-Added Trade and Business Cycle Synchronization," *Journal of International Economics* 99: 251-262.

[32] Eaton, J., and S. Kortum (2002): "Technology, Geography, and Trade," *Econometrica* 70: 1741-1779.

[33] Eggertsson, G., A. Ferrero, and A. Raffo (2014): "Can Structural Reforms Help Europe?" *Journal of Monetary Economics* 61: 2-22.

[34] Erceg, C. J., D. W. Henderson, and A. T. Levin (2000): "Optimal Monetary Policy with Staggered Wage and Price Contracts," *Journal of Monetary Economics* 46: 281-313.

[35] Feenstra, R. C. (2003): " A Homothetic Utility Function for Monopolistic Competition Models, without Constant Price Elasticity," *Economics Letters* 78: 79-86.

[36] Fillat, J. L., and S. Garetto (2015): "Risk, Returns, and Multinational Production," *Quarterly Journal of Economics* 130: 2027-2073.

[37] Frankel, J. A., and A. Rose (1998): "The Endogeneity of the Optimum Currency Area Criteria," *Economic Journal* 108: 1009-1025.

[38] Gabaix, X. (2011): "The Granular Origins of Aggregate Fluctuations," *Econometrica* 79: 733-772.

[39] Ghironi, F. (2017): "Macro Needs Micro," *Oxford Review of Economic Policy*, forthcoming.

[40] Ghironi, F., and M. J. Melitz (2005): "International Trade and Macroeconomic Dynamics with Heterogeneous Firms," *Quarterly Journal of Economics* 120: 865-915.

[41] Ghironi, F., and M. J. Melitz (2007): "Trade Flow Dynamics with Heterogeneous Firms," *American Economic Review (Papers and Proceedings)* 97: 356-361.

[42] Grossman, G. M., and E. Rossi-Hansberg (2008): "Trading Tasks: A Simple Theory of Offshoring," *American Economic Review* 98: 1978-1997.

[43] Helpman, E., and O. Itskhoki (2010): "Labour Market Rigidities, Trade and Unemployment," *Review of Economic Studies* 77: 1100-1137.

[44] Helpman, E., and O. Itskhoki (2015): "Trade Liberalization and Labor Market Dynamics with Heterogeneous Firms," *mimeo*, Harvard University and Princeton University.

[45] Helpman, E., O. Itskhoki, and S. Redding (2010): "Inequality and Unemployment in a Global Economy," *Econometrica* 78: 1239-1283.

[46] Helpman, E., O. Itskhoki, and S. Redding (2013): "Trade and Labor Market Outcomes" *Advances in Economics and Econometrics*, Tenth World Congress, Volume II, Applied Economics, pp. 459-504.

[47] Helpman, E., M. J. Melitz, and S. R. Yeaple (2004): "Export Versus FDI with Heterogeneous Firms," *American Economic Review* 94: 300-316.

[48] Johnson, R. C., and G. Noguera (2012): "Accounting for Intermediates: Production Sharing and Trade in Value Added," *Journal of International Economics* 86: 224-236.

[49] Kalemli-Ozcan, S., E. Papaioannou, and J. Peydro (2013): "Financial Regulation, Financial Globalization, and the Synchronization of Economic Activity," *Journal of Finance* 63: 1179–1228.

[50] Kose, M. A., and K.-M. Yi (2001): "International Trade and Business Cycles: Is Vertical Specialization the Missing Link?" *American Economic Review (Papers and Proceedings)* 91: 371-375.

[51] Kose, M. A., and K.-M. Yi (2006): "Can the Standard International Business Cycle Model Explain the Relation between Trade and Comovement?" *Journal of International Economics* 68: 267-295.

[52] Krugman, P. (1979): "Increasing Returns, Monopolistic Competition, and International Trade," *Journal of International Economics* 9: 469-479.

[53] Krugman, P. (1980): "Scale Economies, Product Differentiation, and the Pattern of Trade," *American Economic Review* 70: 950-959.

[54] Lombardo, G., and F. Ravenna (2014): "Openness and Optimal Monetary Policy," *Journal of International Economics* 93: 153-172.

[55] Manova, K. (2013): "Credit Constraints, Heterogeneous Firms, and International Trade," *Review of Economic Studies* 80: 711-744.

[56] Melitz, M. J. (2003): "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica* 71: 1695-1725.

[57] Melitz, M. J, and S. J. Redding (2014): "Heterogeneous Firms and Trade," in G. Gopinath, E. Helpman, and K. Rogoff, eds., *Handbook of International Economics*, vol. 4, pp. 1-54, Amsterdam, Elsevier.

[58] Mortensen, D. T., and C. A. Pissarides (1994): "Job Creation and Job Destruction in the Theory of Unemployment," *Review of Economic Studies* 61: 397-415.

[59] Naknoi, K. (2008): "Real Exchange Rate Fluctuations, Endogenous Tradability and Exchange Rate Regimes," *Journal of Monetary Economics* 55: 645-663.

[60] Obstfeld, M., and K. Rogoff (1995): "Exchange Rate Dynamics Redux," *Journal of Political Economy* 103: 624-660.

[61] Obstfeld, M., and K. Rogoff (1996): *Foundations of International Macroeconomics*, Cambridge, MIT Press.

[62] Ossa, R. (2011): "A "New Trade" Theory of GATT/WTO Negotiations," *Journal of Political Economy* 119: 122-152.

[63] Ramondo, N., and V. Rappoport (2010): "The Role of Multinational Production in a Risky Environment," *Journal of International Economics* 81: 240-252.

[64] Rodríguez-López, J. A. (2016): "Liquidity and International Trade," *mimeo*, University of California, Irvine.

[65] Rogoff, K. (1996): "The Purchasing Power Parity Puzzle," *Journal of Economic Literature* 34: 647-668.

[66] Rotemberg, J. J. (1982): "Monopolistic Price Adjustment and Aggregate Output," *Review of Economic Studies* 49: 517–531.

[67] Russ, K N. (2007): "The Endogeneity of the Exchange Rate as a Determinant of FDI: A Model of Entry and Multinational Firms," *Journal of International Economics* 71: 344-372.

[68] Zlate, A. (2016): "Offshore Production and Business Cycle Dynamics with Heterogeneous Firms," *Journal of International Economics* 100: 34-49.