Fiscal Integration with Internal Trade: Quantifying the Effects of Equalizing Transfers[†]

Trevor Tombe
University of Calgary

Jennifer Winter
University of Calgary

This Version: September 2016

Abstract

Financial transfers between regions of a country are ubiquitous. Richer regions contribute (often indirectly) to poorer regions, and this affects their welfare, productivity, and industry composition. Financial inflows raise welfare by funding current account deficits, and imports raise productivity by shutting down the lowest productivity firms. But there is little quantitative work examining these effects for fiscal transfers within countries. We fill this gap by augmenting and exploring a rich quantitative trade model with endogenous fiscal transfers, calibrated to detailed data for trade and financial flows within Canada. We find transfers significantly increase welfare, productivity, and specialization in downstream (final goods) sectors in recipient regions; the reverse is true in contributor regions. The effects are large. Alberta's welfare and productivity are 9% and 0.6% lower, respectively, while increase PEI's are 33% and 1.6% higher. Overall, real income differences are less than half what they would without fiscal integration. Finally, transfers affect gains from trade and spread those gains across all regions, even if policy (like the New West Partnership) liberalizes trade only among some.

JEL Classification: F1, F4, H5, R1

Keywords: Fiscal integration; internal trade; gains from trade; productivity

[†] Previous version circulated as "What's Inside Counts: Migration, Taxes, and the Internal Gains from Trade".

Tombe (Corresponding Author): Assistant Professor, Department of Economics, University of Calgary, 2500 University Drive NW, Calgary, Alberta, T2N1N4. Email: ttombe@ucalgary.ca. Phone: 1-403-220-8068. Winter: Assistant Professor and Director of Energy and Environmental Policy, The School of Public Policy, University of Calgary. Email: jwinter@ucalgary.ca. We greatly benefited from comments and suggestions made by anonymous referees and various conference participants at the SED Annual Meeting 2012, MidWest Macro 2012, CEA Annual Meeting 2012, AEA Annual Meeting 2015, and various seminar participants at Wilfrid Laurier University, and the University of Calgary. We also gratefully acknowledge the financial support of the Social Science and Humanities Research Council (specifically, IG 435-2015-0151 and an Institutional Grant to Wilfrid Laurier University).

1 Introduction

Financial transfers to offset large income differences between regions are ubiquitous. Explicit programs exist in some form or another within many countries, including in Australia, Belgium, Canada, China, France, India, Germany, South Africa, Switzerland, the United Kingdom, and others. In the United States, while no explicit program exists, some nonetheless respond to a state's average income – Medicaid, food stamps, or unemployment insurance for example.[1] While a substantial body of work exists (Boadway et al., 2008), little is known about how such equalizing transfers interact with trade flows. We fill this gap. In particular, with the aid of a rich quantitative model and detailed data on within-country trade and financial flows, we uncover important effects of fiscal transfers on trade flows, specialization patterns, gains from trade, and the effect of trade policy. In recipient regions, transfers increase welfare, productivity, and specialization in downstream sectors; the reverse holds in contributor regions. The way in which regions gain from lower trade costs also crucially depend on how fiscal transfers respond.

Before providing further details behind the model, data, and results, let's take a step back and build some intuition. How do trade and transfers interact? Imagine a region in autarky, without any imports or exports. Financial transfers into this region are nothing more than "helicopter money", affecting only nominal variables, not real. Incomes and prices rise proportionally and real incomes are left unchanged. For welfare gains to exist at all, prices must rise less than incomes, and openness to trade will deliver just that. We formalize this more clearly with the aid of a simple model in the Appendix. Of course, this may sound familiar, as it is related to a very old literature linking transfers with real exchange rate movements – known as *The Transfer Problem*.[2] Our substantive focus, however, is distinct from this literature. We also differ by using a modern, quantitative trade model featuring multiple regions, multiple interconnected sectors, and an endogenous fiscal transfer regime, all grounded upon high quality data on transfers and trade. We will discuss the model and data shortly, but first highlight two new dimensions where transfers and trade interact.

First, transfers may affect a region's or an industry's average productivity by changing the set of actively producing firms. Transfers affect incomes and wages, and therefore production costs. With trade, financial inflows will raise wages more than prices, so the lowest productivity firms will shut down and average productivity will therefore rise. This effect – the so-called Ricardian selection effect – is a common feature in international trade research and an important source of gains from trade. Second, fiscal integration also changes the way we think about trade and trade costs. Central government income taxes are levied on nominal, not real, incomes. Changes in one's income has tax implications while changes in prices do not; the source of the gains from

[1] Even without intending equalization, Albouy (2009) shows US federal taxes disproportionately burden areas with above-average incomes and are not compensated for by federal expenditures. For a comprehensive examination of fiscal transfer systems around the world, see Boadway and Shah (2007).

[2] Starting just after World War I, notably with Keynes (1929), later updated by Samuelson (1952, 1954) to include transport costs, and studied for decades later. More recently, see, for example, Lane and Milesi-Ferretti (2004) or Corsetti et al. (2013).

trade therefore matters. Typically, if import costs fall, then so do wages and prices (though prices fall more). If fiscal transfers shift income towards lower wages areas, then a region with falling import costs will gain from trade *and* from increased transfers. On the other hand, if export costs fall, then wages and prices rise (though wages rise more). In this case, a region with falling export costs will gain from trade *but lose* from reduced transfers. We show these effects are quantitatively very important, with large differences between regions and between sectors.

For our quantitative analysis, we build on recent developments in international trade theory and augment a workhorse model to incorporate an empirically reasonable within-country fiscal transfer system. Our model is, at its core, an Eaton and Kortum (2002) trade model with multiple sectors linked through rich input-output relationships as in Caliendo and Parro (2015). On top of this core, we introduce a simple way in which imbalances can be endogenized. Instead of exogenous lump-sum transfers, typical in the trade literature, we presume a federal government adjusts taxation and spending levels across regions in response to changes in average income levels. Essentially, income I_n in each region n is related to factor income w_n such that $I_n \propto w_n^{1+\gamma}$, where $\gamma \leq 0$ governs the strength of fiscal integration. If $\gamma = 0$ there is no integration. If $\gamma < 0$ then income is redistributed from high income regions to low income region. Following Dekle et al. (2007), we also explore the effect of exogenously removing the fiscal transfers we observe in data.

The inter-sectoral linkages will matter a great deal, qualitatively and quantitatively. As some sectors supply inputs to others, shocks to one part of the economy cascade through, and are multiplied by, these linkages. In addition, fiscal transfers will have differential effects across sectors. A region receiving transfers will see an expansion of sectors close to final consumers (the downstream sectors) relative to input suppliers (the upstream sectors). The source of this effect is intuitive. Financial inflows raise a region's household income, increasing their demand for final goods. Wages also increase in these regions, lowering the competitiveness of upstream sectors that do not see the same increased demand as downstream sectors do. The opposite occurs regions with financial outflows. This intuition is identical to Acemoglu et al. (2015), who show demand shocks propagate upstream.

We fit the model to high quality and uniquely detailed data on internal trade and fiscal redistribution between provinces of Canada. Canada provides a unique opportunity to study fiscal integration and trade. Not only is high quality data on both readily available, but federally facilitated financial flows are large and strongly a function of regional income. Poor regions receive very large net transfers – on the order of 10-20% of GDP – and overall transfers are equivalent to roughly 2% of Canada's total GDP. We also have the full matrix of trade flows between provinces for multiple sectors. Properly calibrated, the model closely fits observed trade imbalances and exactly matches observed trade flows. We find $\gamma \approx -0.3$, which implies 10% higher pre-transfer earnings in a province is associated with 7% higher post-transfer income. As for trade costs, we rely on recent evidence from Albrecht and Tombe (2016), who provide a variety of internal trade costs estimates for multiple sectors and each of Canada's provinces. It turns out internal trade costs are high, and have strong asymmetries; that is, export costs are higher in poorer regions (as Waugh, 2010, found between countries). As discussed earlier, these asymmetries matter for the effects of fiscal integration.

We perform a variety of counterfactual simulations with our full model. By simulating a counterfactual move to $\gamma = 0$ from our initial equilibrium, we quantify the effect of fiscal integration in Canada. We find substantial effects, with welfare gains on the order of 15-20% for poor regions and as low as -10% in rich; for productivity, gains are 1-2% for poor and -0.5% for rich. Beyond the aggregate effect, there are important implications for the spatial distribution of economic activity at the sector level. Regions that are net contributors of transfers see their upstream sectors expand while their downstream sectors contract. The opposite holds among regions that are net recipients. Measuring upstreamness as in Antras et al. (2012), we find that over *half* of the variation in upstreamness observed in the data can be accounted for by Canada's system of fiscal integration.

Turning to gains from trade, our model with fiscal integration has quantitatively relevant differences with a standard model. Moving to autarky not only eliminates the gains from trade, but also completely eliminates any effect that fiscal transfers have on welfare or productivity. Without trade, there can be no trade imbalance and therefore no effect of transfers on welfare. In this sense, trade and fiscal integration complement each other. When trade costs change, it crucially matters how. We find that when internal asymmetries are eliminated, the welfare gains are far smaller than the productivity gains for poor regions – roughly half as large as in a standard model. As discussed earlier, lower export costs mean lower nominal wages and therefore smaller fiscal transfers. In general, we show models that ignore between-region financial transfers towards poor regions will overestimate gains from trade for poor regions and underestimate gains for rich regions.

We end our Canadian analysis by looking at bilateral trade deals between provinces. This is a growing trend in Canada to liberalize internal trade. BC, Alberta, and Saskatchewan have established the New West Partnership Agreement, for example, and The Ontario-Quebec Trade and Cooperation Agreement is a similar deal. In the international trade literature, it is well known that bilateral deals can create trade diversion effects that can harm non-members. The same basic logic applies within a country, but we show fiscal integration spreads gains to everyone. We will show all regions experience welfare gains when only certain provinces liberalize trade. Trade diversion effects still exist, and productivity (typically) falls in regions outside the agreement, but their welfare increase as fiscal transfers more than compensate for this loss.

Work on the welfare and productivity consequences of fiscal integration within an economic union is limited, and often uses Canada as a case study. The efficiency effects of equalization payments typically focus on the between-region reallocation of factors (such as worker migration) that such payments induce (Boadway and Flatters, 1982; Watson, 1986). There is also work looking at tax interaction effect, incentives of governments, and other political economy concerns (Dahlby and Wilson, 1994). Instead, we focus on within-region effects on welfare, productivity, and the composition of economic activity. Between regions, we allow only for trade in goods and services, not primary factors of production. This is novel.

Research investigating the magnitude and consequences of within-country trade costs is also a growing area, as new data and methods become available (Cosar and Fajgelbaum, 2012; Atkin and Donaldson, 2013; Allen and Arkolakis, 2014; Agnosteva et al., 2014; Redding, 2015). We contribute little to the literature measuring the internal costs of trade, though in the appendix we demonstrate that trade cost asymmetries are as important within-countries as they are between countries. Following Waugh (2010), we combine trade data with spatial price data to show that poor regions typically face larger costs of exporting than rich regions. Our primary contribution to this literature is to highlight the quantitatively important interactions between internal trade and fiscal integration.

2 Fiscal Integration and Trade Costs Within Canada

We begin our analysis by outlining key features of integration in Canada. We present measures of equalizing transfers between regions, and estimates of the internal trade costs faced by each region and sector. Canada provides a unique setting to jointly examine internal trade and fiscal integration. Not only does detailed trade data exist across provinces and sectors, but federal revenue and expenditures are reported by province. We can therefore precisely measure between province financial transfers facilitated by the federal government. In this section, we present these data and relate fiscal transfers to provincial incomes and trade imbalances. We end the section with a brief review of existing internal trade cost estimates.

2.1 Fiscal Integration

How fiscally integrated are Canadian provinces? The federal government transfers funds between regions in many ways. Most prominently, through a specific system of Equalization Payments, the federal government transfers funds to poorer provincial governments according to a preset formula. The purpose, enshrined in the constitution, is "ensure that provincial governments have sufficient revenues to provide reasonably comparable levels of public services at reasonably comparable levels of taxation" (Subsection 36(2) of the Constitution Act, 1982). The transfers do not end there, however. Federal program spending and transfers to individuals (through the national pension system, for example) may deviate from where federal tax revenue is raised.

Statistics Canada reports federal tax revenues and expenditures by province in two sources. One (CANSIM Table 384-0004) does this for the period 1981-2009 while the other (384-0048) covers 2007-2014. We provide these data in Table 1 as a share of each province's GDP for 2010 (the year of our trade data, to come). We call a *net fiscal transfer* a situation where federal expenditures exceed revenue. An overall federal deficit at the time means net transfers are larger than they would have be with a balanced budget. For our purposes, however, only the relationship between transfers and provincial incomes matters, not their overall level. In any case, fiscal integration is large and transfers almost 2% of Canada's GDP between provinces. For relatively lower income

Table 1: Fiscal Integration in Canada (2010)

	Share of Provincial GDP				
Province	Federal Revenue	Federal Expenditure	Net Transfers	Actual GDP/Capita	Pre-Transfer GDP/Capita
AB	16.8%	9.5%	-7.3%	\$72,349	\$78,075
BC	17.7%	18.0%	0.3%	\$45,929	\$45,779
MB	16.4%	25.6%	9.3%	\$43,662	\$39,965
NB	16.8%	32.6%	15.7%	\$40,121	\$34,664
NL	17.2%	26.1%	8.9%	\$55,721	\$51,186
NS	18.1%	36.3%	18.2%	\$39,115	\$33,105
ON	17.3%	18.6%	1.3%	\$48,039	\$47,431
PE	17.3%	42.1%	24.8%	\$36,858	\$29,543
QC	12.8%	18.5%	5.6%	\$41,383	\$39,428
SK	14.3%	15.3%	1.0%	\$60,269	\$59,702

Summarizes the magnitude and distribution of between-province transfers in Canada. GDP data are from 384-0037 and federal revenue and spending by province are from CANSIM 384-0047. Pre-transfer GDP/capita is $Y_n/(1+t_n)$, where Y_n is actual GDP/capita and t_n is net transfers. We use year 2010 data to match the trade data used later in the paper.

Atlantic provinces, net transfers are sizable. Transfers to Prince Edward Island, Nova Scotia, and New Brunswick, for example, add 24.8%, 18.2%, and 15.7% to their per capita GDP. The result for regional income disparities is also large – the variance of actual log GDP/capita is *half* the variance of pre-transfer GDP/capita.

Why are transfers related to a region's GDP/Capita? Most transfers are not explicitly designed to equalize incomes but do so nonetheless. Consider federal tax revenue. Regions with higher employment rates or with disproportionately more high-income households will tend to pay more federal personal income taxes. On the spending side, regions with greater employment and higher incomes will also see lower federal spending on employment insurance payments. To examine this more rigorously, we decompose inter-provincial transfers into eight components and report key metrics in Table 2. We measure transfers as half the absolute value of deviations from average per-capita values; that is, $T^j = \frac{1}{2}\sum_{i=1}^{N} P_i|c_i^j - \bar{c}^j|$, where c_i^j are per-capita values in province i for component j and $\bar{c}^j$ is the national average. As components interact, with some offsetting others depend on the order in which they are introduced, we also report the average marginal contribution of each across all permutations of components (that is, their Shapley values).

The bulk of fiscal transfers are in components that are sensitive to a province's GDP/capita. Over 40% of all transfers are from personal and corporate income taxes alone. Add to those explicit transfer programs from the federal government, along with GST payments and net EI contributions, and roughly three-quarters of transfers automatically respond to economic conditions. To show this more clearly, we report their correlation to GDP per capita in the last column. All are intuitive. Higher income regions disproportionately contribute to federal revenue through higher personal and corporate income taxes, and greater EI and CPP payments relative to their receipts. Government-to-government transfers are also negatively related to income, this is especially so

Table 2: Fiscal Integration in Canada, by Component (2010)

Component	*Transfers (% of GDP)* Raw Data	Shapley Values	Share of Transfers	Correlation with GDP/Capita
Taxes from Households	0.57%	0.49%	29.2%	0.86
Equalization and Other Transfers	0.48%	0.36%	21.7%	-0.37
Taxes from Corporations	0.35%	0.23%	14.0%	0.95
OAS Receipts	0.12%	0.10%	5.7%	-0.63
EI Payments less Receipts	0.13%	0.09%	5.4%	0.31
CPP/QPP Payments less Receipts	0.13%	0.08%	4.8%	0.74
GST Revenue	0.07%	0.06%	3.5%	0.75
Other Revenue and Spending Items	0.52%	0.26%	15.7%	0.72

Decomposes the aggregate between-province transfers by component. Transfers here are defined as half the absolute value of deviations from average per-capita values; that is, $T^j = \frac{1}{2}\sum_{i=1}^{N} P_i|c_i^j - \bar{c}^j|$, where c_i^j are per-capita values in province i for component j, and $\bar{c}^j$ is the national average. As components interact, with some offsetting others, we report the average marginal contribution of each across all permutations of components (that is, their Shapley values) in column two. Column three is the share of total transfers accounted for by these adjusted transfer values. Column four report the correlation coefficient of $(t_i^j - \bar{t}^j)$ with a province's GDP per capita.

given the Equalization Program which accounts for much of these transfers. To be sure, not all components may be related to a region's economic conditions. Other revenue and spending items (the last row) include large expenditures in Ontario and Nova Scotia in particular. The former is where the capital is located, and the latter hosts the headquarters of Canada's Atlantic Fleet. Items such as these aside, it is clear that a large majority of inter-provincial transfers respond to underlying economic conditions in a province.

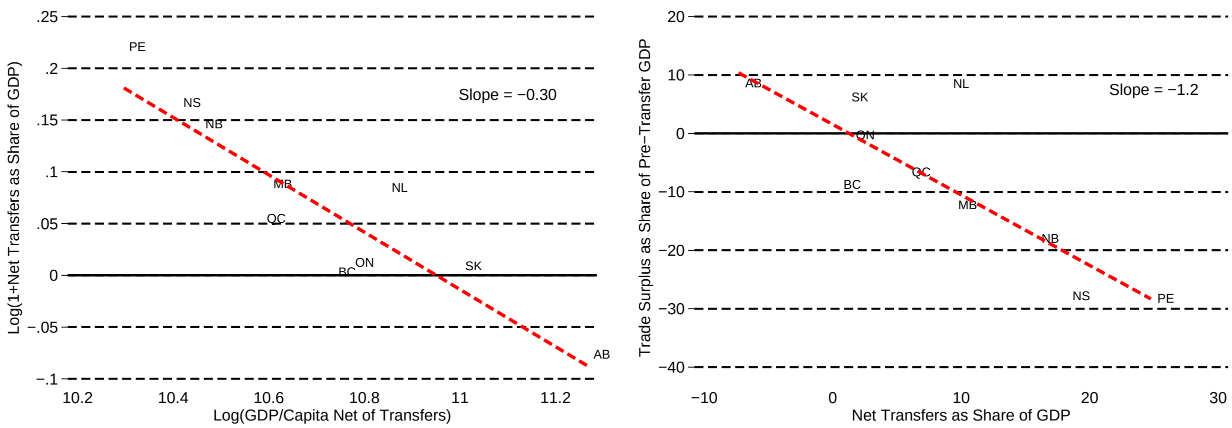
Returning to aggregate transfers, how can we model such transfers? Consider fiscal integration as a tax (or subsidy) to income. Specifically, let income be $I_n = w_n t_n$, where pre-transfer income is w_n and the adjustment due to fiscal transfers is t_n. If for a particular province $t_n = 1$, then there is no net transfer while if $t_n < 1$ income is lowered. It is straightforward to infer t_n for each province from the data. For example, from Table 1 shows Alberta's average per capita GDP is \$72,349, absent fiscal transfers it would have been \$78,075, and therefore $t_{AB} = 0.93$.

With the systematic relationship between transfers and GDP/capita in mind, consider the case where $t_n \propto w_n^{\gamma}$, where γ governs the strength of transfers. If $\gamma = 0$ then every province's post-transfer income equals its pre-transfer income. With the data in Table 1 we estimate γ with a simple regression of log transfer rates on log pre-transfer earnings. We plot this relationship in Panel (a) of Figure 1, which illustrates a precisely estimated $\gamma = -0.3$, with standard error of 0.05, provides a very good fit of the data. Intuitively, 10% higher pre-transfer earnings for a province is associated with 7% higher post-transfer income. We rely on this relationship to quantify the effect of fiscal integration in the model to come.

Fiscal integration also affect trade flows. In fact, within-country fiscal transfers can be thought of as capital account transactions. A province's current account – its export and import flows –

Figure 1: Fiscal Transfers, Income, and Trade Patterns

(a) Provincial GDP/Capita (b) Trade Imbalances



Panel (a) displays the relationship between provincial GDP/capita (net of transfers) and the net transfer share of GDP. Relatively poor regions receive larger net inflows. The implied elasticity of the transfer rate with respect to pre-transfer income is -0.3 (std. err. of 0.05). Panel (b) displays the relationship between net fiscal transfers and each trade imbalances. Relatively poor regions receive larger net inflows and this funds trade deficits. The slope of the relationship is -1.2 (std. err. of 0.28). All data is for year 2010.

are therefore affected if payments are to balance. In the theory to come, it is straightforward to show $t_n - 1 = -S_n/w_nL_n$, where S_n is region n's total trade surplus. This region's total net fiscal transfer is $(t_n - 1)w_nL_n$ and so $(t_n - 1)w_nL_n = -S_n$. The transfers therefore completely account for any trade deficit. In Panel (b) of Figure 1, we plot provincial trade deficits from the data as a share of pre-transfer GDP against net transfer rates $t_n - 1$. We cannot reject that the the slope of this relationship is -1, as our model implies. Provinces that "pay into" fiscal transfers tend to run trade surpluses while provinces that receive net inflows have trade deficits.

Trade deficits are actually a key source of welfare gains from fiscal transfers. Consider an economy in autarky (no trade). Financial transfers into this economy are nothing more than "helicopter money". The general equilibrium effect of financial inflows is to raise incomes and prices in tandem. The resulting change in real income is zero. Only trade allows the additional income be spent on production from outside the province, which dampens the price effect of the inflows. To further reinforce this intuition, we present a simple Armington model of trade with fiscal transfers in the appendix.

Another effect of fiscal transfers is on productivity. With trade, a financial inflow will raise wages more than prices. This raises costs and leads buyers to source more of their purchases from producers in other regions. These imports substitute for the lowest productivity firms, who will therefore exit. With fewer low productivity firms, average productivity in the region increases. This is known as the Ricardian selection effect and it plays a key role in many quantitative trade models. By how much productivity changes depends crucially on how trade flows respond. This will be clear in the full model to come, but first we provide some evidence of the magnitude of Canada's internal trade costs.

2.2 Internal Trade Costs

How integrated are Canada's product markets? Barriers to internal trade rarely take the form of explicit taxes or tariffs. Although examples exist – the Octroi in Ethiopia or the Local Body Tax in various Indian municipalities – barriers are typically non-tariff and, therefore, difficult to quantify. Consider sales taxes levied on goods purchased from another state without an offset for sales taxes paid in that other state, taxation of nonresident commercial vehicles, discriminatory liquor laws, local government procurement procedures that favour local suppliers, or restrictions on professional certifications. For Canada, Beaulieu et al. (2003) provides an anecdotal review of a wide variety of inter-provincial trade barriers, covering province-specific occupational licenses, home-biased government procurement, or local marketing boards for agricultural goods.

These examples are illustrative. For our quantitative analysis to come, we use recent and systematic evidence on the magnitude of internal trade costs in Canada from Albrecht and Tombe (2016). We reprint their main results in Table 3. The data we use is the same as in their setting and while our models differ slightly, fiscal transfers do not affect the trade cost estimates. We leave the precise details to their paper, and our supplementary analysis in the appendix, and discuss here only the broad interpretation of their various measures.

The first column of Table 3 reports a summary measure of overall trade costs in Canada based on what is known as a Head-Ries Index. It estimates the average trade cost between two regions, regardless of the direction of trade, relative to the cost of trading within each region (say, between cities). Overall, this measure finds average internal trade costs of nearly 68% in Canada, with larger costs in poor regions and substantial variation across sectors. This measure is symmetric, in the sense that it does not distinguish trade costs facing goods moving from Ontario to Quebec, say, with trade costs for goods moving from Quebec to Ontario. Waugh (2010) demonstrates that between countries, there are country-specific costs of exporting. That is, for symmetric costs are t^j_{ni} and export costs t^j_i, the actual cost of importing into region n from region i is $\tau^j_{ni} = t^j_{ni} t^j_i$. In the appendix, we show this form of trade cost asymmetry is also a key feature of internal trade costs in Canada. The second column of Table 3 reports the average values of t^j_i. As with international trade costs, we find poor regions tend to have higher export costs than rich regions. This fact will matter when we explore the gains from lower trade costs in the presence of fiscal transfers.[3]

The third and fourth columns of Table 3 report two policy-relevant measures of trade costs that will be key for our quantitative exercises to come. First, the contribution of asymmetric trade costs estimates by how much trade costs would fall if all asymmetries were removed. Intuitively, consider this exercise as the effect of harmonizing regulations across provinces. With no regulatory differences, trade costs shouldn't differ when moving from Alberta to BC versus BC to Alberta. The fourth column considers distance as the only relevant non-policy trade costs. It is costly to ship goods across space. To remove the effect of distance, regress of total trade costs on distance between provinces and take the residuals. The fourth column reports these non-distance costs.

[3] In the Appendix, we provide a simple model to illustrate how trade cost asymmetries and fiscal transfers interact.

Table 3: Average Trade Costs Within Canada

(a) By Exporting Province

	Relative Symmetric Costs	Exporter-Specific Trade Costs t_i^j	Contribution of Asymmetric Trade Costs	Contribution of Non-Distance Trade Costs
Alberta	56.1%	-15.5%	4.1%	7.2%
British Columbia	78.5%	-11.4%	6.0%	10.5%
Manitoba	74.0%	-4.8%	11.9%	9.8%
New Brunswick	66.4%	7.3%	16.4%	24.4%
Newfoundland	47.4%	-6.8%	14.4%	3.2%
Nova Scotia	85.4%	14.3%	19.0%	31.5%
Ontario	73.5%	-15.8%	1.3%	17.1%
Prince Edward Island	106.1%	22.2%	30.3%	32.1%
Quebec	62.5%	-1.4%	13.4%	17.4%
Saskatchewan	62.8%	11.9%	34.1%	14.3%
Canada	67.8%	0.0%	7.8%	14.5%

(b) By Industry

	Relative Symmetric Costs	Exporter-Specific Trade Costs t_i^j	Contribution of Asymmetric Trade Costs	Contribution of Non-Distance Trade Costs
Agriculture, Mining	24.4%	-25.7%	6.3%	-8.3%
Food, Textiles	42.0%	-21.0%	5.8%	-4.4%
Wood	24.9%	-14.4%	2.1%	3.6%
Paper	25.7%	-17.8%	3.4%	0.6%
Chemicals, Rubber	12.5%	-16.7%	1.9%	1.6%
Metals	63.2%	-2.8%	9.8%	11.8%
Equipment, Vehicles	37.4%	-17.0%	4.3%	3.1%
Manufacturing, n.e.c.	60.2%	-9.5%	4.8%	9.2%
Utilities	–	–	–	–
Construction	–	–	–	–
Wholesale and Retail	101.9%	-14.8%	6.6%	14.8%
Hotels and Restaurants	97.0%	3.4%	9.8%	29.4%
Transport	83.5%	-8.6%	10.8%	16.9%
Communication	84.8%	19.6%	12.2%	55.3%
Finance	91.7%	-5.0%	12.4%	36.2%
Real Estate	192.4%	8.4%	12.1%	57.8%
Software	132.3%	18.4%	19.7%	54.6%
Other Business Services	90.6%	-7.4%	8.1%	18.7%
Public Admin.	–	–	–	–
Education	230.0%	66.5%	15.5%	105.3%
Health and Social	245.8%	40.1%	16.7%	82.8%
Other Services	134.0%	17.1%	10.7%	44.5%

Reports trade cost measures found by Albrecht and Tombe (2016). Details are in section 2.2, and the appendix.

3 A Model of Internal Trade, Migration, and Taxes

To fully quantify the consequences of fiscal integration in Canada, and examine how it interacts with internal trade costs, we require a model. In this section, we build on a recent multi-sector model of trade featuring realistic input-output relationships - specifically, the model of Caliendo and Parro (2015). We adjust the model in two ways. First, we explicitly distinguish internal from international trade flows. Second, a central government taxes and spends differentially across provinces in such as way as to mitigate income differences. The latter component of the model is original to this paper. The core trade components of the model are standard.

3.1 The Core Components of the Model

There are $1 + N$ regions, $N = 10$ provinces of Canada plus the rest of the world aggregated as one entity. Each region is endowed with L_n workers, who are immobile between regions but perfectly mobile between sectors. All labour and product markets are perfectly competitive.

There are J sectors each producing a composite non-tradable final good using a CES technology

$$Y_n^j = \left(\int_0^1 y_n^j(\omega)^{\frac{\sigma^j - 1}{\sigma^j}} d\omega \right)^{\frac{\sigma^j}{\sigma^j - 1}}, \tag{1}$$

where $y_n^j(\omega)$ are individual product varieties and σ^j is the elasticity of substitution within sector j. The final good is either consumed or used as an intermediate input within region n. On the consumption side, households derive utility from these final goods through

$$U_n = \prod_{j=1}^{J} \left(C_n^j \right)^{\beta^j}, \tag{2}$$

where C_n^j is the amount of the sector j good consumed out of Y_n^j. Households earn income from inelastically supplying labour to each sector, earning a wage w_n. A government may supplement this income through inter-provincial fiscal transferred (described later).

Goods not consumed are used as intermediates by producers of individual product varieties within region n. There is a continuum of individual product varieties within each sector, produced with labour and material inputs. Production technologies are identical within a sector but for differences in total factor productivity. Across sectors, the importance of various inputs can differ. With wages w_n and the price of sector j goods P_n^j, the cost of an input bundle is

$$c_n^j \quad \propto \quad w_n^{\phi^j} \prod_{k=1}^{J} \left(P_n^k \right)^{\gamma^{jk}\left(1-\phi^j\right)}, \tag{3}$$

where ϕ^j is labour's share and γ^{jk} is the share of intermediates purchased by sector j from sector k. A producer with productivity φ will therefore have marginal costs c_n^j / φ.

Final goods producers will source each product variety from the lowest cost source, either at home or from another region. Products shipped between regions incur an iceberg trade cost $\tau_{ni}^j \geq 1$, where τ_{ni}^j goods must be shipped from region i in order for one unit to arrive at region n. The resulting price paid by buyers in region n for a product from region i with productivity φ will therefore be $\tau_{ni}^j c_n^j / \varphi$. If productivity across products within each sector is identically and independently distributed Frechet, with CDF $F_n^j(\varphi) = e^{-T_n^j \varphi^{-\theta^j}}$, then a well known result in Eaton-Kortum models is that the share of region n's total spending on goods from region i in sector j is

$$\pi_{ni}^j = \frac{\left(\tau_{ni}^j c_i^j / A_i^j\right)^{-\theta^j}}{\sum_{k=1}^{N+1} \left(\tau_{nk}^j c_k^j / A_k^j\right)^{-\theta^j}}, \tag{4}$$

and the sector j price index in region n is

$$P_n^j \propto \left[\sum_{i=1}^{N+1} \left(\tau_{ni}^j c_i^j / A_i^j\right)^{-\theta^j}\right]^{-1/\theta^j}. \tag{5}$$

The proportionality constant in the price index is completely irrelevant for our purposes. Given sectoral price P_n^j for each sector, the overall price index for region n is

$$P_n = \prod_{j=1}^{J} \left(P_n^j\right)^{\beta^j}.$$

Finally, a central government taxes and spends in each region proportionally to income such that $I_n = w_n L_n t_n$. The following proposition establishes the precise form for the fiscal adjustment term t_n such that the central government budget balances.

Proposition 1 *With a constant elasticity $1 + \gamma$ of after-transfer income I_n with respect to pre-transfer income $w_n L_n$, the balanced-budget fiscal adjustment term is given by*

$$t_n = (w_n / \bar{w})^{\gamma} \tag{6}$$

where $\bar{w} = \left[\sum_{n=1}^{N} \left(\frac{w_n L_n}{\sum_{n=1}^{N} w_n L_n}\right) w_n^{\gamma}\right]^{1/\gamma}$ is the weighted power mean of wages.

Proof: See appendix.

The parameter γ governs the strength of fiscal equalization across regions. There is no international fiscal transfers, so $t_{1+N} = 1$ always holds. Notice if $\gamma = 0$ there is no fiscal equalization and $t_n = 1$ for all regions. As the strength of fiscal equalization increases, $\gamma < 0$ becomes more negative. If $\gamma = -1$ then all differences in post-transfer per worker income are eliminated. Specifically, $I_n = \bar{w}^H L_n$, where $\bar{w}^H$ is the harmonic mean of wages across regions in Canada.

3.2 A Useful Method to Solve and Simulate the Model

To solve the model, it is helpful conceptually (and especially computationally) to build on the long history of input-output economics. Inter-Country Input-Output models are particularly useful, with a long history starting with Isard (1951) and more recently Koopman et al. (2014). Following these models, the following proposition provides a simple way to solve equilibrium wages, given trade shares.

Proposition 2 *Given trade shares π^j_{ni}, the equilibrium revenue of all sectors in all regions solves*

$$\mathbf{R} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{F}, \tag{7}$$

where $\mathbf{R}$ is the $NJ \times 1$ vector of sectoral revenue. It stacks the $J \times 1$ vectors $\mathbf{R_n}$ with elements R^j_n.

The matrix $\mathbf{A}$ is the $NJ \times NJ$ global input coefficient matrix

$$\mathbf{A} = \begin{bmatrix} \mathbf{A_{11}} & \cdots & \mathbf{A_{N1}} \\ \vdots & \ddots & \vdots \\ \mathbf{A_{1N}} & \cdots & \mathbf{A_{NN}} \end{bmatrix}, \tag{8}$$

with elements $\mathbf{A_{ni}}$ as the $J \times J$ input coefficient matrix, with elements $\gamma^{kj}(1-\phi^k)\pi^j_{ni}$ for the j^{th} row and k^{th} column. The vector $\mathbf{F}$ the $NJ \times 1$ vector of final demands with elements $\sum_i \alpha^j I_i \pi^j_{in}$ for the row indexed $j + J \times (n-1)$. That is, $\mathbf{F}$ simply stacks the $J \times 1$ vectors $\mathbf{F_n}$ with elements $\sum_i \alpha^j I_i \pi^j_{in}$.

Proof: See appendix.

Equation 7 is a familiar expression in any Input-Output model. The key difference is that the in our setup, the input coefficients are endogenous and solved in full general equilibrium. They react to changes in productivity, trade costs, input prices, or fiscal transfers. Importantly, proposition 2 allows us to solve for equilibrium wages as a function of trade shares. The vector $\mathbf{F}$ represents the global spending on final goods from each region and sector. It depends only on wages and trade shares.[4] The matrix of global input coefficients matrix $\mathbf{A}$ depends only on trade shares. Finally, a vector of sales $\mathbf{R}$ implies wages in each region, since $w_n = \sum_j \phi^j R^j_n / L_n$. All together, this is a system of equations that solves N equilibrium wages given trade shares π^j_{ni}.

If our goal was to estimate equilibrium wages and incomes consistent with observed trade shares from data, we would be done (and we would have learned little). Instead, our goal is to estimate counterfactual responses to policy changes – namely, fiscal transfers or changes in trade costs. Conveniently, there is a simple yet powerful method to solve these counterfactual responses. It is known as the Exact-Hat Algebra approach of Dekle et al. (2007). Specifically, consider moving from an initial equilibrium consistent with data to a new counterfactual equilibrium. Denote the

[4] With wages, we know income from $I_n = w_n L_n t_n$ and t_n is from equation 6 and depends only on wages, so the vector of final demand depends only on wages.

equilibrium change in all variables as $\hat{x} = x'/x$, we can write the changes in equations 3 to 5 as

$$\hat{c}_n^j = \hat{w}_n^{\phi^j} \prod_{k=1}^{J} \left(\hat{P}_n^k\right)^{\gamma^{jk}\left(1-\phi^j\right)}, \tag{9}$$

$$\hat{\pi}_{ni}^j = \left(\hat{\tau}_{ni}^j \hat{c}_i^j / \hat{P}_n^j\right)^{-\theta^j}, \tag{10}$$

$$\hat{P}_n^j = \left[\sum_{i=1}^{N+1} \pi_{ni}^j \left(\hat{\tau}_{ni}^j \hat{c}_i^j\right)^{-\theta^j}\right]^{-1/\theta^j}. \tag{11}$$

Equations 9 to 11 define a system $\hat{\boldsymbol{\pi}} = f\left(\hat{\mathbf{w}}; \hat{\boldsymbol{\tau}}\right)$, which maps wage changes, given trade cost changes, to trade share changes. With counterfactual trade shares ${\pi_{ni}^j}' = \pi_{ni}^j \hat{\pi}_{ni}^j$, proposition 2 gives counterfactual sales and wages. The equilibrium wage changes solve this system, taking the initial trade shares π_{ni}^j as given. So, with proposition 2 together with equations 9 to 11 we can solve the equilibrium response to any change to trade costs (τ_{ni}^j) or fiscal integration (γ), all from an initial equilibrium that exactly matches trade data.

3.3 Changes in Welfare and Productivity

Our key outcomes of interest are welfare and productivity for all regions and sectors. For a given sector, real value-added is simply total value-added divided by the price index $w_n L_n^j / P_n^j$, so labour productivity (real value-added per worker) is simply w_n / P_n^j. For aggregate labour productivity, we look at overall real wages w_n / P_n in region n. This is simply a region's total value-added per worker $\sum_{j=1}^{n} w_n L_n^j / L_n = w_n$ deflated by the aggregate price index P_n. Finally, welfare from equation 2 is the real income per worker $I_n / L_n P_n$. As $I_n = w_n L_n t_n$, welfare is $w_n t_n / P_n$ with the fiscal adjustment term t_n given in Proposition 1.

Proposition 2 of Albrecht and Tombe (2016) provides a convenient and compact expression for equilibrium real wage changes. We do not reproduce the proof here, but the intuition is straightforward. In a standard Eaton-Kortum model without input-output relationships, (log) real wage changes depend on changes in the home share of spending $\hat{\pi}_{nn}^j$. Specifically, equation 10 with $\phi^j = 1$ for all j implies $log(\hat{w}_n / \hat{P}_n^j) = -log(\hat{\pi}_{nn}^j)/\theta^j$. Collect these changes into a $J \times N$ matrix $\mathbf{G}$. With input-output relationships, we can simply transform $\mathbf{G}$ according to

$$\tilde{\mathbf{G}} = (\mathbf{I} - \tilde{\mathbf{A}}')^{-1}\mathbf{G},$$

where $(\mathbf{I} - \tilde{\mathbf{A}})^{-1}$ is the $J \times J$ Leontief Inverse Matrix, where the input matrix $\tilde{\mathbf{A}}$ has elements $\gamma^{kj}(1 - \phi^k)$.[5] The matrix $\tilde{\mathbf{G}}$ is the $J \times N$ matrix of equilibrium real wage changes for all sectors given $\hat{\pi}_{nn}^j$. Next, with a slight abuse of notation, collect aggregate real wages into a vector $\hat{\mathbf{y}}$ with elements $\hat{w}_n / \hat{P}_n$. This is simply

$$\hat{\mathbf{y}} = \mathbf{G}'(\mathbf{I} - \tilde{\mathbf{A}})^{-1}\boldsymbol{\beta},$$

[5] The tilde distinguishes this matrix from the *global* input coefficient matrix $\mathbf{A}$ defined earlier.

where $\boldsymbol{\beta}$ is a $J \times 1$ vector with elements β^j. With these aggregate real wage changes, the welfare of a worker in region n is

$$\hat{U}_n = \left(\hat{w}_n / \hat{P}_n\right) \times \hat{t}_n,$$

or in vector form $\hat{\mathbf{U}} = \hat{\mathbf{y}} \otimes \hat{\mathbf{t}}$.

What do these expressions mean in plain language? The vector $J \times 1$ vector $(\mathbf{I} - \tilde{\mathbf{A}})^{-1}\boldsymbol{\beta}$ is a very straightforward measure of a sectors "influence" on an economy. A sector may be extremely valuable as an input supplier to many other sectors, so productivity shocks in that sector cascade throughout the economy. Recent research by Acemoglu et al. (2012), Jones (2013), and Carvalho and Gabaix (2013) all show in closed-economy settings that this vector collects the elasticities of aggregate output with respect to sectoral productivity. In our setting, this vector represents by how much standard gains from trade $\mathbf{G}$ are amplified by input-output linkages. We refer to $(\mathbf{I} - \tilde{\mathbf{A}})^{-1}\boldsymbol{\beta}$ as the vector of *Input-Output Multipliers*, though they should not be confused with multipliers from classic input-output analysis. The linkages are very important for our quantitative results, and also for our qualitative results regarding the distribution of economic activity across sectors and regions.

3.4 Calibrating the Model

To perform our quantitative analysis, we must calibrate parameters $(\gamma, \pi^j_{ni}, \beta^j, \phi^j, \gamma^{jk}, \theta^j)$. Most model parameters have readily available counterparts in data. Earlier, we calibrated the strength of fiscal transfers to $\gamma = -0.3$. For trade shares π^j_{ni}, we use CANSIM Table 386-0003, which provides internal and international trade, production, and expenditure data for each of Canada's provinces and for a variety of commodities. We use the 2010 data. We map commodities in the trade and production data to ISIC Rev. 3 industry categories and aggregate these sectors to 22 for which positive production exists in all provinces. It is straightforward to calculate π^j_{ni} as the ratio of trade flows in sector j from region i to region n relative to region n's total spending for sector j goods. For production and preference parameters ϕ^j and β^j, we turn to the OECD structural analysis database. The value-added to output ratio of each sector is ϕ^j and the share of final demand shares allocated to each sector is β^j. We report ISIC codes, value-added to output ratios, final demand shares, and other industry characteristics in the Appendix. The inter-sectoral input shares γ^{jk} are also from the OECD STAN, though we do not report them individually.

What remains are the Frechet parameters θ^j. From equation 4, these are also the cost-elasticity of trade flows. Countless papers estimate these elasticities (Head and Mayer, 2014), though there are no within-country sector-specific estimates that we are aware of. Between countries, however, Caliendo and Parro (2015) estimate elasticities at a similar level of aggregate. As their model is the base upon which ours is build, we adopt their estimates. Sectors for which they do not have estimates, we follow Costinot and Rodriguez-Clare (2014) and set $\theta^j = 5$. We report all elasticities along with the other industry-specific parameters in the Appendix.

4 Quantitative Exercises

With the full model now established, we proceed to our quantitative experiments where we change either fiscal integration (through the parameter γ) or trade costs (through $\hat{\tau}^j_{ni}$). We begin with a simple experiment to gauge the effect of current fiscal transfers. We then examine how the presence of fiscal transfers changes the gains from trade across regions. Overall, we find fiscal transfers can have large welfare and productivity effects. Fiscal transfers also dramatically increase the welfare benefits of trade for poor regions, while shrinking gains from trade in rich. We end our quantitative analysis by looking at policy, both trade and fiscal integration policy. Importantly, we use the model to illustrate the potential effects of increasing the level of fiscal integration in the Eurozone – a policy discussion that is increasingly relevant.

4.1 Gains from Fiscal Transfers

How valuable is Canada's inter-provincial transfer system? To answer this question, we simulate moving from the initial equilibrium to one where there are no fiscal transfers. We do this in two ways. First, we move from $\gamma = 0.3$ to $\gamma' = 0$. This corresponds to quantifying the effect of our simplified representation of Canada's system of fiscal integration. Second, we quantify the effect of the actual observed fiscal transfers by moving from an initial equilibrium where trade imbalances exogenously match observed transfers, which we then set to zero. This is similar to Dekle et al. (2007)'s analysis between countries. In both experiments, we hold trade costs unchanged, so $\hat{\tau}^j_{ni} = 1$ for all (n, i, j). The resulting welfare changes $\hat{U}_n$ and productivity changes $\hat{w}_n/\hat{P}_n$ in each region tell us the effect of fiscal transfers. We refer to $\hat{U}^{-1}$ as the welfare gains from fiscal transfers and $(\hat{w}_n/\hat{P}_n)^{-1}$ as the productivity gains.

Let's start with the first experiment. We find fiscal transfers have large effects. Our main estimates are in the first two columns of Table 4. The welfare gains in poor regions are sizable and the welfare loses in rich regions are equally so. This fits our earlier intuition well. Trade deficits are the source of welfare gains, and recipient provinces have large deficits and contributor provinces have large surpluses. Our framework is particularly useful to quantify the productivity effect of fiscal transfers. Poor regions experience over 1% increase in their aggregate productivity and rich regions lose roughly -0.5%. We are unaware of any other estimates of the productivity implications of inter-provincial transfers. While small relative to the welfare gains, they aren't trivial effects. They're equivalent to gains of \$430 per person in Nova Scotia or nearly \$630 in PEI and loses in Alberta of over \$360 per person. Nationally, we aggregate across provinces and find real GDP actually rises by roughly 0.05% (~\$1 billion).

What is the source of productivity gains? First, financial inflows increase wages in the receiving provinces. This raises production costs and consequently lowers the competitiveness of domestic producers, on average. The share of products purchased within the province falls, which implies a smaller home share π^j_{nn}. This increases productivity – after all, it's the lowest productivity producers that shut down. This is the standard Ricardian effect of trade. Second, inter-

Table 4: Gains from Trade and Fiscal Transfers

Region	GDP/Capita	Endogenous Transfers		Observed Transfers		Gains from Trade	
		Welfare	Productivity	Welfare	Productivity	Welfare	Productivity
AB	$72,349	-10.1%	-0.5%	-9.0%	-0.5%	6.9%	18.3%
BC	$45,929	6.1%	0.4%	-1.9%	-0.2%	28.3%	21.4%
MB	$43,662	7.6%	0.5%	8.5%	0.6%	33.0%	24.2%
NB	$40,121	5.8%	0.3%	17.1%	1.0%	49.4%	41.7%
NL	$55,721	-3.4%	-0.3%	7.5%	0.1%	44.8%	49.4%
NS	$39,115	16.2%	1.1%	20.7%	1.6%	42.0%	23.5%
ON	$48,039	-0.8%	-0.1%	-0.9%	-0.1%	12.7%	13.5%
PE	$36,858	23.4%	1.7%	32.8%	1.6%	60.8%	32.5%
QC	$41,383	5.2%	0.4%	4.5%	0.3%	21.8%	16.2%
SK	$60,269	-7.2%	-0.4%	-0.8%	0.0%	20.1%	29.0%

Displays the effect of fiscal transfers on productivity and welfare in each region. The counterfactual involves shutting down fiscal transfers and reporting the ratio of initial productivity and welfare to the counterfactual GDP and welfare. The gains from trade columns display the effect of moving all provinces to autarky. The overall welfare gains equal the combined change in productivity and the direct fiscal effects.

sectoral linkages amplify the effect of changes in home shares through the input-output multipliers $(\mathbf{I} - \tilde{\mathbf{A}})^{-1}\boldsymbol{\beta}$. We illustrate by how much these multipliers matter for productivity changes in Figure 2. Input-output linkages account for roughly two-thirds of the overall productivity changes.

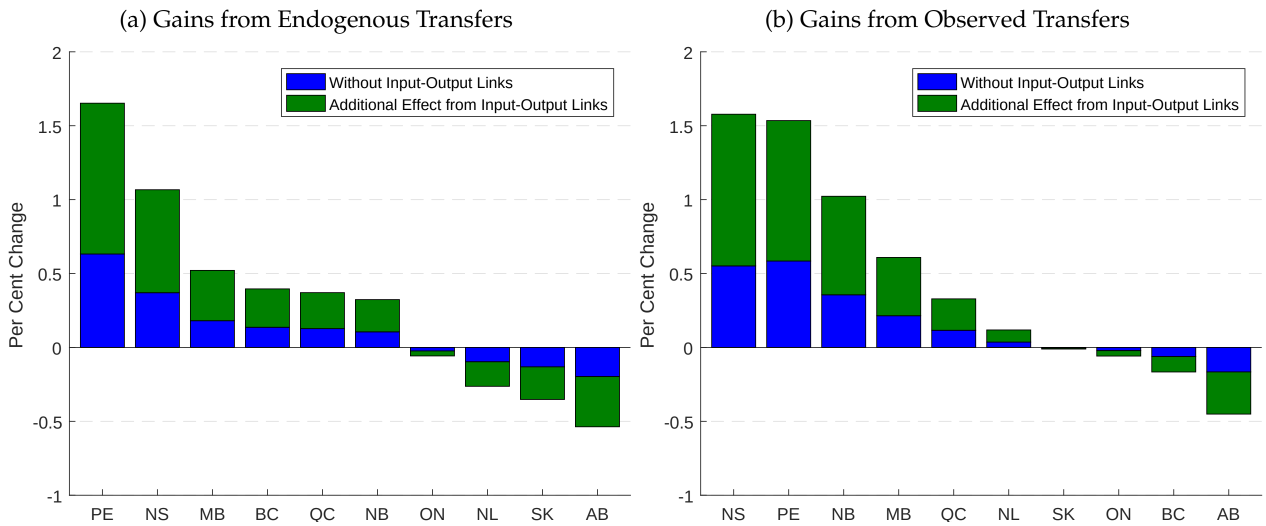
Turning now to our second experiment, where we quantify the effect of Canada's observed between-region fiscal transfers. This requires the model be slightly adjusted. Instead of modeling transfers as in Proposition 1, we simply set trade imbalances S_n to exogenous match observed fiscal transfers. Equilibrium income is then initially $I_n = w_n L_n + S_n$. Little else changes. It helps to recall Figure 1. This second experiment involves exogenously shutting down observed (actual) transfers. Any imbalances unrelated to transfers (see panel (b) of that figure) remain in the counterfactual equilibrium as S'_n. We report the results in the third and four columns of Table 4.

The results of the two experiments are largely similar, though there are certain important differences. As BC receives less net transfers than we would expect based solely on its GDP per capita, the second experiment shows this provinces' welfare and productivity are lower as a result of Canada's fiscal integration. For the Maritime provinces and Newfoundland, the reverse is true: their gains are higher than our results based on endogenous transfers suggested. Overall, while these results are our preferred estimates of the gains from Canada's system of fiscal integration, we rely on the endogenous transfers in what follows. Many of our quantitative exercises require we estimate counterfactual transfers, so endogenizing them with Proposition 1 is critical.

4.2 Gains from Trade

We turn next to the gains from trade in the presence of fiscal transfers. That is, holding $\gamma = 0.3$ fixed at its initial value, we move all provinces to autarky. We do this by simulating $\hat{\tau}^j_{ni} \to \infty$ for

Figure 2: Productivity Gains from Fiscal Integration in Canada



Displays the change in welfare and aggregate productivity of each region resulting from Canada's internal fiscal transfers. Panel (a) shows effect of the endogenous transfers implied by the approximation in Proposition 1. Panel (b) shows the observed transfers in data described in Section 2.

all trading pairs $n \neq i$ and sectors j. Comparing counterfactual welfare and productivity to the initial equilibrium then reveals the gains associated with the observed level of inter-provincial and international trade. These results are in the last two columns of Table 4. The productivity gains in the last column are identical to the welfare gains in a model without fiscal transfers. Notice however that the welfare gains are often substantially higher. For provinces receiving transfers, welfare gains exceed productivity gains and sometimes by a wide margin. In a model without fiscal transfers, the productivity gains listed *are* the welfare gains. So, fiscal transfers amplify the welfare gains from trade for relative poor regions and dampen the gains for rich regions.

How? Moving to autarky not only eliminates the gains from trade, but also completely eliminates any effect that fiscal transfers have on welfare or productivity. Without trade, there can be no trade imbalance and therefore no scope for net financial inflows to raise welfare. In this sense, trade and fiscal integration complement each other. For rich regions, the opposite is the case. The trade surpluses induced by net financial outflows lower welfare. Moving to autarky eliminates these surpluses, so what these regions lose from moving to autarky they gain from eliminating the negative effect of financial outflows, thus dampening the welfare effects of trade.

4.3 Effect of Fiscal Transfers on Within-Province Industrial Structure

Not only are there aggregate gains or loses from fiscal transfers, but there are also important within-province effects. The relative size of different sectors responds to fiscal transfers. How? Fiscal transfers change a province's level of household income. If income rises, then demand will rise disproportionately for final goods. Sectors that produce goods mainly for final consumption will expand, bidding up wages. This will lead sectors producing mainly intermediate inputs to shrink. Their costs are rising but they are not experiencing as large an increase in demand. The reverse will hold in provinces whose incomes decline due to fiscal transfers. To investigate this formally, we must define a notion of how far a sector is from final consumers. Sectors that are "far" from final consumers are "upstream" sectors.

How can we measure upstreamness? Let's start with the classic notion of forward linkages. Consider a matrix $\tilde{\mathbf{B}}$ collecting the share of each sector's output going to each other sector as inputs.[6] That is, the element in the i^{th} row and j^{th} column is the share of sector i's output used by sector j as inputs. The row-sum of this matrix is a measure of each sector's direct forward linkages. There are also indirect forward linkages, as supplying inputs to sector j is indirectly supplying inputs to any sector supplied by sector j. It turns out, including all these along with the direct forward linkages is the row-sum the so-called Ghosh Inverse Matrix $(\mathbf{I}-\tilde{\mathbf{B}})^{-1}$. Sectors with many forward linkages are then considered upstream.

This forward linkage measure has a very long history, though more recently Fally (2012) develops another measure of a sector's "distance" to final consumers. If a sector sells output to relatively upstream sectors, then Fally (2012) posits that this sector is also upstream. He defines upstreamness of sector j as $u^j = 1 + \sum_k b^{jk} u^j$, where b^{jk} are the elements of the output matrix $\tilde{\mathbf{B}}$ just described. Solving this equation yields $\mathbf{u} = (\mathbf{I}-\tilde{\mathbf{B}})^{-1}\boldsymbol{\iota}$, where $\boldsymbol{\iota}$ is a $J \times 1$ vector of ones. The same as the classic forward linkage measure. Antras et al. (2012) show that this measure is equivalent to the average number of production stages each sector's output is from final consumers. We proceed with this intuition in mind.

In autarky, the average upstreamness of all provinces is the same. After all, households have identical preferences and firms have identical production technologies across all regions. Without trade, the distribution of economic activity across sectors will therefore be the same. With trade, specialization takes place and different regions expand output of different sectors relative to others – comparative advantage at work. It turns out that in the data, higher income regions tend to concentrate relatively more in upstream sectors. This is consistent with recent evidence that upstreamness in international exports is increasing in a country's income (Antras et al., 2012). In appendix Figure 5, we illustrate this relationship.

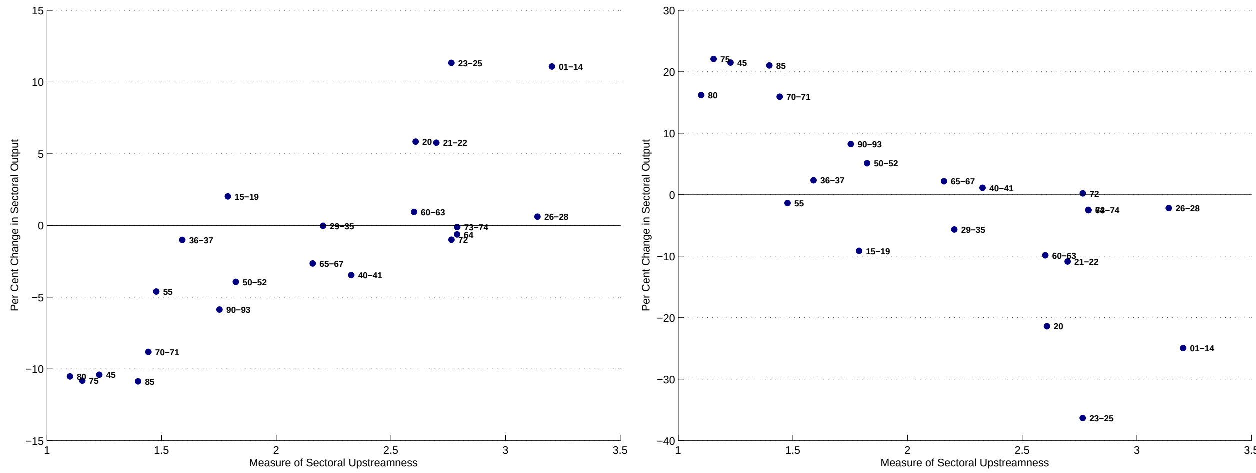
Fiscal transfers, however, also affect the pattern of specialization. We discussed the intuition at the beginning of this section and display our quantitative results in Figure 3. We plot the effect of fiscal transfers on each sector within two exemplar provinces, Alberta and Prince Edward Island. That is, we compare each industry's size in the initial equilibrium with $\gamma = -0.3$ to a counterfactual equilibrium where $\gamma' = 0$. As before, we only change the extent of fiscal integration, so hold trade costs fixed and therefore $\hat{\tau}^j_{ni} = 1$ for all (n, i, j).

For Alberta, there is a clear positive relationship between a sector's upstreamness and the

[6]This is a direct corollary of the input matrix $\tilde{\mathbf{A}}$ described earlier. In a single region closed-economy version of our model, sectoral output would be exactly $\mathbf{R} = (\mathbf{I}-\tilde{\mathbf{A}})^{-1}\boldsymbol{\alpha}$. The elements of the output matrix $\tilde{\mathbf{B}}$ would then be $\gamma^{kj}(1-\phi^k)R^j/R^k$ for the k^{th} row and j^{th} column. It is straightforward to show $\tilde{\mathbf{B}} = \hat{\mathbf{R}}^{-1}\tilde{\mathbf{A}}\hat{\mathbf{R}}$, where (with an abuse of our hat-notation) $\hat{\mathbf{R}}$ is a diagonal matrix of the vector $\mathbf{R}$.

Figure 3: Within-Province Effect of Fiscal Transfers on Industries

(a) Alberta (Net Contributor; $t_n < 1$) (b) Prince Edward Island (Net Recipient; $t_n > 1$)



Displays the change in industry output (equivalently value-added) in Alberta and PEI. Industry codes are ISIC Rev. 3 two-digit codes. These patterns are representative of all net contributors and net receipients of fiscal transfers. The horizontal axis is each industry's upstreamness, as measured by the average number of production stages away from final consumption. It also corresponds to the classic total forward linkage measure as the row-sum of a Ghosh Inverse Matrix. See section 4.3 for details.

change in its output. Relatively upstream sectors expand while downstream sectors contract. For PEI, the effect is reversed. This confirms the intuition with which we opened this section. Provinces that receive net transfers see downstream sectors expand and upstream sectors contract. Interestingly, while provinces that are net contributors experience welfare and productivity losses, not all sectors are harmed. Upstream sectors, even within net contributing provinces, see their output, employment, and GDP increase due to the fiscal transfer system. Equivalently, there is a spatial reallocation of economic activity: upstream sectors shift towards higher income provinces.

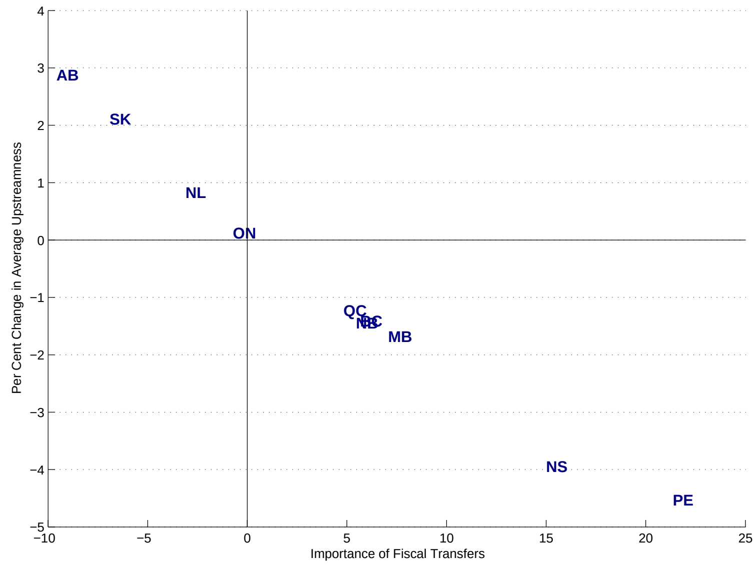
These shifts can be visualized across all provinces. In Figure 4, we plot the change in average (output-weighted) upstreamness in each province against the magnitude of initial fiscal transfers. At the high end, Alberta's upstreamness measure is 3% larger than it would be without fiscal transfers. At the low end, Nova Scotia and PEI see their upstreamness decline by between 4 and 5%. This is quantitatively important. We find 56% of all the differences across provinces in upstreamness is explained by Canada's fiscal transfer system.[7] Fiscal transfers are therefore a key reason why higher income provinces tend to produce relatively more in upstream sectors.

4.4 Gains from Lowering Internal Trade Costs

We've explored the gains from fiscal integration and trade. Let's turn now to the welfare and productivity consequences of lower internal trade costs. For this, we turn to the trade cost estimates from Section 2.2. We use the same data, and our model – while different – would yield identical trade cost estimates. That is, the presence of fiscal transfers in no way affects the procedures

[7]Based on changes in the variance of log upstreamness across provinces.

Figure 4: Effect of Fiscal Transfers on Upstreamness of Production



Displays the change in average upstreamness of production for each province due to fiscal transfers. Intuitively, it captures the average number of production stages a typical dollar of output is from a final consumer. It also corresponds to the classic total forward linkage measure as the row-sum of a Ghosh Inverse Matrix. See section 4.3 for details.

in their paper to estimate trade costs. We report various measures for provinces and sectors in Table 3. The experiments we consider here eliminate these trade cost estimates τ_{ni}^{j} by simulating $\hat{\tau}_{ni}^{j} = 1/\tau_{ni}^{j}$. The strength of fiscal integration is held constant at $\gamma = 0.3$. We report the results of each exercise in Table 5.

Our first two columns report the change in welfare and productivity from eliminating asymmetric trade costs within Canada. Notice the welfare gains are far smaller than the productivity gains for poor regions. Recall asymmetric trade costs are such that it is typically more costly to export from poor regions that it is to export from rich. This has the effect of lowering wages (and prices) within poor regions, which increases the transfer payments they receive. As asymmetric trade costs fall, their wages rise and transfers consequently shrink. This is a previously unexplored and quantitatively significant effect. In general, in the presence of fiscal transfers to areas with low income, when gains from trade come in the form of higher wages, the transfer system will claw-back some of those gains. The reverse effect happens in rich regions. To the extent that harmonizing trade policies and regulations across provinces, which would have the effect of eliminating asymmetries in trade costs, poor regions will see lower gains. The incentive to agree to such reforms is therefore lower than previous research suggests.

The third and fourth columns involve lowering all trade costs unrelated to physical distance between provinces. Policy makers, of course, cannot change the fact that it will always be more costly to ship a good from Ontario to British Columbia than it is to ship from Ontario to Quebec. This experiment reflects that fact. The gains are substantial, with poor regions seeing welfare and productivity rising by well over 20%. The differences between welfare and productivity gains

Table 5: Gains from Lower Internal Trade Costs

	Asymmetric Costs		Non-Distance Costs		All Internal Costs	
Province	Welfare	Productivity	Welfare	Productivity	Welfare	Productivity
AB	3.0%	2.5%	6.2%	5.9%	55.8%	55.1%
BC	2.7%	2.7%	4.7%	4.5%	60.5%	62.6%
MB	3.8%	5.0%	8.0%	7.9%	90.3%	105.0%
NB	4.3%	7.7%	24.4%	28.0%	101.5%	126.1%
NL	2.6%	4.9%	22.5%	24.0%	101.8%	125.0%
NS	3.6%	7.0%	18.7%	22.2%	103.6%	130.5%
ON	3.9%	2.9%	3.6%	3.4%	33.5%	27.4%
PE	8.5%	16.3%	27.1%	31.9%	187.4%	259.5%
QC	1.8%	2.4%	6.8%	6.9%	41.4%	42.7%
SK	4.1%	8.4%	16.4%	17.4%	76.9%	91.7%

Displays the effect on welfare and aggregate productivity from lowering various measures of internal trade costs. The difference between productivity and welfare is only the direct effect of fiscal transfers. The productivity effects approximate what a model without fiscally integrated regions would predict. Overall, standard models overestimate gains in poor regions and underestimate gains in rich regions.

implies the fiscal transfer system has little effect here.

Finally, eliminating all internal trade costs, though not a feasible policy reform, illustrates large differences between welfare and productivity gains. Welfare gains are substantially smaller in poor regions than productivity gains, reflecting lower transfer payments as a result of the internal trade liberalization. Models that fails to account for between-region financial transfers towards poor regions will therefore overestimate gains from trade for poor regions and underestimate gains for rich regions.

4.5 Bilateral Trade Deals and Fiscal Integration

We end our Canadian analysis by looking at bilateral trade deals between provinces. This is a growing trend in Canada, as provinces such as BC, Alberta, and Saskatchewan have established the New West Partnership Agreement. This seeks to harmonize regulations and lower barriers to the trade in goods and workers between the three provinces and improve procurement rules. The Ontario-Quebec Trade and Cooperation Agreement seeks to do the same. An agreement among Atlantic Canadian provinces to harmonize trucking regulations, which lowers inter-provincial trade costs, is another example. In the international trade literature, it is well known that bilateral deals can create trade diversion effects that can harm non-members. The same basic logic applies within a country, but does fiscal integration allow all regions to benefit from bilateral deals? After all, what benefits some provinces will lead them to contribute more to inter-provincial transfers, spreading some of the gains. We quantitatively explore this possibility here.

We simulate lowering trade costs between certain provinces by 10%. Specifically, we set $\hat{\tau}^j_{ni} = 0.9$ if n and i are both within the group of provinces liberalizing, and $\hat{\tau}^j_{ni} = 1$ otherwise. As before, the strength of fiscal integration is help constant. We choose the sets of provinces to correspond to

Table 6: Effect of Lowering Certain Bilateral Trade Costs by 10%

	Lower Trade Costs Between Certain Provinces					
	BC-Alberta-Sask		Ontario-Quebec		Maritimes (NB-NS-PE)	
Province	Welfare	Productivity	Welfare	Productivity	Welfare	Productivity
AB	1.05%	1.33%	0.31%	-0.07%	0.01%	0.00%
BC	1.32%	1.82%	0.33%	-0.01%	0.02%	0.00%
MB	0.17%	-0.04%	0.31%	-0.04%	0.01%	0.00%
NB	0.18%	-0.03%	0.22%	-0.19%	0.69%	1.15%
NL	0.18%	-0.02%	0.28%	-0.02%	0.00%	0.00%
NS	0.18%	-0.03%	0.27%	-0.11%	0.77%	1.35%
ON	0.18%	-0.01%	1.12%	1.24%	0.01%	0.00%
PE	0.19%	-0.01%	0.28%	-0.04%	2.11%	2.96%
QC	0.19%	-0.01%	1.87%	2.45%	0.01%	-0.01%
SK	2.27%	2.78%	0.30%	-0.08%	0.01%	0.00%

Displays the effect on welfare and aggregate productivity in all regions from only certain regions lowering trade costs. These are three separate experiments, where the provinces indicated in the header lower bilateral trade costs by 10%; that is, $\hat{\tau}^j_{ni} = 0.9$ for all provinces within the set indicated. All other trade costs are unchanged.

the three examples of bilateral agreements just mentioned, though this is by no means an analysis of those agreements. We report all results in Table 6. Comparing the welfare and productivity gains, we see that all regions experience welfare gains when only certain provinces liberalize trade. Trade diversion effect still exist, and productivity falls in regions excluded from the agreement. These productivity changes are a close approximation to the welfare and productivity effects in a model without fiscal transfers, which we confirm in the Appendix. Consequently, neglecting fiscal transfers may lead one to falsely conclude that liberalizing trade among only certain provinces may be harmful to other provinces.

5 Conclusion

Fiscal transfers between regions to alleviate income disparities are very common. Even absent explicit programs, equalization is often a simple consequence of having a large federal government. While a substantial body of work studies the effects of fiscal integration, the literature typically abstracts from trade to focus on tax or political economy considerations. We demonstrate the welfare and productivity consequences of fiscal integration depend crucially on trade. To do this, we expand an otherwise standard quantitative trade model, along with detailed data for trade and financial flows between Canadian provinces, to quantify the effect of fiscal integration.

Through various counterfactual simulations, we find welfare and productivity in recipient (poor) regions increases, sometimes dramatically so. The reverse is true in contributor (rich) regions. In Canada, gains to poor provinces are on the order of 10-20% while gains for rich provinces can be as low -10%. We also uncover quantitatively important effects of fiscal transfers on trade flows, specialization patterns, gains from trade, and the effect of trade policy. Transfers represent a demand shock to downstream industries, disproportionately expanding them in recipient regions; in contributor regions, upstream sectors expand. Finally, fiscal integration greatly increases the dispersion of gains from trade across regions – amplifying gains for poor regions and dampening them for rich. Gains from trade policy changes are also affected. Gains to poor regions from asymmetric trade cost reductions are dramatically shrunk. Bilateral trade deals, which typically harm non-members, actually benefit everyone when fiscal integration is sufficiently strong. Overall, this research uncovers novel results of the within-region effects of fiscal integration on welfare, productivity, and the composition of economic activity.

References

Acemoglu, Daron, Ufuk Akcigit, and William Kerr, "Networks and the Macroeconomy: An Empirical Exploration," *NBER Working Paper*, 2015, (21344).

_, Vasco Carvalho, Asuman Ozdaglar, and Alireza Tahbaz-Salehi, "The Network Origins of Aggregate Fluctuations," *Econometrica*, 2012, *80* (5), 1977–2016.

Agnosteva, Delina, James Anderson, and Yoto Yotov, "Intra-national Trade Costs: Measurement and Aggregation," *NBER Working Paper 19872*, 2014.

Albouy, David, "The Unequal Geographic Burden of Federal Taxation," *Journal of Political Economy*, 2009, *117* (4), 635–667.

Albrecht, Lukas and Trevor Tombe, "Internal Trade, Productivity, and Interconnected Industries: A Quantitative Analysis," *Canadian Journal of Economics*, 2016, *49* (1).

Allen, Treb and Costas Arkolakis, "Trade and the Topography of the Spatial Economy," *The Quarterly Journal of Economics*, 2014, (129), 1085–1140.

Antras, Pol, Davin Chor, Thibault Fally, and Russell Hillberry, "Measuring the Upstreamness of Production and Trade Flows," *American Economic Review*, 2012, *102* (3), 412–16.

Arkolakis, Costas, Arnaud Costinot, and Andres Rodreguez-Clare, "New Trade Models, Same Old Gains?," *American Economic Review*, 2012, *102* (1), 94–130.

Atkin, David and Dave Donaldson, "Who's Getting Globalized? The Size and Nature of Intranational Trade Costs," 2013.

Beaulieu, Eugene, James Gaisford, and Jim Higginson, *Interprovincial trade barriers in Canada: How far have we come? Where should we go?*, Van Horne Institute for International Transportation and Regulatory Affairs, 2003.

Boadway, Robin and Anwar Shah, *Intergovernmental Fiscal Transfers : Principles and Practice* number 7171. In 'World Bank Publications.', The World Bank, September 2007.

_ and Frank Flatters, "Efficiency and Equalization Payments in a Federal System of Government: A Synthesis and Extension of Recent Results," *The Canadian Journal of Economics*, 1982, *15* (4), pp. 613–633.

__ , Thiess Buettner, and David E. Wildasin, "New directions in fiscal federalism: Introduction," *Journal of Public Economics*, 2008, *92* (12), 2285 – 2287.

Caliendo, Lorenzo and Fernando Parro, "Estimates of the Trade and Welfare Effects of NAFTA," *The Review of Economic Studies*, 2015, *82* (1), 1–44.

Carvalho, Vasco and Xavier Gabaix, "The Great Diversification and Its Undoing," *American Economic Review*, 2013, *103* (5), 1697–1727.

Corsetti, Giancarlo, Philippe Martin, and Paolo Pesenti, "Varieties and the transfer problem," *Journal of International Economics*, 2013, *89* (1), 1 – 12.

Cosar, Kerem and Pablo Fajgelbaum, "Internal Geography, International Trade, and Regional Outcomes," 2012.

Costinot, Arnaud and Andres Rodriguez-Clare, "Trade Theory with Numbers: Quantifying the Consequences of Globalization," in Gita Gopinath, Alhanan Helpman, and Kenneth Rogoff, eds., *Handbook of International Economics*, Vol. 4 2014. Chapter 4.

Dahlby, B. and L.S. Wilson, "Fiscal Capacity, Tax Effort, and Optimal Equalization Grants," *The Canadian Journal of Economics*, 1994, *27* (3), pp. 657–672.

Dekle, Robert, Jonathan Eaton, and Samuel Kortum, "Unbalanced Trade," *American Economic Review*, 2007, *97* (2), 351–355.

Eaton, Jonathan and Samuel Kortum, "Technology, Geography, and Trade," *Econometrica*, 2002, *70* (5), 1741–1779.

Fally, Thibault, "Production Staging: Measurement and Facts," 2012.

Head, Keith and John Ries, "Increasing Returns versus National Product Differentiation as an Explanation for the Pattern of U.S.-Canada Trade," *American Economic Review*, 2001, *91* (4), 858–876.

__ and Thierry Mayer, "Gravity Equations: Workhorse,Toolkit, and Cookbook," in Gita Gopinath, Alhanan Helpman, and Kenneth Rogoff, eds., *Handbook of International Economics*, Vol. 4 2014. Chapter 3.

Isard, Walter, "Interregional and Regional Input-Output Analysis: A Model of a Space-Economy," *Review of Economics and Statistics*, 1951, *33* (4), 318–28.

Jones, Charles, "Misallocation, Economic Growth, and Input-Output Economics," in "Advances in Economics and Econometrics," Vol. 2, Cambridge University Press, 2013.

Keynes, J. M., "The German Transfer Problem," *The Economic Journal*, 1929, *39* (153), pp. 1–7.

Koopman, Robert, Zhi Wang, and Shang-Jin Wei, "Tracing Value-Added and Double Counting in Gross Exports," *American Economic Review*, 2014, *104* (2), 459–94.

Lane, Philip and Gian Maria Milesi-Ferretti, "The Transfer Problem Revisited: Net Foreign Assets and Real Exchange Rates," *The Review of Economics and Statistics*, 2004, *86* (4), 841–857.

Novy, Dennis, "Gravity Redux: Measuring International Trade Costs With Panel Data," *Economic Inquiry*, 2013, *51* (1), 101–121.

Redding, Stephen J., "Goods Trade, Factor Mobility and Welfare," 2015.

Samuelson, Paul, "The Transfer Problem and Transport Costs: Analysis of Effects of Trade Impediments," *The Economic Journal*, 1952, *62* (246), 278–304.

_ , "The Transfer Problem and Transport Costs, II: Analysis of Effects of Trade Impediments," *The Economic Journal*, 1954, *64* (254), 264–289.

Watson, William G., "An Estimate of the Welfare Gain from Fiscal Equalization," *The Canadian Journal of Economics*, 1986, *19* (2), pp. 298–308.

Waugh, Michael E., "International Trade and Income Differences," *American Economic Review*, 2010, *100* (5).

Appendix

Proof of Proposition 1

Define $t_n = Bw_n^{\gamma}$ and find the term B such that the central government budget balances. The government budget balances if $\sum_{n=1}^{N}(t_n - 1)w_n L_n = 0$ and therefore

$$\begin{aligned} \sum_{n=1}^{N} w_n L_n &= \sum_{n=1}^{N} t_n w_n L_n, \\ &= B \sum_{n=1}^{N} w_n^{\gamma} w_n L_n, \\ \Rightarrow \quad B^{-1} &= \sum_{n=1}^{N} w_n^{\gamma} \left(\frac{w_n L_n}{\sum_{n=1}^{N} w_n L_n} \right). \end{aligned}$$

Raising each side to the power $1/\gamma$, we have $B^{-1/\gamma} = \left[\sum_{n=1}^{N} w_n^{\gamma} \left(\frac{w_n L_n}{\sum_{n=1}^{N} w_n L_n} \right) \right]^{1/\gamma} \equiv \bar{w}$. Plug this into the initial definition of t_n to yield our result

$$\begin{aligned} t_n &= Bw_n^{\gamma}, \\ &= \left(w_n / B^{-1/\gamma} \right)^{\gamma}, \\ &= \left(w_n / \bar{w} \right)^{\gamma}. \blacksquare \end{aligned}$$

Proof of Proposition 2

Total sales in region n and sector j is equals total spending from all other regions, $R_n^j = \sum_{i=1}^{N} \pi_{in}^j X_i^j$. Total spending includes final and intermediate input spending, $X_n^j = \alpha^j I_n + \sum_{k=1}^{J} \gamma^{kj}(1 - \phi^k) R_n^k$. Together, we have $R_n^j = \sum_{i=1}^{N} \pi_{in}^j \alpha^j I_i + \sum_{i=1}^{N} \sum_{k=1}^{J} \pi_{in}^j \gamma^{kj} (1 - \phi^k) R_i^k$. It is helpful to write these expressions in matrix form. Define $\mathbf{A_{ni}}$ as the $J \times J$ input coefficient matrix, with elements $\gamma^{kj}(1-\phi^k)\pi^j_{ni}$ for the j^{th} row and k^{th} column. Now, form the $NJ \times NJ$ matrix

$$\mathbf{A} = \begin{bmatrix} \mathbf{A_{11}} & \cdots & \mathbf{A_{N1}} \\ \vdots & \ddots & \vdots \\ \mathbf{A_{1N}} & \cdots & \mathbf{A_{NN}} \end{bmatrix}.$$

Call this matrix the *global input coefficient matrix*.

Next, define global demand as the $NJ \times 1$ vector $\mathbf{F}$ with elements $\sum_i \alpha^j I_i \pi^j_{in}$ for the row indexed $j + J \times (n-1)$. This represents the global spending on final goods from each region and sector. In particular, stack the $J \times 1$ vectors $\mathbf{F_n}$ with elements $\sum_i \alpha^j I_i \pi^j_{in}$, which is the global demand for final goods from each of region n's sectors. With wages, we know income from $I_n = w_n L_n t_n$ and t_n is from equation 6 and depends only on wages, so the vector of final demand depends only on wages. Given the matrix of global input coefficients $\mathbf{A}$ and the vector of final demand $\mathbf{F}$, total revenue for each region and sector is the $NJ \times 1$ vector

$$\mathbf{R} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{F}.$$

This is a familiar expression in any Input-Output model. Given the vector of region-sector sales $\mathbf{R}$, we know the implied wages in each region, since $w_n = \sum_j \phi^j R^j_n / L_n$. So, the set of N equilibrium wages is the solution to these equations. ■

Supplementary Tables and Figures

Table 7: Industry Data from OECD-STAN

Industry	ISIC Rev. 3 Codes	Value-Added Share, ϕ^j	Final Goods Share, β^j	Input-Output Mult., μ^j	Upstream Measure, u^j	Trade Elasticity, θ^j
Agriculture, Mining	01-14	0.63	0.014	0.128	3.202	11.92
Food, Textiles	15-19	0.33	0.050	0.089	1.789	4.56
Wood	20	0.35	0.001	0.014	2.608	10.83
Paper	21-22	0.43	0.009	0.044	2.698	9.07
Chemicals, Rubber	23-25	0.21	0.027	0.120	2.764	19.16
Metals	26-28	0.34	0.005	0.090	3.139	5.02
Equipment, Vehicles	29-35	0.26	0.086	0.197	2.204	6.19
Manufacturing, n.e.c.	36-37	0.45	0.015	0.023	1.590	5.00
Utilities	40-41	0.73	0.013	0.033	2.327	5.00
Construction	45	0.40	0.133	0.154	1.228	5.00
Wholesale and Retail	50-52	0.61	0.110	0.185	1.824	5.00
Hotels and Restaurants	55	0.49	0.037	0.048	1.477	5.00
Transport	60-63	0.50	0.017	0.060	2.601	5.00
Communication	64	0.59	0.001	0.009	2.788	5.00
Finance	65-67	0.55	0.058	0.135	2.159	5.00
Real Estate	70-71	0.78	0.114	0.147	1.442	5.00
Software	72	0.57	0.006	0.035	2.764	5.00
Other Business Services	73-74	0.66	0.005	0.072	2.789	5.00
Public Admin.	75	0.51	0.140	0.154	1.154	5.00
Education	80	0.79	0.057	0.061	1.100	5.00
Health and Social	85	0.71	0.048	0.071	1.397	5.00
Other Services	90-93	0.61	0.057	0.095	1.753	5.00

Industry data from the OECD Structural Analysis Database. The Input-Output Multiplier μ^j is the j^{th} element of $(\boldsymbol{I}-\tilde{\boldsymbol{A}})^{-1}\boldsymbol{\beta}$, where $(\boldsymbol{I}-\tilde{\boldsymbol{A}})^{-1}$ is the Leontief Inverse Matrix and $\boldsymbol{\beta}$ if the vector of final goods shares β^j. The trade elasticity is from the Caliendo and Parro (2015) estimates, averaged up to a slightly higher level of aggregation. Sectors 40 and above have elasticities of 5, consistent with Costinot and Rodriguez-Clare (2014). The measure of upstreamness is the average number of production stages output from each sector is from final consumers; it is the row-sum of the Ghosh Inverse Matrix $(\boldsymbol{I}-\tilde{\boldsymbol{B}})^{-1}$ described in section 4.3.

Table 8: Welfare Effect of Lower Trade Costs

Region	Without Fiscal Transfers			With Fiscal Transfers		
	Asymmetric Costs	Non-Distance Costs	All Internal Costs	Asymmetric Costs	Non-Distance Costs	All Internal Costs
AB	3.0%	6.2%	55.8%	2.4%	5.5%	51.1%
BC	2.7%	4.7%	60.5%	2.8%	4.9%	64.6%
MB	3.8%	8.0%	90.3%	5.2%	8.4%	108.2%
NB	4.3%	24.4%	101.5%	8.0%	28.3%	130.8%
NL	2.6%	22.5%	101.8%	5.0%	23.5%	125.1%
NS	3.6%	18.7%	103.6%	7.9%	24.3%	142.0%
ON	3.9%	3.6%	33.5%	2.8%	3.2%	26.8%
PE	8.5%	27.1%	187.4%	18.6%	35.1%	285.4%
QC	1.8%	6.8%	41.4%	2.5%	7.2%	45.0%
SK	4.1%	16.4%	76.9%	8.7%	17.2%	88.8%

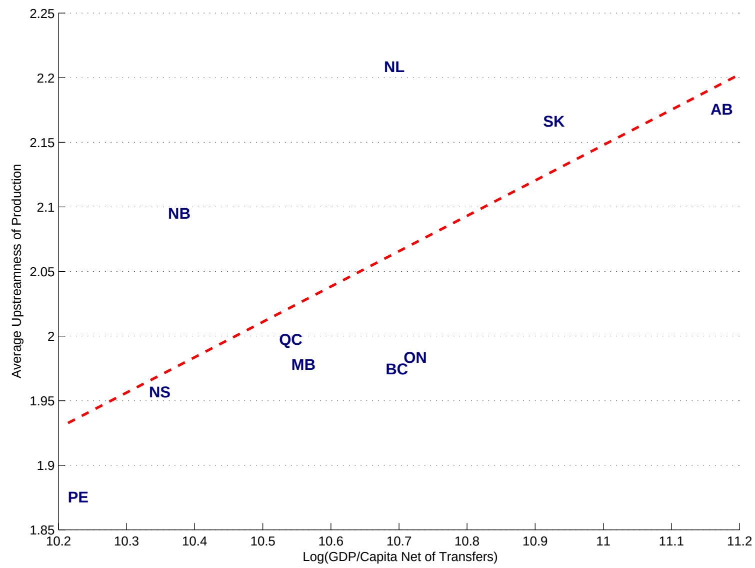
Displays the effect on welfare from lowering various measures of internal trade costs. The welfare gains in a model without fiscal integration closely approximate the real GDP effects in a model with fiscal integration (reported in the main text).

Table 9: Productivity Effect of Lower Bilateral Trade Costs - Comparing Models

Outcomes for All Provinces:	Lower Trade Costs Between Certain Provinces					
	BC-Alberta-Sask		Ontario-Quebec		Maritimes (NB-NS-PE)	
	No Fiscal Transfers	With Fiscal Transfers	No Fiscal Transfers	With Fiscal Transfers	No Fiscal Transfers	With Fiscal Transfers
AB	1.28%	1.33%	-0.08%	-0.07%	0.00%	0.00%
BC	2.03%	1.82%	-0.04%	-0.01%	0.00%	0.00%
MB	-0.07%	-0.04%	-0.07%	-0.04%	0.00%	0.00%
NB	-0.05%	-0.03%	-0.22%	-0.19%	1.09%	1.15%
NL	-0.03%	-0.02%	-0.03%	-0.02%	0.00%	0.00%
NS	-0.06%	-0.03%	-0.16%	-0.11%	1.43%	1.35%
ON	-0.03%	-0.01%	1.19%	1.24%	0.00%	0.00%
PE	-0.04%	-0.01%	-0.09%	-0.04%	3.15%	2.96%
QC	-0.03%	-0.01%	2.58%	2.45%	-0.01%	-0.01%
SK	2.83%	2.78%	-0.09%	-0.08%	0.00%	0.00%

Displays the productivity effect in all regions from only certain regions lowering trade costs. We repeat this for a model with and without fiscal transfers to confirm that the productivity changes with fiscal transfers are a very close approximation to the welfare and productivity effect without fiscal transfers. Note that welfare changes equal productivity changes when there are no transfers. These are three separate experiments, where the provinces indicated in the header lower bilateral trade costs by 10%; that is, $\hat{\tau}^j_{ni} = 0.9$ for all provinces within the set indicated. All other trade costs are unchanged.

Figure 5: Upstreamness vs Average Incomes



Displays the average level of upstreamness of each province. That is, the output-weighted average across all sectors of their Fally (2012) measure of upstreamness. It is the average number of production stages the typical dollar of output is away from a final consumer.

A Simple Model of Fiscal Integration and Trade

To ground our intuition and clearly illustrate the logic, consider the simple and widely known general equilibrium trade model: the Armington model. There are N regions, each endowed with a unit mass of workers and each produces its own differentiated good. Production is linear in labour and productivity is A_n. With this simple production technology, marginal costs are wages relative to labour productivity, w_n/A_n.

Turning to the demand side, consumers maximize a CES composite of goods from all regions,

$$U_n = \left[\sum_{i=1}^{N} q_{ni}^{(\sigma-1)/\sigma}\right]^{\sigma/(\sigma-1)}, \tag{12}$$

where q_{ni} is the quantity of region i's good consumed in region n and $\sigma > 1$ is the elasticity of substitution. The price of consuming goods from your own region is only the marginal production costs. The price of goods from another region (imports) also includes a trade cost. Denote these as iceberg costs $\tau_{ni} \geq 1$, which reflects how many goods must be shipped from region i for one good to arrive in region n. The consumer price inclusive of trade costs is then $\tau_{ni}w_i/A_i$.

With CES preferences and what we know about production costs, it is straightforward to solve for equilibrium demands. Given household income (and spending) I_n, the demand for region i goods from region n consumers, denoted X_{ni}, is the familiar CES demand expression

$$X_{ni} = \left(\frac{\tau_{ni}w_i/A_i}{P_n}\right)^{1-\sigma} I_n, \tag{13}$$

where P_n is the aggregate price index in region n,

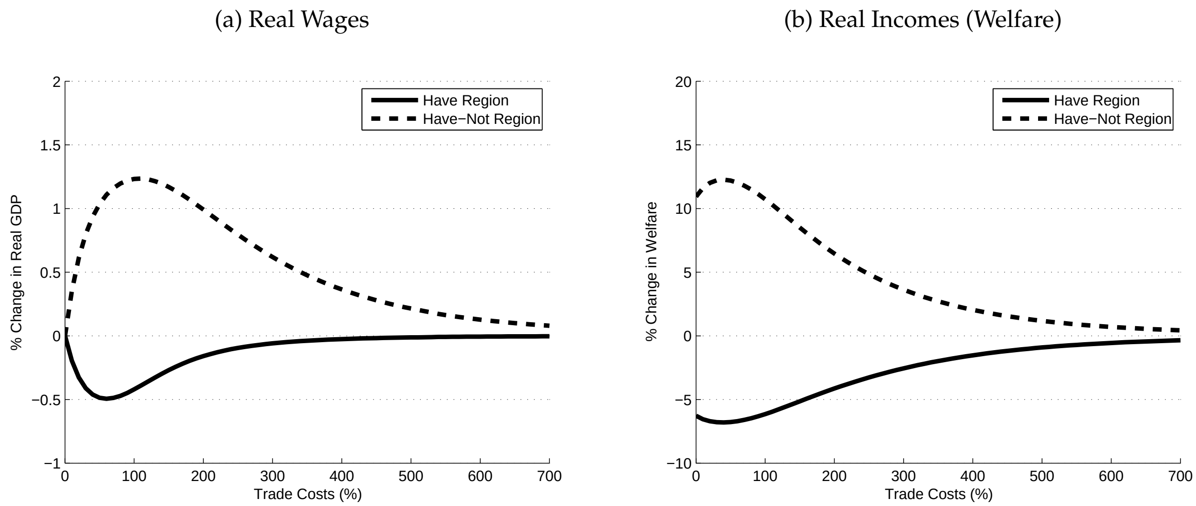
$$P_n = \left[\sum_{i=1}^{N} \left(\tau_{ni}w_i/A_i\right)^{1-\sigma}\right]^{1/(1-\sigma)}. \tag{14}$$

Finally, suppose central government taxation and spending is sensitive to a region's income. Income net of taxes and transfers is $I_n = w_n t_n$, where $t_n < 1$ in regions where the government taxes more than spends, and $t_n > 1$ otherwise. As we saw in the previous section, $t_n \propto w_n^{\gamma}$, with $\gamma \approx -0.3$ provides a good match to data. The constant of proportionality in t_n will be denoted B and is set to ensure a balanced central government budget.[8] To close the model, total labour income equals total sales, $w_n = \sum_{i=1}^{N} X_{in}$. These expressions, along with 13 and 14, solve the model.

The model behaves in intuitive and convenient ways. Two aggregate outcomes are particularly relevant: real wages and real income. First, from equation 13, and defining the share of total spending allocated to one's own goods $\pi_{nn} \equiv X_{nn}/I_n$, we have $w_n/P_n = A_n \pi_{nn}^{1/(1-\sigma)}$. So, changes in π_{nn} (the *home share*) are a sufficient statistic for real wage changes. This is a familiar result in

[8]Specifically, for $t_n = Bw_n^{\gamma}$ we require $\sum_n w_n(t_n - 1) = 0$ which implies $B = 1/\sum_n \left(\frac{w_n}{\sum_n w_n}\right) w_n^{\gamma}$.

Figure 6: The Effect of Fiscal Transfers (Simple Model)



Displays the change in welfare and productivity in a simple two-region model that results from implementing a fiscal transfer system $t_n \propto w_n^{\gamma}$, where $\gamma = -0.3$. Specifically, we solve equations 13 and 14 for various trade costs τ. Region 1 is the "have" region, with $A_1 = 2 \times A_2$. We set $\sigma = 5$. See section 5 for details.

trade and holds across a broad spectrum of models (Arkolakis et al., 2012). Though productivity is fixed, changes in real wages in the full model to come reflect changes in labour productivity. Second, given transfers, real income (welfare) is $U_n = I_n/P_n = A_n \pi_{nn}^{1/(1-\sigma)} t_n$. Now, define $\hat{x} = x'/x$ as the equilibrium relative change in some variable x. Consider moving from an initial equilibrium without transfers ($\gamma = 0$) to one with equalizing transfers ($\gamma < 0$). Changes in real wages and welfare are

$$\begin{aligned} \hat{w}_n/\hat{P}_n &= \hat{\pi}_{nn}^{1/(1-\sigma)}, \\ \hat{U}_n &= \hat{\pi}_{nn}^{1/(1-\sigma)} \hat{t}_n, \end{aligned}$$

where $\hat{t}_n = B\hat{w}_n^{\gamma}$. So, transfers can only matter for real wages if they change the pattern of trade, through $\hat{\pi}_{nn}$. If trade patterns are unaffected, then transfers can only matter for welfare if they fund a trade imbalance, as $\hat{t}_n = 1 - S_n/w_n L_n$. We compute the equilibrium of this model for two regions, one of which is twice as productive as the other and set $\sigma = 5$. In Figure 6, we display the results of moving from $\gamma = 0$ to $\gamma = -0.3$ for various levels of trade costs.

If trade is frictionless ($\tau_{ni} = 1$ for all n, i), then prices are identical across all regions and all regions allocate the same spending share to each other region; that is, $\pi_{nn} = \pi_{in}$ for all n, i. Normalizing global income to one, it is straightforward to show

$$w_n = \frac{A_n^{(1-\sigma)/\sigma}}{\sum_{i=1}^{N} A_i^{(1-\sigma)/\sigma}},$$

which do not depend on γ. So, fiscal transfers have no effect on relative wages when trade costs are zero. If wages do not respond to transfers, then neither do prices or trade shares. Real wages are therefore unaffected by transfers. Of course, each region's welfare is affect, as $t_n > 1$ for the receiving region and $t_n < 1$ for the other.

At the opposite extreme, in autarky we have $\tau = \infty$ and home shares in both regions are one. Fiscal transfers will not change home share in this situation either, as trade is not possible. However, unlike when trade is frictionless, the welfare of transfers is zero. Intuitively, this should not be surprising. Fiscal transfers into a closed economy are nothing more than an increase in the money supply. In this model, the only effect is an equal proportional change in incomes and prices. There is no change in *real* incomes. Recall also that fiscal inflows finance a trade imbalances, as $t_n = 1 - S_n / w_n L_n$. The welfare effect of transfers comes fully from such imbalances.

Overall, as internal trade becomes easier the welfare effects of fiscal transfers become larger. For productivity, only in intermediate cases when trade costs are neither zero nor infinite do fiscal transfers affect productivity. Of course, this is only intuition from a simple model. Just how costly is internal trade in Canada? We answer this question in the next section.

Extending the Simple Model: Asymmetric Trade Costs

In our simple model, the cost of trading between regions τ did not depend on the direction of trade. The internal trade cost estimates of Albrecht and Tombe (2016) found an important role for what are known as *trade cost asymmetries*, where the cost of shipping from region 2 to region 1 τ_{12} may differ from the reverse flow τ_{21}. In particular, let trade costs from i to n be $\tau\tau_i^e$, where τ is as above (the symmetric trade costs) and τ_i^e is some additional exporter-specific cost. To see how this matters, notice the trade share expression becomes

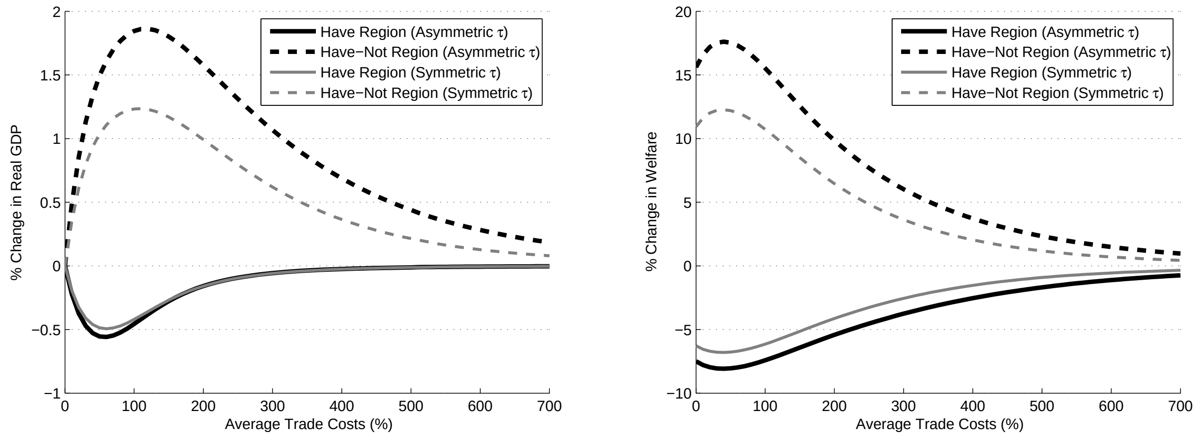
$$\pi_{ni} = \left(\frac{\tau\tau_i^e w_i / A_i}{P_n} \right)^{1-\sigma}.$$

As before, the spending region n allocates to imports from region i will be low if region i's productivity A_i is low. But now, if costs of exporting from region i are high, region n will also import less. In this sense, high export costs and low productivity have similar effects on trade. As trade flows affect equilibrium wages, high export costs will imply lower equilibrium wages. Intuitively, high export costs will mean low export volumes, so wages must also be low to bring import volumes down to balance trade.

As fiscal transfers depend on nominal incomes, and export costs lower wages, the effects of fiscal integration are larger when trade costs are asymmetric. To illustrate this effect, we repeat out earlier plot and illustrate the effect of introducing a fiscal transfer system when it is costly to export from the relatively poor region. The horizontal axis of Figure 7 is now the *average* trade cost between the two regions, with cost of exporting from the poor region are 25% higher than the average trade cost. As before, fiscal transfers have zero effect on real wages when trade is either frictionless or prohibitively costly. For intermediate levels of trade costs, a fiscal transfer system has a larger effect on welfare and real wages when trade costs are asymmetric.

Figure 7: The Effect of Fiscal Transfers with Asymmetric Trade Costs (Simple Model)

(a) Real Wages (b) Real Incomes (Welfare)



Displays the change in welfare and productivity in a simple two-region model that results from implementing a fiscal transfer system $t_n \propto w_n^\gamma$, where $\gamma = -0.3$. This mirrors Figure 6 but with asymmetric trade costs, where exports from the poor region are more costly than from the rich region. Specifically, we solve equations 13 and 14 for various trade costs τ with asymmetries such that $\tau = \sqrt{\tau_{12}\tau_{21}}$. Region 1 is the "have" region, with $A_1 = 2 \times A_2$. We set $\sigma = 5$. See section 5 for details.

This will matter for trade policy. Removing asymmetries in internal trade costs will disproportionately increase wages in poor regions, which will reduce their transfers. So, the region gains on the one hand from trade liberalization but loses on the other hand from lower fiscal transfers. To the extent that internal trade liberalization in Canada lowers asymmetries the gains to poor regions will be dampened.

Measuring Trade Costs in Canada

We adopt the Albrecht and Tombe (2016) measure of trade costs within Canada. Their results are replicated in Table 3. For added clarity, we expand upon their results to illustrate the important of asymmetries. We also provide further evidence that asymmetries take the export-cost form.

How large are trade costs in Canada? For a broad class of models, one can infer barriers to trade from observable data on trade flows and production conditional on an assumption for the cost-elasticity of trade (Head and Ries, 2001; Novy, 2013). This estimate is known as a Head-Ries Index and takes the form,

$$\bar{\tau}_{ni} = \left(\frac{\tau_{ni}\tau_{in}}{\tau_{nn}\tau_{ii}}\right)^{\frac{1}{2}} = \left(\frac{x_{nn}x_{ii}}{x_{ni}x_{in}}\right)^{\frac{1}{2\theta}}, \tag{15}$$

where $\bar{\tau}_{ni}$ is the geometric-average of actual trade costs, x_{ni} is the trade flows imported by region n that originate from region i, x_{nn} is the output of region n consumed locally, and θ is the cost-elasticity of trade. Interpreting this measure is simple, as it represents what is called an *iceberg* trade cost: a producer in region i must ship τ_{ni} units of a good for one unit to arrive at the desti-

Table 10: Symmetric Internal Trade Costs

	Exporter									
Importer	AB	BC	MB	NB	NL	NS	ON	PE	QC	SK
AB		86	110	176	198	188	91	269	128	89
BC	86		145	199	251	192	105	284	132	147
MB	110	145		200	196	207	105	282	145	111
NB	176	199	200		91	99	133	114	113	244
NL	198	251	196	91		111	137	186	130	317
NS	188	192	207	99	111		129	125	139	244
ON	91	105	105	133	137	129		168	74	115
PE	269	284	282	114	186	125	168		194	293
QC	128	132	145	113	130	139	74	194		168
SK	89	147	111	244	317	244	115	293	168	

Our measure of symmetric tariff-equivalent internal trade costs between all Canadian provinces. We follow Head and Ries (2001) and Novy (2013) and use only data on production and trade to estimate trade costs. This approach is known as the Head-Ries Index of trade cost. See section **??** for details.

nation region n. That being said, the τ_{nn} terms in the denominator of equation 15 make clear that we can only measure trade costs *relative to within-region* trade costs. A value of $\bar{\tau}_{ni} > 1$ therefore implies inter-regional trade is more costly than trade within a region. (say, between cities). Finally, this measure is valid whether a country's total trade balances or not. The model we develop in Section 3 features endogenous trade imbalances and the above expression will hold.

To measure $\bar{\tau}_{ni}$, we require data on trade flows x_{ni} and gross output consumed locally x_{nn}. We use sectoral data on inter-provincial trade, international trade, and gross output in 2010 from Statistics Canada's CANSIM Table 386-0003. In this section, we work only with aggregated data. In the quantitative analysis, we work with 22 sectors for which each province has at least some production. Finally, we require a value for the cost-elasticity of trade θ. We review evidence in Section 3.4 but here we simply set $\theta = 5$. Any particular trade cost measure we present can be easily rescaled to other values.

What about trade cost asymmetries? Our previous Head-Ries measure was symmetric by construction. There are two ways to measure trade cost asymmetry. First, we can use price differences between regions along with data on trade flows to infer trade costs. Second, we can infer them from fixed-effects within a standard Gravity regression. Let's begin with the price-based measure. As Waugh (2010) demonstrates, the same large class of trade models for which equation 15 holds, we have

$$\tau_{ni} = \frac{P_n}{P_i} \left(\frac{\pi_{ni}}{\pi_{ii}} \right)^{-\frac{1}{\theta}}, \tag{16}$$

where τ_{ni} is the cost for region n to import from region i, P_n is the aggregate price index in region n, and π_{ni} is the fraction of region n expenditures allocated to goods from region i. We have spatial price data for Canadian provinces through the inter-city price index constructed by Statistics

Table 11: Asymmetric Trade Cost Estimates

	Exporter									
Importer	AB	BC	MB	NB	NL	NS	ON	PE	QC	SK
AB		83	152	221	288	226	69	445	110	136
BC	89		183	278	377	245	80	518	123	197
MB	75	111		200	178	201	60	398	105	110
NB	136	136	200		78	92	62	182	76	224
NL	129	158	215	105		100	66	238	93	292
NS	154	147	213	107	122		71	192	98	264
ON	115	132	162	234	238	207		349	84	171
PE	150	139	193	63	141	73	61		89	205
QC	148	142	192	159	174	190	65	358		234
SK	51	105	112	266	343	224	70	407	115	

Our measures of asymmetric tariff-equivalent internal trade costs between all Canadian provinces. We follow Waugh (2010) and use additional price data to distinguish between the direction of trade for a given pair. See section 5 for details.

Canada.[9] These are price *level* comparisons, not standard CPI price indexes. Using these data and the trade data outlined earlier, we can calculate τ_{ni} using this expression. In Table 10, we provide our estimates of $\bar{\tau}_{ni}$ and τ_{ni} for all regional pairs within Canada. For example, British Columbia incurs a 183% tariff-equivalent cost of trade when it imports from Manitoba but the reverse flow, Manitoba's imports from British Columbia, incur only a 111% cost. Overall, poorer regions, such as the Maritime provinces, tend to display higher trade costs costs in general, and higher costs of exporting in particular, than richer regions of Canada.

An alternative way to estimate asymmetric trade costs involves a fixed-effect regression. Consider the case where trade cost asymmetries are due to additional export costs – region-specific costs that are incurred regardless of the eventual destination. To measure export costs, we Waugh (2010). It is straightforward to show $ln\,(\pi_{ni}/\pi_{nn}) = S_i - S_n - \theta ln(\tau_{ni})$, where the S terms capture region-specific factors such as productivity and factor prices. If $\tau_{ni} = D_{ni}^{\delta}\tau_i$ then

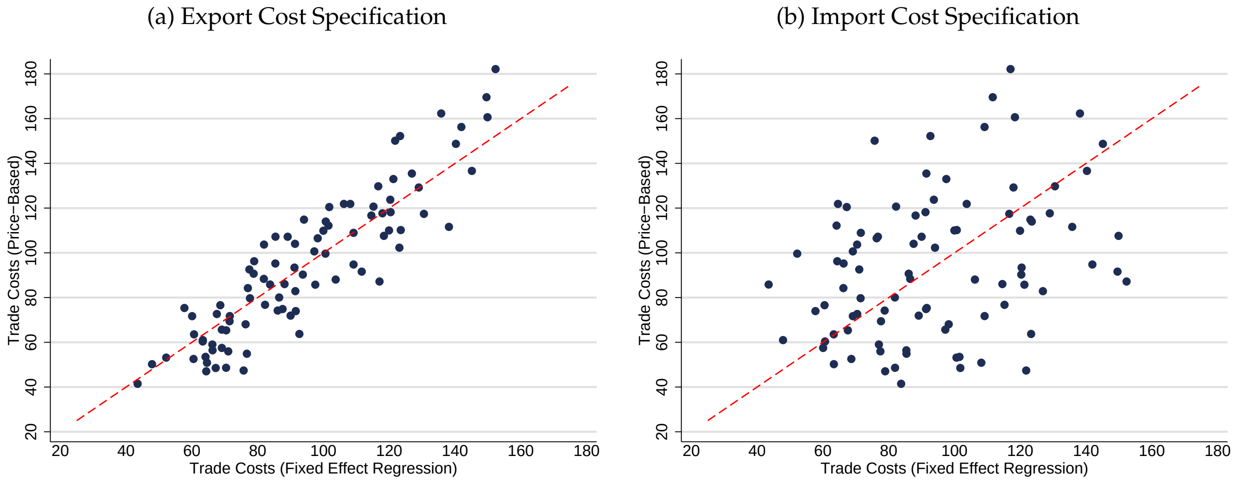
$$ln\left(\frac{\pi_{ni}}{\pi_{nn}}\right) = \delta ln(D_{ni}) + \iota_n + \eta_i + \epsilon_{ni}.$$

where $\eta_i = S_i - \theta ln(\tau_i)$ and $\iota_n = -S_n$. So, we infer the exporter specific trade costs from fixed-effect estimates $\hat{\tau}_i = e^{-(\hat{\eta}_i + \hat{\iota}_i)/\theta}$ and adjust the symmetric trade cost measure $\bar{\tau}_{ni}$ with

$$\tau_{ni} = \bar{\tau}_{ni}\sqrt{\hat{\tau}_i/\hat{\tau}_n}. \quad (17)$$

[9]We consider P_i as the simple average of the spatial price index across the following goods: Alcoholic beverages, bakery and other cereal products, clothing and footwear, dairy products and eggs, fruit and vegetables, gasoline, household furnishings and equipment, meat, poultry and fish, other food, personal care supplies and equipment, purchase of passenger vehicles, and tobacco products. Our results hold very closely if we only look at the All-Items index.

Figure 8: Comparing Two Methods to Estimate Trade Costs



Displays price-based trade cost estimates from equation 16 with the fixed-effect regression estimates from equation 17. Panel (a) interprets fixed-effects results as a province-specific export cost while panel (b) interprets the fixed-effects as an import cost.

If trade cost asymmetries were the result of region-specific *import* costs, we identify them in the same way but then $\tau_{ni} = \bar{\tau}_{ni}\sqrt{\hat{\tau}_n/\hat{\tau}_i}$.

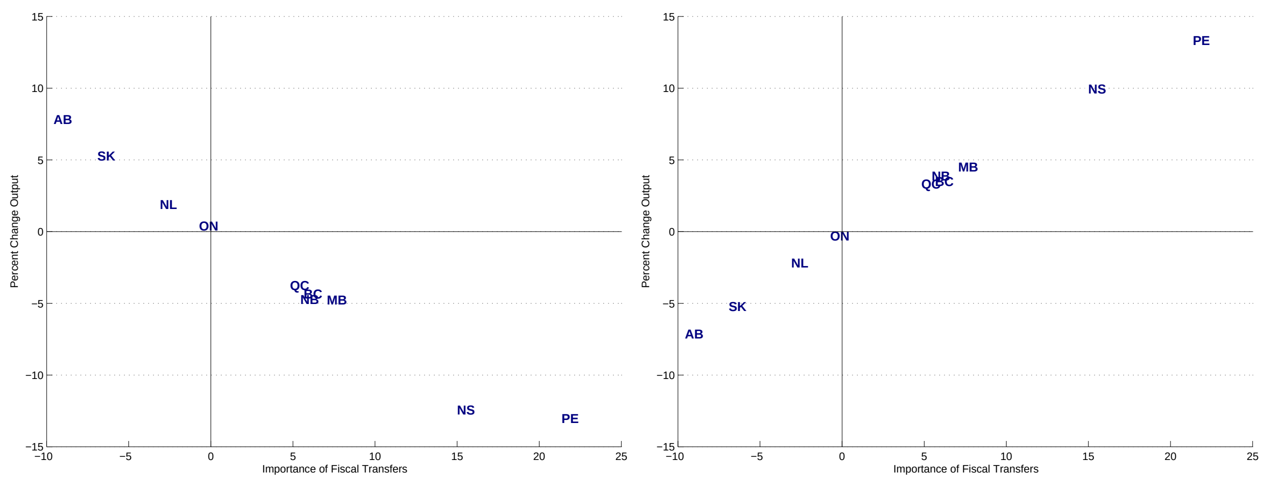
We plot both sets of τ_{ni} estimates in Figure 8. This exercise is important, as we do not have sectoral price level data across all regions. Based on the aggregate results, the export-cost specification is a good match to the price-based estimates. We therefore use the export-cost specification to estimate trade costs for all sectors.

Effect of Fiscal Transfers on Upstreamness - A Binary Metric

The main paper presents evidence that fiscal transfers lead have provinces to become more specialized in upstream sectors, and have-not provinces in downstream. We can illustrate this effect without relying on any particular measure of upstreamness. Instead, we separate all sectors into two groups: upstream and downstream. Resource, manufacturing, transport, and business services sectors are labeled upstream (specifically sectors with ISIC codes 01-37, 60-64, and 73-74). The other sectors are downstream sectors. In Figure 9, we plot the change in output of these two aggregate sectors. There is a clear pattern: upstream sectors shift towards "have" provinces while downstream sectors do the reverse. The magnitudes are also large. Alberta and Saskatchewan's upstream sectors, for example, expand more than 5% due to Canada's fiscal transfer systems. Meanwhile, the downstream sectors in Nova Scotia and Prince Edward Island expand as much as 10%.

Figure 9: Sectoral Reallocation Across Provinces in Response to Fiscal Transfers

(a) Upstream Sectors (b) Downstream Sectors



Displays the change in industry output (equivalently value-added) across provinces, where industries are aggregated into "intermediate" sectors (ISIC 01-37, 60-64, and 73-74) and "final goods" sectors (ISIC 40-55, 65-72, 75-93). The horizontal axis is the importance of fiscal transfers for each province, as measured by t_n.

The Canadian Journal of Economics
La Revue canadienne d'économique

Disclosure Statement

Under our *Conflicts of Interest and Ethical Guidelines for Authors*, this form should be appended to the submitted paper so as to be available to the editor and referees. For submissions with more than one author, a form must be completed by and attached for each of the authors. A short statement summarizing the information in this form will be included in the acknowledgment footnote of the published version of the paper. If one of the situations does not apply to you, please write "None".

Paper title: Fiscal Integration with Internal Trade: Quantifying the Effects of Equalizing Transfers

Sources of financial support: SSHRC Insight Grant 435-2015-0151

Interested parties that provided financial or in-kind support: n/a
(An interested party is an individual or organization that has a stake in the paper for financial, political or ideological reasons.)

Paid or unpaid positions in organizations with a financial or policy interest in this paper: n/a

If the paper was partly or wholly written under contract, please write the name of the organization: n/a

Does the paper satisfy all CJE guidelines on originality, authorship, and conflicts of interest as set out in the CJE's Conflict of Interest and Ethical Guidelines for Authors? Yes

Name, affiliation, and contact information:
Trevor Tombe
University of Calgary
ttombe@ucalgary.ca
403-220-8068

The Canadian Journal of Economics
La Revue canadienne d'économique

Disclosure Statement

Under our *Conflicts of Interest and Ethical Guidelines for Authors*, this form should be appended to the submitted paper so as to be available to the editor and referees. For submissions with more than one author, a form must be completed by and attached for each of the authors. A short statement summarizing the information in this form will be included in the acknowledgment footnote of the published version of the paper. If one of the situations does not apply to you, please write "None".

Paper title: Fiscal Integration with Internal Trade: Quantifying the Effects of Equalizing Transfers

Sources of financial support: SSHRC Insight Grant 435-2015-0151

Interested parties that provided financial or in-kind support: n/a
(An interested party is an individual or organization that has a stake in the paper for financial, political or ideological reasons.)

Paid or unpaid positions in organizations with a financial or policy interest in this paper: n/a

If the paper was partly or wholly written under contract, please write the name of the organization: n/a

Does the paper satisfy all CJE guidelines on originality, authorship, and conflicts of interest as set out in the CJE's Conflict of Interest and Ethical Guidelines for Authors? Yes

Name, affiliation, and contact information:
Jennifer Winter
University of Calgary
jwinter@ucalgary.ca
403-210-7889