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Oleg Itskhoki: 2022 John Bates Clark Medalist

Andrew Atkeson and Gita Gopinath

The 2022 John Bates Clark Medal of the American Economic Association was awarded to Oleg Itskhoki, Professor of Economics at the University of California, Los Angeles, for his fundamental contributions to international macroeconomics and international trade. Since the end of World War II, the world economy has been engaged in an ongoing, if at times fitful, process of opening to international trade in goods and flows of private capital. The field of international macroeconomics explores how this process of globalization affects the choices nations can and should make regarding their monetary and fiscal policies. Oleg's insights into trade and exchange rate behavior have far-reaching implications that will be the focus of considerable research in the years to come.

Oleg was born in Russia at the end of the Soviet Union. He reports that he played a lot of tennis until the age of 16 and did not really think of an academic career until he had to apply to college at the end of high school. He was initially drawn to economics in the hope that he might find a good job in the post-Soviet economy. It was not until after his undergraduate studies at Moscow State University that he encountered modern economics in the master's program at the New Economic School in Moscow. There he was introduced to the Dixit and Norman (1980) and Obstfeld and Rogoff (1996) textbooks, which sparked his fascination with international economics. He attended Harvard as a PhD student, and he points to a long list of faculty there as key influences, including John Campbell, Ken Rogoff,

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and Jim Stock, as well as Daron Acemoglu and Jordi Galí at the Massachusetts Institute of Technology. His participation as a student in a reading group organized by newly arrived young Harvard faculty members Aleh Tsyvinski, Gita Gopinath, Pol Antràs, and Manuel Amador was particularly meaningful in showing him how new ideas are born and developed. He counts himself most fortunate to have had the opportunity early on in his PhD studies to work with Elhanan Helpman as well. After spending several years at Princeton University, along with visiting appointments at the University of Chicago and Stanford, Oleg moved to the University of California, Los Angeles, in 2019, where he holds the Venu and Ana Kotamraju Endowed Chair in Economics.

In this paper, we aim to put Oleg's research in the broader context of some of the main questions and puzzles that have confronted international macroeconomics since the breakdown of the Bretton Woods system of fixed exchange rates more than 50 years ago. We examine some of Oleg's most prominent work on these puzzles with a focus on four areas: (1) firms' strategies for pricing their products in international markets in the face of volatile nominal exchange rates; (2) how firms' choices to set prices in a dominant currency such as the US dollar change the impact of exchange rate shocks on the macroeconomy; (3) policy options to gain macroeconomic flexibility for countries that fix their exchange rate or adopt a common currency; and (4) a proposed unified resolution of major puzzles regarding the interaction of exchange rates and the macroeconomy that have stymied international macroeconomics for many years. We also describe Oleg's contributions to our understanding of the impact on inequality of increasing international trade. We refer to his key papers throughout by number, as listed in Table 1.

Table 1
Selected Papers by Oleg Itskhoki

1	Gita Gopinath, Oleg Itskhoki, and Roberto Rigobon. 2010. "Currency Choice and Exchange Rate Pass-Through." *American Economic Review* 100 (1): 304–36.
2	Gita Gopinath and Oleg Itskhoki. 2010. "Frequency of Price Adjustment and Pass-Through." *Quarterly Journal of Economic*s 125 (2): 675–727.
3	Gita Gopinath and Oleg Itskhoki. 2011. "In Search of Real Rigidities." In *NBER Macroeconomics Annual 2010*, vol. 25, edited by D. Acemoglu and M. Woodford, 261–309. Chicago: University of Chicago Press.
4	Mary Amiti, Oleg Itskhoki, and Jozef Konings. 2014. "Importers, Exporters, and Exchange Rate Disconnect." *American Economic Review* 104 (7): 1942–978.
5	Mary Amiti, Oleg Itskhoki, and Jozef Konings. 2019. "International Shocks, Variable Markups, and Domestic Prices." *Review of Economic Studies* 86 (6): 2356–402.
6	Gita Gopinath and Oleg Itskhoki. 2021. "Dominant Currency Paradigm: A Review." Forthcoming in *Handbook of International Economics*, vol. 6.
7	Mary Amiti, Oleg Itskhoki, and Jozef Konings. 2022. "Dominant Currencies: How Firms Choose Currency Invoicing and Why It Matters." *Quarterly Journal of Economics* 137 (3): 1435–493.
8	Emmanuel Farhi, Gita Gopinath, and Oleg Itskhoki. 2014. "Fiscal Devaluations." *Review of Economic Studies* 81 (2): 725–60.
9	Omar Barbiero, Emmanuel Farhi, Gita Gopinath, and Oleg Itskhoki. 2019. "The Macroeconomics of Border Taxes." In *NBER Macroeconomics Annual 2018*, vol. 33, edited by Jonathan Parker and Martin S. Eichenbaum, 395–457. Chicago: University of Chicago Press.
10	Oleg Itskhoki and Dmitry Mukhin. 2021. "Exchange Rate Disconnect in General Equilibrium." *Journal of Political Economy* 129 (8): 2183–232. Lead article.
11	Oleg Itskhoki and Dmitry Mukhin. 2021. "Mussa Puzzle Redux." NBER Working Paper 28950, National Bureau of Economic Research, Cambridge, MA. MFA Best Paper Award in Asset Pricing, 2021.
12	Elhanan Helpman, Oleg Itskhoki, Marc-Andreas Muendler, and Stephen J. Redding. 2017. "Trade and Inequality: From Theory to Estimation." *Review of Economic Studies* 84 (1): 357–405.
13	Elhanan Helpman, Oleg Itskhoki, and Stephen J. Redding. 2010. "Inequality and Unemployment in a Global Economy." *Econometrica* 78 (4): 1239–283.
14	Elhanan Helpman and Oleg Itskhoki. 2010. "Labour Market Rigidities, Trade and Unemployment." *Review of Economic Studies* 77 (3): 1100–137.

We begin with a review of the state of the literature in international economics prior to Oleg's work to provide a context for understanding Oleg's contributions to this field.

Background

The experience of the world economy during the past 50 years following the breakdown of the Bretton Woods system of fixed exchange rates has raised many questions and puzzles. A useful point of entry to these issues is the concept of

international real relative prices. At the macroeconomic level, changes in international real relative prices are measured by the changes in the *real exchange rate* and the *terms of trade*.

Changes in the real exchange rate are defined as changes in the relative price of consumption baskets in various countries measured in a common currency; that is, as the sum of inflation differentials across countries and changes in the nominal exchange rate. Thus, mechanically, changes in real exchange rates are related to changes in nominal exchange rates to the extent that inflation differentials across countries move or do not move to offset changes in nominal exchange rates.

Changes in the terms of trade are defined as changes in the ratio of an index of prices for goods that are exported, to an index of prices for goods that are imported (expressed in a common currency) from the perspective of a single country. At the micro level, fine-grained data on international real relative prices are increasingly available from price quotes for individual goods at the retail and the wholesale levels, and at the border as goods are exported and imported.

Over recent decades, many countries have moved away from monetary policies aimed at maintaining a fixed or stable nominal exchange rate against other currencies to monetary policies that focus on domestic inflation and business cycles, while allowing the nominal exchange rate to vary widely over time. These policy shifts have been accompanied by five notable shifts in the patterns of international real relative prices.

1. International real relative prices are much more volatile than they were under fixed exchange rates.

2. These large swings in international real relative prices are very persistent over time.

3. These large and persistent swings in international relative prices are apparent even in fine-grained micro data for traded goods.

4. The direction of movements of these international real relative prices does not appear to be closely connected to movements in other macroeconomic variables.

5. It appears that a country can significantly reduce the volatility of its real exchange rate over the medium term by choosing a monetary policy aimed at stabilizing its nominal exchange rate against other currencies.

At some level, the first observation—that international real relative prices move in the short term as the nominal exchange rate moves—is not much of a puzzle. Since the foundational work of Robert Mundell and Marcus Fleming in the 1960s,[1] the idea that movements in nominal exchange rates affect real relative prices in the short term because nominal prices are "sticky" has been central to many models used in international macroeconomics. To put it another way, broad inflation differentials across countries are typically slow to move in the short term, whereas nominal exchange rates can be quite volatile over short time periods.

[1] See the description of Robert Mundell's contributions by the Nobel Prize Committee at https://www.nobelprize.org/uploads/2018/06/advanced-economicsciences1999.pdf and Rose (2000). For modern development of these ideas, see Obstfeld and Rogoff (1996).

However, the second and third observations were a real surprise to academics and policymakers alike. Before the move to floating exchange rates among most major currencies, many expected that—at least over the medium and long terms—arbitrage in goods markets would anchor international real relative prices independent of the behavior of nominal exchange rates. The logic behind this expectation is straightforward: through international trade, goods should flow from countries where they are cheap to countries where they are expensive until real relative prices of goods (measured in units of a common currency) are stabilized. This arbitrage in goods markets should stabilize real relative prices across countries regardless of whether nominal exchange rates are volatile or stable. This hypothesis is known as the hypothesis of "purchasing power parity."

But by the mid-1990s, this initial expectation had clearly been proven wrong, as major currencies—such as the US dollar and the Japanese yen—experienced wide swings in their real exchange rates over periods of five years or more in the 1980s and 1990s, which in turn led to large and persistent movements in international real relative prices. This apparent failure of arbitrage in goods markets to limit fluctuations in international real relative prices over long time horizons came to be known as the "purchasing power parity puzzle" (Rogoff 1996).

The purchasing power parity puzzle deepens with a dive into the micro or disaggregated price data. In standard modeling frameworks, movements in the real exchange rate correspond to changes in the relative price of traded and nontraded goods across countries. The logic is that arbitrage in goods markets should stabilize the real relative price of *traded* goods across countries, but should have less impact on the real relative prices of goods and services that are not traded. However, Engel (1999) showed that these large and persistent fluctuations in the real exchange rate did not result simply from changes in the relative prices of goods that are not traded across countries. Instead, fluctuations in the real exchange rate measured using traded goods account for nearly all the observed fluctuations in real exchange rates.

Moreover, Engel and Rogers (1996) used micro data on consumer prices for various cities in the United States and Canada during a period in which the US dollar–Canadian dollar nominal exchange rate fluctuated in a wide range. They showed that real relative price volatility at the micro level across cities on either side of the US and Canadian border was much larger than real relative price volatility across cities within the two countries, where the nominal exchange rate is fixed because of the use of a common currency. Thus, it appeared that nominal exchange rate variability between US and Canadian dollars had a substantial impact on the volatility of real relative consumer prices across cities over and above what the geographic distance between those cities might predict. Gopinath et al. (2011) and Cavallo, Neiman, and Rigobon (2014) found similar results using even more micro retail price observations—data from retailers selling identical products in many countries. Cavallo, Neiman, and Rigobon (2014) demonstrate that products within the set of countries whose common currency is the euro frequently sell at a real relative price of one, as predicted by purchasing power parity, while this real relative price fluctuates substantially with changes in nominal exchange rates

between countries without a common currency. These studies, and much related work, raised questions about why firms operating across international boundaries would choose to allow the real relative price of their products sold across different locations to vary so much with changes in the nominal exchange rate.

The fourth observation presented an additional puzzle regarding the behavior of exchange rates. That real exchange rates among major currencies undergo wide swings over five-year horizons or more would not be as puzzling if it were possible to account for these movements in international real relative prices, even after the fact, based on movements in observed macroeconomic fundamentals. But after 50 years of searching for a robust connection between exchange rate movements and movements in macroeconomic variables, we have come up mostly empty-handed. Meese and Rogoff (1983) demonstrated this apparent disconnect between exchange rates and macroeconomic fundamentals very soon after the breakdown of the Bretton Woods system of fixed exchange rates. The "exchange rate disconnect puzzle" they identified persists to this day.[2]

The large and persistent swings in real exchange rates between major countries also lead to questions about whether and how they can be avoided—or at least moderated—by appropriate policies. Here, our fifth observation about policies suggests intriguing possibilities. Empirical research by Mussa (1986) and Flood and Rose (1995), together with the micro data on retail prices cited above, raises the possibility that countries can limit the volatility of their international real relative prices over a medium- to long-term horizon through monetary policy aimed at maintaining a fixed nominal exchange rate. These studies do not establish a causal link between the choice of nominal exchange rate policy and the medium- and long-term volatility of real exchange rates. However, they document a robust, broad historical connection between nominal exchange rate volatility and real exchange rate volatility—along with remarkably little connection between changes in the volatility of other macroeconomic fundamentals when a country shifts between a fixed and floating nominal exchange rate regime. This observation is often called the "Mussa puzzle."

Oleg, in work with a range of coauthors, has made important contributions to addressing each of these puzzles, with his most recent work in papers [10] and [11] being the most ambitious in seeking to account for all five of these puzzles in a unified framework. We discuss four strands of his work on these puzzles in turn.

Micro Data on Firms' Pricing Policies

This first strand of Oleg's research develops models of firms' strategies for pricing their products in international markets in the face of volatile nominal exchange rates. He also evaluates those models with increasingly rich micro data.

[2] See Obstfeld and Rogoff (2000) and the published comments on this paper by Jeanne (2000) and Engel (2000) for a good summary of the state of the earlier literature on these puzzles.

In a pair of papers written in collaboration with Gita Gopinath [1, 2] and Roberto Rigobon [1], Oleg and his coauthors use detailed micro data on prices, collected by the US Bureau of Labor Statistics for its construction of price indices for exported and imported goods, to shed new light on the decisions of firms actively engaged in international trade to set prices paid at the border for imported and exported goods. These micro data on prices of exported and imported goods, first explored in Gopinath and Rigobon (2008), are unlike prior work with micro data based on retail or wholesale prices. These new micro data allow researchers to see the links between changes in exchange rates and the pricing of traded goods, free of the nontraded local distribution costs that contaminate the link between the prices of traded goods themselves and what consumers eventually pay at the retail level. In addition, researchers can see not only the extent and duration of stickiness in the prices of traded goods but also how firms respond to shocks when they choose to reset those prices.

Several important empirical regularities emerged from the study of these micro data. First, and most basically, these data confirmed that prices for imported and exported goods are typically sticky. Thus, there is a mechanical link (at least in the short term) between changes in the nominal exchange rate and the real relative prices of imported and exported goods, or the terms of trade, as is central to the analytical framework pioneered in the 1960s by Mundell (1963).

The nature of this mechanical link between changes in the nominal exchange rate and the terms of trade and sticky prices depends on the currencies in which firms set their nominal prices. For example, say that firms set their nominal prices for traded goods in the currency of the country where the good is produced, in what is called "producer currency pricing." Then, exported goods' prices are sticky in the exporter's currency and imported goods' prices are sticky in the currency of the countries exporting these goods. If the nominal exchange rate changes so that a country's currency becomes more valuable than those of its trading partners, the real prices of its exports rise relative to those of its imports. In contrast, if firms set their nominal prices in the currency of the country to which the good is shipped, in what is called "local currency pricing," then the reverse is true, given the same change in the nominal exchange rate. Therefore, to figure out how changes in nominal exchange rates affect a country's terms of trade, it is critical to understand how firms make decisions about the currency in which to invoice their products.

It is here that papers [1] and [2] make substantial contributions. In these micro data, it is evident that firms do not fully adjust their nominal prices in response to nominal exchange rate changes, even when they choose to change their nominal prices. More importantly, Oleg, Gita, and Roberto find systematic links between the choices firms made to invoice their products in different currencies and the choices they made to change their nominal prices in response to exchange rate changes. In [1], focusing on the response of US import prices to changes in the nominal exchange rate, Oleg and his coauthors document a systematic difference in the response of the US dollar price of the goods invoiced

in dollars (as is true for local currency pricing) and those that are invoiced in a foreign currency (as is true for producer currency pricing), even when these nominal prices are reset. In [2], Oleg and Gita show that firms that change their prices more often also make bigger changes in their nominal prices in response to nominal exchange rate changes over the long term.

Both of these findings call for theories that jointly explain firms' choice of invoicing currency when their prices are sticky and their decisions to change their nominal prices in response to changes in nominal exchange rates. These papers demonstrate that firms choose to price in a currency in which their desired prices are stable.

Papers [1] and [2] highlight two key mechanisms that influence pricing. The first is the *imported intermediate input channel*. An exporting firm that relies on imported inputs priced, say, in US dollars has a marginal cost that is relatively stable in dollars and consequently will price its exports in US dollars, because the sticky dollar price is close to optimal even during periods of nonadjustment.

The second mechanism concerns *strategic complementarities in firms' price-setting decisions,* which refers to the extent to which firms' desired prices depend on their own marginal cost of production as well as on the prices other firms are charging. Standard models in which firms are perfectly competitive in product markets or face a constant elasticity of their residual demand curve, independent of the prices chosen by their competitors, have no strategic complementarities. In those models, firms choose a price equal either to their marginal cost or to that marginal cost times a constant proportional markup, regardless of the prices charged by competitors. In contrast, when strategic complementarities are strong, a firm that finds its marginal costs affected by a change in the nominal exchange rate will often not fully pass on the change in marginal cost to its customers but will also adjust the markup of its price over marginal cost. This choice arises from concern about competition with firms whose input prices and marginal costs are not affected by exchange rate changes.

Strategic complementarities explain why, even conditional on changing prices, a firm does not alter its US dollar price by much. In prior work, Goldberg and Hellerstein (2008; 2013) developed structural models of the impact of strategic complementarities on firms' decisions to reset prices in response to changes in exchange rates, with a focus usually on a specific industry. Where Oleg and his coauthors extended this literature is in considering the interaction of imperfect competition and exchange rate variability both on firms' pricing decisions and their decisions to invoice their goods in a particular currency. They show, for example, that a firm whose competitors price in US dollars is motivated to price in dollars as well, so that exchange rate movements do not lead to relative price adjustments that cause the firm to lose market share.

Oleg develops this agenda further in joint work with Mary Amiti and Jozef Konings in [4] and [5], where he brings to bear novel micro data on the pricing decisions of Belgian firms and developed structural frameworks to analyze the strength of the intermediate input channel, of strategic complementarities, and

of the interaction of these forces in shaping firms' invoicing and pricing decisions. This richer data set includes information on the extent to which firms exporting from Belgium import the inputs they use in production, as well as information about these firms' marginal costs and the prices charged by their competitors. With these data, Oleg and his coauthors are able in paper [4] to provide compelling evidence of the two theoretical mechanisms discussed previously and to model the role of these forces in shaping firms' pricing and invoicing decisions, using a model of firms' pricing and choice of currency of invoicing under imperfect competition based on that in Atkeson and Burstein (2008). In [5], they construct augmented micro data not only on firms' marginal costs but also on the prices of their competitors, developing a theoretical framework to directly decompose firms' price changes into a response to changes in its own marginal cost and a response to changes in the prices charged by its competing firms.

The role of strategic complementarities in the pricing decisions of firms is central not only to international macroeconomics, but also to core questions in closed-economy monetary macroeconomics. In both fields, a key question is how monetary or nominal shocks can have a persistent real effect well beyond the horizon for which firms' nominal prices are sticky. In [3], Oleg and Gita compare the evidence and analytical frameworks used in international and closed economy macroeconomics to understand this persistence. Regarding strategic complementarities, studies using data on firms' international pricing decisions have the advantage that nominal exchange rate shocks are frequent, large, and persistent. These studies typically find strong evidence of strategic complementarities. In contrast, with data from closed economies, there are fewer well-identified nominal shocks, and these shocks tend to be smaller and less persistent. Thus, studies relying on data from a single country tend to find only weak evidence of strategic complementarities. In this dimension, work in international economics may inform our future models of the impact of nominal shocks in closed economies.

In these papers, Oleg and his coauthors provide definitive empirical evidence and provocative modeling frameworks to help us understand the economics underlying the purchasing power parity puzzle, the exchange rate disconnect puzzle, and the behavior of the terms of trade. Certainly, a significant portion of the resolution of the purchasing power parity puzzle stems from the fact that many goods and services are not traded internationally, and thus changes in the nominal exchange rate do not significantly affect the pricing decisions of firms producing these goods and services. The direct micro evidence marshaled in these papers, however, indicates that the industrial organization of the markets in which firms that export and import traded goods also plays an important role in resolving these puzzles. One characteristic of this industrial organization is that firms that can choose currencies in which they price their products based on the characteristics of the specific shocks and competition they face. Moreover, due to heterogeneous use of imported intermediate inputs and heterogeneous product market competition, these firms, in equilibrium, do not choose to fully change their nominal prices (in the currency

in which they are invoiced) in response to changes in nominal exchange rates, even over relatively long time horizons.

Dominant Currency Pricing

In standard open economy macroeconomic models, when the nominal prices of exported and imported goods are sticky, a change in the nominal exchange rate can mechanically alter the real relative price of a country's exports and imports and thus alter world consumers' desired allocation of spending across countries. Prior to the work discussed above with micro data, the magnitude and direction of this effect of nominal exchange rate changes on a country's terms of trade were not clear. As previously discussed, when prices for imported and exported goods are sticky, the mechanical impact of a change in the nominal exchange rate on a country's terms of trade depends on the currencies in which firms choose to price exported and imported goods. Under producer currency pricing, the effect of the exchange rate on the terms of trade goes one way; under local currency pricing, it goes the other way.

But Gopinath (2015) and Gopinath et al. (2020) document the absence of *both* of these pricing paradigms in the micro data. Instead, most firms that are engaged in trade worldwide price their goods in one of a few dominant currencies—primarily the US dollar or the euro. In [6], Oleg and Gita survey this evidence. The terms of trade for many countries tend to be stable despite large nominal exchange rate changes, contrary to the earlier classic models of Mundell and Fleming. Further, when a country's exchange rate depreciates, there is a relatively muted impact on its exports in the short term; mainly, the country's imports decline as the relative prices of imports rise relative to domestic goods.

In [7], Oleg, working again with Mary Amiti and Jozef Konings, tackles the question of why firms engaged in international trade would choose to invoice their products in a dominant currency. They use micro data with evidence on the choice of currency invoicing at the firm-product-destination-month level. They show that firms' choice of currency for invoicing their products is an active choice that persists over time and that this choice is more closely tied to firm and destination-country characteristics than to industry or product characteristics. They show that for Belgian imports and exports outside the euro area, dominant currency pricing is widespread: the vast majority of these exports and imports outside the euro area are invoiced in either euros or US dollars. They extend their previous modeling of firms' currency invoicing and pricing decisions to allow for dominant currency pricing and show that firms' product invoicing decisions are systematically related to attributes such as firm size (a proxy for market share), firms' share of imported intermediate inputs and the currency invoicing of those intermediate inputs, and the currency invoicing decisions of competitors. Based on this match between theory and data, they argue that

strategic complementarities and imported intermediate inputs in firms' currency invoicing decisions can entrench an invoicing currency in a dominant role for a long time.

Fiscal Policy as a Substitute for Exchange Rate Devaluations

One classic dilemma for policymakers is whether to pursue a fixed nominal exchange rate (or even to adopt a common currency) or to allow the exchange rate to float. In the standard framework for analyzing the cost and benefits of alternative exchange rate regimes, a fixed exchange rate regime is seen as having the benefit of reducing the volatility of international real relative prices, and the use of a common currency, such as the euro, is seen as facilitating further economic integration across the boundaries of countries that adopt such a common currency. However, these benefits are considered to accompany the cost of less policy flexibility. In particular, if a country with a fixed exchange rate or in a common currency area experiences an economic downturn, it is typically seen as not having the option of changing its nominal exchange rate to alter its terms of trade and thus shift worldwide expenditures toward its national economy. In the standard framework for analyzing this policy dilemma, pioneered by Robert Mundell (1961), the question of whether a country should have a fixed exchange rate or adopt a common currency depended in part on the extent to which that country had access to policy tools other than changes in its nominal exchange rate to deal with negative macroeconomic shocks.

In [8], Oleg, with Emmanuel Farhi and Gita Gopinath, points out that this conventional wisdom overlooks the fact that a country that has a common currency with its neighbors can achieve the effects of an exchange rate devaluation on its terms of trade with a small set of changes in fiscal policies—either a coordinated change in import tariffs and export subsidies or a change in value-added taxes and payroll tax deductions. In the debate leading up to the US corporate tax reform in 2017, this question of the impact of changes in tax policy on the US terms of trade and macroeconomic outcomes took on added urgency as Republicans in the US House of Representatives proposed border adjustments of the tax on corporate profits that would tax imports and allow firms to deduct taxes on exports. In [9], these same three authors, joined by Omar Barbiero, offer an analysis of such a border adjustment of the corporate profits tax. This analysis significantly extends prior work on this question by Lerner (1936), Grossman (1980), and Feldstein and Krugman (1990) by examining the impact of the imposition of a border adjustment to corporate profit taxes in a fully dynamic sticky-price and sticky-wage New Keynesian model with alternative assumptions about the invoicing currency of traded goods. The key finding in this paper is that the short-term macroeconomic impact of such a fiscal policy can be substantial—the magnitude depends on how much firms change their prices in response to the changes in taxes and the induced changes in the US dollar exchange rate. Thus, in this paper, Oleg and his coauthors

draw out the implications of their work on firms' pricing decisions for significant questions in public finance.

Exchange Rate Disconnect

In the strands of research already discussed, Oleg focused on individual pieces of the puzzle of international real relative prices, taking shocks to nominal exchange rates as given. In [10] and [11], Oleg and Dmitry Mukhin aim to assemble the pieces of the puzzle into a coherent whole. They seek an underlying explanation of the shocks that drive changes in nominal exchange rates, together with an account of the connection between these shocks and macroeconomic fluctuations. Their challenge is to do so in a manner that can be reconciled with the five puzzles listed at the start of our background section on the state of the literature in international finance prior to Oleg's work and that can also provide a framework for understanding how adopting a monetary policy aimed at fixing the nominal exchange rate can bring stability to a country's international real relative prices.

Oleg's work in this area starts from the observation that in standard models of the international macroeconomy, real exchange rate volatility is intimately linked to macroeconomic volatility—regardless of whether that volatility is driven by monetary shocks or productivity shocks. This link between the macroeconomy and the real exchange rate is most prominent in versions of these standard models that have complete asset markets, in the sense that macroeconomic risks are optimally shared across consumers in different countries. Such models make a stark prediction that changes in the real exchange rate are directly linked to changes in the ratio of the marginal utility of consumption for domestic and foreign consumers, regardless of the nature of shocks to domestic and foreign economies. The failure of this implication of optimal risk-sharing to hold in the data was first documented in Backus and Smith (1993) and is now referred to as the Backus-Smith puzzle. Of course, the assumption of complete international asset markets is extreme. But research over several decades has confirmed that this tight link between macroeconomic volatility and real exchange rate volatility continues to hold in standard models with quite limited opportunities for cross-border risk sharing as long as the macroeconomic volatility is driven by standard monetary or productivity shocks (for example, see Lustig and Verdelhan 2019).

Given these observations, the literature in international macroeconomics has begun to consider an alternative source of shocks to real exchange rates—shocks to the desired allocation of portfolios across countries. These shocks in asset markets have intellectual antecedents in what were termed "portfolio balance models of exchange rates," developed initially in the 1970s (for example, Kouri 1976). In the popular press, such shocks are typically referred to as shocks to "the demand for dollars" or as "flight" by international investors from or to a particular currency.

Research into such shocks as a source of exchange rate volatility was reinvigorated in work by Jeanne and Rose (2002) and Gabaix and Maggiori (2015). This

work was motivated both by the observation that a small number of major banks worldwide intermediate the vast majority of trading of nominal exchange rate risk in spot and derivatives markets and by the puzzling behavior of interest rates in different currencies and exchange rates observed over the past 50 years. Specifically, if the nominal interest rate for one currency, say the US dollar, is high relative to that for another currency, say the Japanese yen, it might be expected that the value of the dollar would fall relative to that of the yen over time and would equalize the expected returns to investing at these two interest rates when the returns are expressed in a common currency. This prediction is sharply contradicted by the data. Instead, there are large and persistent movements in the expected excess return to investing in one currency versus another; it is typically profitable, at least for major currencies, to invest in a currency when it has a high nominal interest rate relative to others. This behavior of interest rates and changes in nominal exchange rates is referred to as the "Fama puzzle" (Fama 1984). Although there has been extensive effort to understand the Fama puzzle in the context of frictionless capital markets based on variation over time in currency risk premia, recent work has focused on the resolution of the puzzle as arising from frictions in international capital markets that offer profitable trading opportunities to major banks that trade exchange rate risk.

The models of how shocks to the desired allocation of portfolios across countries affect exchange rates start from the hypothesis that frictions in financial markets cause most investors to focus on holding assets denominated in the currency of the country where they live and do business. Such models assume that investors do not actively participate in trading nominal exchange rate risk. Hence, international capital markets have relatively few investors willing to absorb the exchange rate risk inherent in holding portfolios of assets denominated in different currencies when nominal exchange rates are volatile. These investors are referred to as *international arbitrageurs*.

In the face of shocks to the desired allocation of portfolios across assets denominated in different currencies, these international arbitrageurs are called on to absorb the nominal exchange rate risk inherent in such portfolio flows. That is, if households wish to reduce their holdings of euro bonds and increase their holdings of US dollar bonds, then, absent government intervention in bond supplies, international arbitrageurs must absorb that flow by increasing their holdings of euro bonds and decreasing their holdings of dollar bonds. In equilibrium, nominal exchange rates must move in a way that offers these international arbitrageurs a financial reward for taking on additional exchange rate risk in their portfolios. Here, this entails an immediate decline in the exchange rate value of the euro relative to the dollar so as to allow arbitrageurs to earn a high return when the euro returns over the long term to its prior level relative to the dollar. The research challenge is to integrate such a model of nominal exchange rate determination in asset markets with the behavior of international real relative prices in the markets for traded goods and the associated impact of these nominal exchange rate movements on the macroeconomy.

What Oleg and Dmitry achieve in [10] is such an integration. Specifically, they address the question of why, in the face of such financial market shocks to the nominal exchange rate, we do not simply see either volatile flows of traded goods across international boundaries or a relatively rapid response of inflation differentials across countries to restore purchasing power parity. They join the micro and the macro, bringing the insights from Oleg's prior work to bear. The exchange rate movements induced by financial shocks in the model do not result in significant macroeconomic responses in terms of reallocation of expenditure and output across countries, because of all the forces which Oleg previously studied that dampen the response of the terms of trade to exchange rate shocks. In this way, they offer a resolution of the exchange rate disconnect puzzle between the exchange rate and countries' underlying macroeconomies for the large major economies of the world.

In [11], Oleg and Dmitry take their model a step further to address the Mussa puzzle: they seek the causal mechanism through which a country might stabilize its international real relative prices by adopting a fixed exchange rate. In their model, international capital markets are particularly bad at dealing with nominal exchange rate risk because this risk is concentrated in a limited number of international arbitrageurs. When the perceived level of nominal exchange rate risk in the future is high, these arbitrageurs require large swings in their expected compensation for taking on more or less of this risk. These swings in the expected excess returns for international arbitrageurs correspond to large movements in the current level of the nominal exchange rate. In contrast, if a government can reduce the perceived level of nominal exchange rate risk in the future by adopting a fixed nominal exchange rate, these international arbitrageurs are happy to absorb large shocks to desired portfolios today with little or no compensation for risk because there is little such risk for them to be concerned about. In this case, these financial shocks affect neither the current exchange rate nor the macroeconomy because they are fully absorbed by private actors in international financial markets.

Papers [10] and [11] are quite recent, but they may have the greatest impact of Oleg's papers to date. Many countries in the world, particularly emerging market economies, have begun to experiment with unconventional policies to address shocks to capital flows together with exchange rate and macroeconomic volatility. Such policies go beyond the typical setting of nominal interest rates to include direct intervention in foreign exchange markets, measures to control cross-border flows of private capital, and macroprudential measures aimed at enhancing the stability of domestic financial sectors. As noted by Adrien and Gopinath (2020), policymakers worldwide are assessing these policy choices in a somewhat eclectic manner that does not rely on a clear analytical framework to assess how these policy tools should be used in an integrated way. Basu and others (2020a, b) develop a welfare theoretic framework to assess the optimal choice of multiple instruments in an integrated manner. Oleg's papers [10] and [11] are important contributions to this agenda.

The Impact of International Trade on Inequality

Early in his research, in [12], [13], and [14], Oleg studies the link between increased volume of international trade and inequality among workers. This question has been of intense policy interest, especially given the long post–World War II effort to reduce barriers to international trade through multilateral and bilateral agreements. Standard trade models typically address this question by looking at the impact of reduced barriers to international trade on workers with different observable characteristics—such as employment sector, education, experience, and occupation. In the data for the United States, however, much of the observed increase in inequality is "residual," in the sense that it is not accounted for by workers' observable characteristics. Oleg's work in this area is focused on understanding how trade affects both unemployment and this residual income inequality for workers.

In [14], coauthored with Elhanan Helpman, Oleg develops a model of the relationship between international trade and unemployment, a question not usually studied in standard models, which typically do not include the labor market frictions leading to unemployment.[3] This model serves as a framework for assessing the interaction of labor market frictions and impediments to trade in shaping welfare, trade flows, unemployment, and productivity.

In [13], coauthored with Helpman and Stephen Redding, Oleg extends this model to consider the interaction of trade and within-group inequality for employed workers. This model extends the standard Diamond-Mortensen-Pissarides model of search frictions, which results in a situation in which workers will be heterogenous in their unobserved ability. The next step is to embed this framework in a Melitz (2003) model of the selection of larger firms into international trade, because larger firms can afford to pay the fixed costs of participation in international markets. Taken together, this model explains that larger firms will screen applicants more intensively to employ higher-quality workers, pay these workers more, and select into participation in international trade. In the model, as in the data, firms that participate in international trade are larger, pay higher wages, and have higher labor productivity. Oleg and his coauthors develop novel results in this framework regarding the nonmonotonic relationship between increasing trade and inequality as barriers to international trade fall from a prohibitively high level to zero.

In [12], coauthored with Helpman, Redding, and Marc Muendler, Oleg takes this model to linked firm-worker data in Brazil. The authors first demonstrate that much of the inequality between workers in Brazil is driven by differences in wages across firms, consistent with their model. They then go on to estimate a structural model. This paper presented the first serious quantitative exercise evaluating the impact of trade cost reductions on within-group wage inequality.

[3]Davidson, Martin, and Matusz (1999) is an early study of the interaction of trade liberalization and unemployment generated by search frictions. Artuç, Chaudhuri, and McLaren (2010) study the dynamic impact of trade liberalization of wages when workers has switching costs between sectors.

Conclusion

The field of international macroeconomics has entered a new era of intellectual excitement based on advances both in theories and in the data and empirical strategies we have available to evaluate those theories. Oleg's research with his coauthors has fundamentally altered our understanding of the relationship between nominal exchange rates, prices of internationally trade goods, and macroeconomic fundamentals. His work has helped demystify several long-standing puzzles in the literature. In turn, this has led to a deeper understanding of monetary and exchange rate policy in open economies.

In addition to being a prolific scholar, Oleg is an exceptional teacher and collaborator. He has an infectious enthusiasm for everything he works on which comes through in the classroom and which makes him a great coauthor. Even as a student, Oleg handled the seminar jousting incredibly well and was never rattled. This quality to absorb constructive feedback while ignoring petty comments helped him professionally as an economist. His kindness and generosity has also made him a great mentor to students. He brings a boundless optimism and enthusiasm for economics to everything he does.

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