The Stolper-Samuelson Theorem and Its Applications

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ABSTRACT

The Stolper-Samuelson theorem, a cornerstone of trade theory, relates changes in output prices to factor returns in a general equilibrium setting. This entry examines the theorem's theoretical foundations, its extensions, and its empirical applications, especially in explaining the distributional consequences of globalization. While foundational, the theorem's predictions are often inconsistent with empirical evidence, particularly concerning the rising skill premium in both developed and developing nations. We review literature that incorporates skill-biased technological change, firm heterogeneity, global value chains, and labor market frictions, which offer a more nuanced understanding. The entry also examines the theorem's application to the political economy of trade, including its influence on shaping policy preferences and the rise of populism. We conclude that while the original theorem provides a critical starting point, modern trade complexities require integrated theoretical approaches.

The Stolper-Samuelson Theorem is a fundamental proposition in international trade theory relating output price changes to input price changes within a general equilibrium framework. Embedded within the Heckscher-Ohlin theory, it analyzes how changes in the relative prices of goods, driven by international trade, affect the returns to factors of production. The theorem has played a central role in debates on trade policy and the broader socioeconomic implications of globalization. Empirical evidence has shown that the Stolper-Samuelson framework is often insufficient to explain the complexity of modern trade patterns and factor price dynamics. Global value chains, intermediate goods trade, and technology are among some of the factors that require newer theoretical approaches for a more accurate understanding of how trade impacts economies and income distribution. Researchers continue to explore more complex economic environments, including models with more than two goods or factors, firm heterogeneity, non-traded goods, trade in intermediate goods, and imperfect labor mobility.

The Original Stolper-Samuelson Theorem and Theoretical Extensions

In its simplest form, the theorem says that trade protection helps the scarce factor or that free trade hurts the scarce factor. More precisely, the theorem articulates that, in a two-good, two-factor, and two-country model (the classic Heckscher-Ohlin framework), an increase in the relative price of a good will lead to a rise in the real return to the factor used intensively in its production while reducing the real return to the other factor. While not directly related to trade, it implies that by altering the relative prices of goods, trade has direct implications on the returns to factors of production, ultimately

influencing income distribution. The theorem is particularly significant for understanding that while there are overall gains from trade, it also generates distributional conflict over trade policy. This insight explains why trade liberalization is often met with mixed reactions domestically: while some groups (those owning the abundant factor) benefit, others (those owning the scarce factor) may lose out. Beyond trade, it also forms the backbone of models and applications that examine technological changes, offshoring, the politics of trade policy, inequality within and across countries, and the broader socioeconomic implications of globalization.

The intuition is as follows: In an economy with two sectors—one producing exports and the other competing with imports, a tariff or similar policy that raises the price of imports will cause that sector to expand. This expansion occurs at the expense of the export sector, assuming full employment of resources. The shift boosts the demand for and hence the relative return to the factor used intensively in the import-competing sector, the relatively scarce factor. Under free entry and zero profit, the increase in average cost in the import-competing sector must equal the rise in import price. If both factors are used, and since export prices remain unchanged, the price of the scarce factor rises relative to the prices of all goods, raising its real returns. Concomitantly, the real returns of the abundant factor fall. The theorem assumes perfect competition but can be extended to a setting with imperfect competition and increasing returns to scale.

Generalizing the theorem to higher dimensions is fraught. Mapping from goods prices to factor prices is not well-defined if the number of goods does not equal the number of factors, and factor price responses to trade shocks are not always unambiguous.

However, with more goods and more factors, at least one factor stands to gain unambiguously from trade, and at least one factor stands to lose unambiguously. While the basic message of the original theorem survives, it is difficult to outline which factors will gain and which will lose. With a continuum of goods and two factors of production, how returns to factors change following trade liberalization depends on how different a country's factor endowment is from the rest of the world and on the elasticity between the factors. We could also obtain a scenario where the return to the scarce factor rises relative to the abundant factor following trade liberalization once we allow for non-traded goods. For instance, following trade liberalization, a country abundant in unskilled workers starts exporting some goods that were earlier non-traded but are the most skill-intensive. It also stops producing some of its most skill-intensive non-traded goods. To the extent that the first effect dominates, adjustment at the traded-nontraded margin can cause skilled and unskilled wages to rise together but benefit skilled workers more than unskilled workers (Xu, 2003). Another way this effect can play out is through outsourcing (Feenstra and Hanson, 1996). Trade liberalization and easing of capital controls enable firms to outsource production stages to lower-cost locations. While these outsourced tasks are unskilled-labor-intensive for developed countries, they are skill-intensive relative to existing industries in developing nations. This shift raises the average skill intensity of production in both economies and drives up returns to skilled workers in all countries.

In the original framework, real returns adjust primarily due to changes in product prices. However, new trade models and new-new trade models emphasize two other sources of gains from trade. In new trade models, consumers have a "love-for-varieties," and trade makes newer varieties available, lowering the overall price index of varieties. In

new-new trade models, trade leads to a reallocation of production from low-productive to high-productive firms, increasing aggregate productivity. Allowing for heterogeneity in consumer preferences and firm productivity, real wages of both factors can increase if the gains from variety expansion and productivity growth are strong enough. Work combining these models within the original Hecksher-Ohlin and Stolper-Samuelson framework allows high-productive firms to be more intensive in the use of skilled labor (Bernard, Redding, and Schott, 2007; Burstein and Vogel, 2017). Model calibrations show that the within-industry shift towards more productive firms is a stronger mechanism in the impact of trade on relative wages than the across-sector shifts predicted by Stolper-Samuelson. Other extensions incorporate heterogeneity within broad categories of workers (e.g., ‘‘Managers’’ and ‘‘Workers’’) who work in teams; their productivity depends on the quality of the match. Trade liberalization induces re-matching and generates distributional effects across industries, as in the original formulation, as well as within occupations and industries (Grossman, Helpman, & Kircher, 2017).

The rise of global value chains (GVCs) complicates the predictions of the Stolper-Samuelson Theorem, as the production of goods is fragmented across multiple countries, and trade in intermediate goods has become increasingly important. For instance, participating in GVCs results in trade in tasks (Grossman and Rossi-Hansberg, 2008). Rhe re-sorting of workers in fewer tasks that they can do more efficiently implies gains for both skilled and unskilled workers. At the same time, there can be an increase in the skill wage gap both within and across countries. With a continuum of skills, the entire distribution of wages within a country is affected. In developing countries, for instance, wage inequality decreases among workers

performing the simplest tasks (bottom of the value chain) but increases among those performing more advanced tasks – an "anti–Stolper-Samuelson effect. Similarly, trade liberalization in intermediate goods can have the opposite impact on factor returns compared to trade liberalization in final goods. Finally, if there are noncompeting goods (not produced domestically), trade liberalization leads to pure consumption gains without affecting returns to factors. Only for competing goods does trade liberalization lead to Stolper-Samuelson effects

~~between both lead to wage increases in specific sectors, but wage decreases in others, depending on how integrated the country is into the global production process. Similarly, trade liberalization in intermediate goods can have the opposite impact on factor returns compared to trade liberalization in final goods. Finally, if there are noncompeting goods (not produced domestically), trade liberalization leads to pure consumption gains without affecting returns to factors. Only for competing goods does trade liberalization lead to Stolper-Samuelson effects.~~

Applications of the Stolper-Samuelson Theorem

Inequality and the Skill Wage Premium

With the rise in globalization, as more and more countries joined the WTO and preferential trading arrangements, the parallel rise in inequality between skilled and unskilled workers (and in the skill wage premium) in advanced countries led economists to analyze if the two were related. The Stolper-Samuelson Theorem predicted that trade liberalization would redistribute income from unskilled workers to skilled workers in skill-abundant countries. Accordingly, advanced economies with abundant skilled labor should experience a rise in the skill-wage premium.

Advanced Economies

Initial findings concluded that the evolving pattern of international trade was a primary cause of relative wage changes where skilled workers gained relative to unskilled workers in advanced economies. Most of these studies were based on U.S. data. Three findings questioned the importance of the trade channel. First, international trade should have increased the relative price of skill-intensive goods in the U.S. and raised the "derived" demand for skills via this channel. However, most evidence points to a declining or constant relative price of skill-intensive goods over this period (Lawrence and Slaughter, 1993). Second, in advanced economies, there was widespread evidence of increased demand for skilled workers *within* industries (Berman, Bound, and Griliches, 1994). Third, even within labor-abundant countries, there was a rise in the wages of skilled workers relative to unskilled workers. Economists refocused on the importance of skill-biased technological change (SBTC disproportionately increases the productivity of skilled labor relative to unskilled labor) in rising inequality, the decline of the power of unions, differential access to schooling, and immigration.

Empirical evidence from the 1980s suggests that technology, particularly SBTC, instead of Stolper-Samuelson, has played a more substantial role in increasing wage inequality in developed countries (Berman, Bound and Machin, 1998). Some of the initial findings were critiqued on the grounds that many used trade deficits and volumes to analyze the relative returns to skilled vs unskilled workers. Stolper-Samuelson relates changes in these returns not to trade volumes but to changes in prices of goods that these factors produce. Moreover, the wage gap stabilized in the 1990s despite continuing technological advances, especially in personal computers and the rise of the Internet.

However, imports from developing countries were simply too small a share of the U.S. economy (Krugman and Lawrence, 1994) to account for such a broad-based shift in the relative wages of skilled workers. In contrast, the scale of the computer and information technology revolution was enormous. Numerous studies found direct relationship between technology adoption and wage changes. Industries and occupations that saw greater computerization, R&D, or automation experienced bigger boosts in relative wages for skilled workers (Autor, Katz, and Krueger, 1998).

Other work recognized the interaction of trade, technology, and labor markets. For instance, highly skilled workers (those with more schooling) are more likely to use computers on the job, suggesting that computer technology complements human capital. There is also mounting evidence that for U.S. cities and states, free labor mobility, as assumed in the Stolper-Samuelson theorem, is questionable, especially for low-skilled workers. Labor mobility, even in developing countries, is limited. More recent studies have tended to give trade a more prominent role, partly because globalization has advanced and a sharp distinction between trade and technology has become more challenging. Recently, there has been a shift in the debate of the relative importance of trade vs. skill-biased technological change by recognizing that technological change was an endogenous response to higher trade openness. Trade liberalization intensifies competition for domestic firms who engage in more defensive innovation, a phenomenon observed in both advanced and middle-income countries. They may also import more machines and capital goods complementary to skilled labor, raising the demand for skilled workers even in developing countries. Similarly, a rising supply of skills (in response to the original increase in the price of the skill-intensive good) can also induce skill-biased changes in technology, while the increased

productivity of skilled workers both in the U.S. and in other countries may eventually return the relative price of skill-intensive goods to its original (pre-trade) level.

Developing Economies

Beyond the U.S., in developing countries, empirical studies using trade liberalization episodes have consistently shown that within most industries in nations such as Argentina, Brazil, Mexico, Chile, and Colombia, the share of skilled workers has increased significantly, challenging the Stolper-Samuelson prediction that trade liberalization would primarily benefit low-skilled workers in these economies. One potential explanation is that the Stolper-Samuelson should be tested not for middle-income countries but for low-income countries. If there are three groups of countries in terms of skilled to unskilled workers (high, medium, and low), trade liberalization can increase or decrease the skill premium in the medium countries but is still expected to reduce the skill premium in the least skilled-labor-abundant country. For countries like India and Indonesia, there is evidence that lowering input tariffs reduces the wage skill premium within firms.

A second potential explanation is that prior to liberalization, the highly protected sectors were the ones that used unskilled workers most intensively and, hence, they were the most impacted by liberalization. In this scenario, the increase in the skill premium is what Stolper–Samuelson would predict. However, this raises more profound puzzles. Why would unskilled abundant countries protect unskilled intensive sectors? Some have suggested that the emergence of China as a powerhouse exporter hurt the unskilled workers in other developing countries, leading to a demand for protectionism. However, following trade liberalization episodes in developing countries, we should but do not observe a reallocation of workers from sectors that

experience relative price declines to those that experience relative price increases. Further complications include that trade liberalization often follows a crisis (India, Indonesia) and is accompanied by reforms that include reducing regulatory burdens and relaxing controls on capital flows. All these make identifying Stolper-Samuelson effects challenging if not impossible.

This complexity indicates that while the Stolper-Samuelson Theorem remains a powerful tool for understanding trade's distributional impacts, it must be supplemented with many other mechanisms and factors, some contextual and some temporal.

NAFTA and China's Entry to the WTO

Two of the most consequential shifts in trade liberalization are entry into free trade arrangements or accession to the WTO. A series of research streams have focused on the impact of NAFTA and China's entry into the WTO. The fear in the U.S. was that import competition from low-wage workers in Mexico would entail not just a decline in wages of low-skilled American workers but also a loss of jobs (Ross Perot's memorable term "giant sucking sound south") to Mexico. The mirror image would be a convergence of Mexican wages towards that of the U.S. Economists have struggled to find a significant net impact for the U.S. economy, largely because U.S. tariffs on Mexico were relatively low. Caliendo and Parro (2014) find that Mexico's welfare increases by 1.31% while U.S.'s welfare increases by only 0.08% following NAFTA's tariff reductions. They use a Ricardian model with trade in intermediates, inter-sectoral linkages, and sectoral heterogeneity in production to quantify welfare effects from tariff changes.

Only unskilled workers in industries that lost protection experienced a significant decline in wage growth relative to a well-defined control group. On the flip side, for Mexico, the evidence shows that the scale effects of NAFTA dominated the Stolper-Samuelson effect, that convergence is weak, and wide regional differences in impact, rendering the free factor mobility assumption questionable. Complicating all this was that NAFTA coincided with a surge in FDI, reorganizing of supply chains that led to a rapid increase in trade in intermediate goods, and a series of crises Mexico experienced in the 1990s. Despite this, research finds that an increase in low-skilled wages was larger in states closer to the U.S.-Mexico border, with a higher concentration of manufacturing production and FDI.

China is a much larger country, and its entry was a bigger deal. A series of papers have found evidence for a big and persistent "China trade shock" (Autor, Dorn and Hanson, 2013.) Commuting zones in the U.S. with higher exposure to Chinese import competition experienced significant declines in manufacturing jobs, wage reductions in manufacturing and non-manufacturing sectors (via spillovers), and lower labor force participation. This work focuses on local labor markets (Commuting Zones), where workers are not perfectly mobile across industries or regions. Such an approach is, therefore, more aligned with a specific-factors model, where workers are not freely mobile.

Politics of Trade Policy

The Stolper-Samuelson theorem, with its redistributive consequences, is suited to understand why certain groups may resist or support trade policies: owners of abundant factors stand to gain from free trade, while owners of scarce factors prefer

protectionism. The literature has documented class or factor-based coalitions (labor vs. capital) when factor mobility is high, reinforcing Stolper-Samuelson-type divisions in trade policy. However, when factor mobility is low, industry-specific lobbying replaces class-based conflict. For instance, when workers are immobile, those employed in export-oriented industries support free trade. The nature of these coalitions has varied and been influenced by factors such as factor mobility, which tends to rise over time.

Globalization, with its distributional effects, is seen as an important factor in the recent emergence of populism (Rodrik, 2018). It generates and even exacerbates economic anxiety within a segment of the population (unskilled and less-educated workers in advanced economies), creating fertile ground for the rise of populist politicians. The form of populism varies across regions. In Europe and the United States, where immigration has been a salient issue, right-wing populism has flourished, emphasizing cultural and nationalist narratives. In contrast, Latin American populism has historically been left-wing, targeting economic elites and foreign corporations rather than immigrants. The China Shock and NAFTA trade agreements disproportionately affected manufacturing-heavy regions, deepening economic distress and driving support for populist candidates like Donald Trump in the U.S. and Brexit in the U.K. The resulting populist politicians have leveraged this discontent to argue for protectionist measures, trade renegotiations, and tariffs. Recent elections reveal the importance of educational polarization in advanced economies, given that highly educated workers benefit disproportionately from globalization and whose skills are complemented by technological advances.

The Stolper-Samuelson logic can also be extended into political economy models, with a focus on the determination of trade policies, accounting for the incentives of politicians. Politicians could be driven by ideology (left-wing parties are more pro-labor), by incentives to win elections that drive them toward the preferred policies of the median voter, or by political contributions from specific interest groups (e.g., business lobbies or trade unions). There is evidence that more pro-labor policies that take the form of higher trade protection in capital-abundant countries and lower protection in labor-abundant countries are adopted under left-wing governments and when inequality is higher (the median voter becomes more pro-labor), in accordance with the predictions of the Stolper-Samuelson logic (Dutt and Mitra, 2006). Conversely, lobbying is mainly organized around industries rather than along factor or class lines (Hiscox, 2001).

Conclusion

The Stolper-Samuelson Theorem has provided a foundational lens through which to view the interaction between trade, factor returns, and income distribution. By predicting that trade liberalization will benefit a country's abundant factor while potentially harming its scarce factor, the theorem lays the groundwork for understanding the distributional impacts of global market integration. Its insights offer a theoretical basis for understanding the relationship between trade and wage inequality. It has also been critical for interpreting the policy preferences of various interest groups and the political economy considerations in the choice of trade policies.

However, as trade dynamics have evolved and as economists obtained access to better data, the limitations of the Stolper-Samuelson framework become apparent. Its reliance on the assumptions of factor homogeneity, perfect competition, and complete factor mobility oversimplifies the complexities of real-world markets. It also elides over scale economies, firm productivity, FDI, global value chains, market power, labor immobility, and offshoring. Empirical evidence increasingly supports the view that while the Stolper-Samuelson Theorem accurately captures some of the basic effects of trade liberalization, a more nuanced picture emerges when some assumptions are relaxed or new factors are considered.

The emergence of New Trade Theory and New New Trade Theory and extensions to the standard Hecksher-Ohlin model has enriched our understanding, addressing many of the empirical discrepancies observed in the traditional Stolper-Samuelson predictions. These newer models emphasize the reallocation of resources among firms, the entry and exit of firms, the crucial role of scale economies, and the rise of intra-industry trade, all of which affect income distribution in ways the original Stolper-Samuelson model does not fully account for.

Furthermore, debates about the root causes of wage inequality – whether driven by trade, technological change, or the interactions between the two – reveal that trade is just one piece of a complex economic puzzle. The Stolper-Samuelson Theorem remains relevant for understanding some distributional outcomes of trade policy. Still, it needs to be complemented by newer theoretical approaches to accurately analyze modern trade patterns and their impact on factor returns. Even research in political economy that focuses on the determination of and support for trade policies is enriched by using

the Stolper-Samuelson theorem as the starting point. By integrating these diverse perspectives, we gain a deeper understanding of the political economy of trade policy, the evolving nature of globalization, and how trade continues to shape the economic landscape for workers and capital owners worldwide.

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