A Genie in a Bottle?
Globalization and Domestic Inflation*

Dan Andrews† Peter Gal‡ William Witheridge§

May 20, 2020

Abstract

Declining inflation and rising trade integration over recent decades has sparked debate on the role of globalization in domestic inflation. This paper explores the implications of global value chain (GVC) integration for producer prices using industry-level data. We find rising participation in GVCs is associated with lower domestic inflationary pressure. Investigating the channels, we show increased GVC participation is associated with raising productivity and reducing wages in importing countries, especially when low-wage countries are integrated in supply chains. We also present evidence that GVC integration dampens the reaction of prices to domestic demand, but accentuates the impact of global demand.

JEL classification: F60, E31, L16

Keywords: Globalization, inflation, competition

*We thank Raphael Auer, Timothy Cogley, Luiz de Mello, Andrew Filardo, Mark Gertler, David Haugh, Nelson Lind, Catherine L. Mann, Giuseppe Nicoletti, Pablo Ottonello, Nigel Pain, Łukasz Rawdanowicz, Dorothée Rouzet, Elena Rusticelli, Sharon Traiberman, David Turner, Beth Anne Wilson and participants at the seminars at the Bank for International Settlements, the OECD, the Reserve Bank of Australia, the Australian Treasury and at the Annual Meeting of the French Economic Association (AFSE), for their valuable comments and Isabelle Fakih and Sarah Michelson for providing helpful editorial assistance. The views expressed in this paper are those of the authors and do not necessarily reflect those of the OECD or its member countries.

†Chief Advisor, Macroeconomic Group, Australian Treasury. Email: dan.andrews@treasury.gov.au.

‡Senior Economist, Economics Department, OECD. Email: peter.gal@oecd.org.

§Corresponding author. PhD Student, Economics Department, New York University. Email: william.witheridge@nyu.edu.

1 Introduction

The combination of low inflationary pressures against a backdrop of strengthening aggregate demand and expanding integration in global value chains (GVCs) in recent years suggests that the structural drivers of inflation might have changed – an idea that dates back to at least Rogoff (2003) but resurfaced more recently (Bianchi and Civelli 2015; Auer, Borio and Filardo 2017). In this context, this paper provides industry-level evidence that an increasing reliance on foreign suppliers in advanced economies has been associated with downward pressure on domestic producer prices, by increasing the ability of firms to substitute domestic inputs with cheaper foreign equivalents (including outsourcing).

Our paper contributes to the trade literature on the fragmentation of GVCs and to the macroeconomic literature on the drivers of low inflation. We provide sectoral-level, cross-country evidence on the channels through which global competition can affect domestic inflation using a combination of various cross-country industry-level data sources over the period 1995-2014 for 22 countries and 33 industries. Our preferred indicator is backward GVC participation (measuring the share of foreign imported content used in domestic production), which allows us to examine a different channel - the role of intermediate inputs in production - than most previous studies which use imports as a share of production.[1] We focus on this measure because greater trade in intermediates exerts particularly strong competitive pressures compared with trade for final goods and services as they increase contestability and substitutability through the production process and are reinforced further along domestic supply chains. Moreover, our Trade in Value Added (TiVA) based indicator focuses on the structural component of global supply chain integration, in contrast to traditional import penetration measures, which can be directly affected by cyclical demand shifts and commodity price changes. Finally, our industry-level approach also provides better identification than purely macro-level analyses by controlling for all time-varying country-specific and industry-specific global shocks absorbed by an appropriate set of fixed effects.

Rising imports in advanced economies – particularly from Asia and Central and Eastern Europe (Baldwin 2013) – can raise competition and lower domestic prices through several

[1] As detailed below, backward GVC participation is defined as foreign value added embodied in exports (this share is equal for domestic production in our data) and excludes final good imports.

channels: (*i*) increasing *contestability* for factors of production (importing intermediate inputs) and on the market for final goods (importing final goods); (*ii*) increasing *substitutability* by being able to shift elements of the production process across borders and choose cheaper suppliers; (*iii*) raising *productivity* through a larger variety and cheaper imports that can be used as inputs and allow for lower output prices (Bloom, Draca and Van Reenen 2015). A systematic test of these channels is provided by Chen, Imbs and Scott (2009), who develop a modified Melitz and Ottaviano (2008) model and use data on manufacturing sectors in 7 advanced European economies. They find that greater trade openness is associated in the short-run with lower relative prices, higher productivity and lower markups. Similarly, research by the IMF (2006) covering 13 advanced economies for 22 industries finds that a higher import share of production has a significant negative effect on relative prices, unit labor costs and wages. Auer and Fischer (2010) focus specifically on imports from low-wage countries for 325 manufacturing industries in the United States and find that greater import competition has reduced producer prices.

We contribute to this strand of trade literature by taking into account GVCs explicitly and more systematically across a large number of countries and sectors, by using data from the recent TiVA joint initiative of the OECD and WTO. TiVA measures where value is created and embodied in goods and services that are traded and consumed worldwide at the level of detailed industries (Hummels, Ishii and Yi 2001; Johnson and Noguera 2012).

Our results show that increases in GVC participation – as measured by higher foreign value added content of gross exports – are associated with lower producer price inflation. The economic magnitudes are significant too: the observed rise in GVCs is associated with 0.15 percentage points lower annual producer price inflation on average, but this magnitude is more than double in some countries with a large increase in GVC participation. Next, we explore the mechanisms at play, which suggests that increased GVC participation is associated with lower inflation via downward pressures on unit labor costs (through raising productivity and reducing wages) in the importing countries, especially when low-wage countries are integrated in their supply chains. These results also imply that domestic inflation in advanced economies could remain contained to the extent that the composition of GVCs continues to shift towards low-wage countries.

Our paper also relates to the macroeconomic literature on the causes of low inflation, with a focus on globalization. A central issue for monetary policy is whether national or international factors determine inflation predominantly and whether the weight of these factors have changed over time (Bernanke 2007; Draghi 2016; Carney 2017). Some studies have shown that globalization – measured by increased trade openness – exerted a significant negative effect on prices in advanced economies or argued that rising globalization – especially GVC integration – accentuated the importance of global relative to domestic factors for inflation (Borio and Filardo 2007; Bianchi and Civelli 2015; Auer et al. 2017; Auer, Levchenko and Sauré 2019).[2] In particular, using cross-country aggregate data, Auer et al. (2017) analyze how GVC participation and other openness measures shape the propagation of global economic slack onto domestic inflation. They find that as GVCs have expanded from 1982 to 2006, this foreign output gap term has become more important relative to the domestic output gap as a determinant of domestic inflation. Yet, other analyses have disputed the size or relevance of these structural changes. Ihrig et al. (2010) follow Borio and Filardo (2007) in estimating a standard Phillips Curve framework for 11 advanced economies but use an alternative foreign output gap measure[3] and find limited support for globalization (measured by traditional trade penetration) affecting the domestic inflation process.[4]

We undertake industry-level analysis to contribute to this literature on the role of globalization in driving inflation outcomes, which has previously been undertaken mostly at the country-aggregate level.[5] While aggregate approaches provide useful views of the overall

[2]Bianchi and Civelli (2015) use country-level data to examine the role of global economic slack (similarly measured by the foreign output gap) and find that global factors affect domestic inflation and trade openness enhances the relative importance of the foreign over the domestic output gap. Auer, Levchenko and Sauré (2019) examine GVCs as a driver of *comovement* in producer price inflation across countries (similarly using sectoral data), whereas we examine if GVCs are associated with a lower *level* of producer price inflation.

[3]We follow Ihrig et al. (2010) and Bianchi and Civelli (2015) in using the largest possible number of trading partners to construct our foreign output gap measure (46 countries in our dataset; Ihrig et al. use 36 and Bianchi and Civelli use 50) rather than the top 10 trading partners for a given year as in Borio and Filardo (2007).

[4]Using a similar approach, earlier work for the United States (Tootell 1998; Ball 2006) and more recently for the euro area (ECB 2017) also find little evidence to support global factors driving changes in inflation.

[5]There is a related literature on sectoral heterogeneity in price setting and the implications for monetary policy (see for example Imbs, Jondeau and Pelgrin 2011). These papers generally adopt a New Keynesian framework with multiple sectors to derive an industry-level Phillips curve which relates industry-level inflation to the industry-level output gap (or marginal costs) and expected future industry-level inflation. We focus on the role of GVC integration in propagating domestic and global economic activity and the impact on inflation measured at the industry-level.

macroeconomic picture, they encounter identification problems to the extent that unobserved time-varying country-specific shocks (aggregate demand, for instance) are correlated with domestic inflation and globalization. We are better able to confront this identification challenge by relying on rich cross-country industry-level data. Our disaggregate approach makes it possible to apply a rich fixed effects structure that can control for time-varying country-specific shocks, global industry shocks and time-invariant country-industry features.[6]

Specifically, we examine if there is global economic slack (i.e. less pressure in global factor markets), does this weigh on inflation more in industries with greater GVC integration? We find that a higher level of GVC integration is associated with dampened producer price inflation via increasing the impact of global economic slack on domestic inflation. Given an average foreign output gap of -1.5 per cent in our sample in 2014, we find that the observed rise in GVC integration was linked with annual producer price inflation being on average 0.25 percentage points lower in 2014, relative to a counterfactual where GVCs remained at 1996 levels. The corresponding figure is more than 0.5 percentage points lower, however, for countries that experienced a particularly large rise in GVC participation.

The paper proceeds as follows. The next section discusses the industry-level data and GVC measurement, presents stylized facts on changes in GVC integration since the mid-1990s, as well as preliminary evidence on the link between GVCs and inflation. Section 3 presents our econometric framework. Section 4 provides the results and estimated impact of the expansion of GVCs on inflation, wages and the propagation of global shocks. Section 5 concludes.

2 Data and preliminary evidence

2.1 Data description

This paper exploits harmonized cross-country industry-level data, sourced from three recently released databases: the OECD-STructural ANalysis (STAN) database, the OECD-

[6]By controlling for country-specific factors, our identification relies on differences across industries, hence exploits relative price changes as opposed to absolute country-level price changes. Accordingly, we interpret our results as providing insights for inflationary pressures related to GVC integration, and do not take a stance on actual aggregate inflation which resulted and depends on the response of monetary policy.

Trade in Value-Added (TiVA) database and the OECD-TiVA Nowcast database. Our dependent variables: prices, unit labor costs, wages and labor productivity are drawn from STAN. We exploit the TiVA databases because measuring trade in value-added terms provides a clearer and more nuanced picture of global integration than gross trade flows. Our final dataset contains industry producer prices[7], unit labor costs, wages, labor productivity and GVC indicators covering 22 OECD countries annually over the period 1995 to 2014 for 33 industries at the detailed 2-digit level of the ISIC Revision 3 industrial classification system. This provides almost 12,000 country-industry-year observations in the baseline specification, which focuses on the link between producer prices and GVC indicators at the industry level. For more details on the data, see Appendix A.1.

2.1.1 GVC indicators

We examine several relevant GVC indicators motivated by the existing literature. Following Johnson and Noguera (2012), our primary variable of interest is the Backward Participation in GVCs indicator, defined as the foreign value added content of gross exports as a share of gross exports, at the country-industry level.[8] This is an intensity measure ranging between 0 and 100 per cent, capturing global integration of the production process through buying or sourcing internationally and the share of this foreign content embodied in a country's exports.[9]

Importantly, our baseline Backward Participation in GVCs indicator captures the indirect impact of foreign imported content through domestic value chains, rather than the direct impact on final demand, differentiating it from standard import intensity measures. To illustrate this with an intuitive example, our baseline GVC indicator captures the role of value added embodied in the imported components of German cars coming from Eastern Europe, but abstracts from German consumers purchasing Japanese cars on the German market (i.e. direct imports of final goods). We make this distinction in order to isolate the structural

[7] We measure producer prices by industry-level gross output deflators.

[8] Auer et al. (2017) also focus on this GVC variable in their analysis of inflation at the country level.

[9] Given the assumptions of the TiVA database that exporters and domestic producers combine foreign output in the same proportion, this intensity measure is the same for domestic production as well as for exports. Put differently, a low export propensity of certain sectors (e.g. construction) still leaves our baseline measure relevant as it captures the intensity of backward global integration of that sector.

component of GVC integration, since alternate measures – such as the foreign value added embodied in domestic final demand or traditional measures of import penetration – are more likely to be directly affected by cyclical (domestic) demand factors and relative price shifts. For instance, an oil price increase can induce rising producer prices of the industries that are heavy users of imported oil, leading to a positive correlation between import penetration and inflation. This would make it more difficult to capture the structural, and potentially moderating, impact of higher GVC integration on inflation. Nevertheless, we also show results on the link between industry inflation and these alternative measures.

Since we are interested in the structural – or medium- to long-term – component of GVC integration, we take further steps (outlined in more detail in Section 3) to abstract from the influence of large relative price shifts. First, we always include country-year interacted fixed effects in our regressions to control for cyclical variations or exchange rate shocks. Second, we use a five-year long difference specification to filter out the impact of any short-run (e.g. year-to-year) changes in GVC intensities as well as prices. Finally, to further mitigate the role of large shifts in commodity prices during the Great Recession and its aftermath, we also estimate our baseline econometric specification using pre-2007 data only.

Finally, we exploit the bilateral trade block of the TiVA database to construct GVC indicators that take into account the source country of foreign value added content. More specifically, we create variables to proxy GVC integration with both "high-wage" and "low-wage" countries based on the level of economic development of the source country.[10]

2.1.2 Other variables

We also draw on a number of structural and policy variables to test the robustness of our baseline results. These include: (*i*) a measure for information and communications technology (ICT) capital intensity, defined as the ratio of real ICT to non-ICT capital services, sourced from the latest EU KLEMS database (Jäger 2017); (*ii*) the stringency of employment protection legislation (EPL) of regular contracts (OECD 2013), interacted with a sector-specific measure for EPL exposure, taken to be the layoff rate from the United States

[10]The group of "high-wage countries" is those that are part of the EU-15 (EU members prior to 2004) plus Australia, Canada, Japan, New Zealand, Norway, Switzerland and the United States, and "low-wage countries" are all other countries, including, among others, Asia and Eastern Europe.

(Andrews and Cingano 2014); and (*iii*) the OECD regulatory burden indicator, which measures the knock-on effects of product market regulations in upstream sectors on downstream sectors via input-output linkages (Bourlès et al. 2013; Égert and Wanner 2016).

When we explore how GVCs shape the propagation of the global economic cycle on industry-level inflation, we exploit annual data on output gaps (sourced from the November 2017 OECD *Economic Outlook* database) to estimate domestic and foreign output gap for a particular industry in a country. Similar to Ihrig et al. (2010) and Bianchi and Civelli (2015), adapted to the industry level, we combine bilateral industry-level GVC data from the OECD TiVA and TiVA Nowcast with these national output gap data to create a country-industry-year specific foreign output gap variable. This is done by weighting the output gap of each trading partner based on the partner's share of the foreign value added (imported) content for a particular sector.[11] In this manner, the weighting is consistent with our main variable of interest, the Backward Participation in GVCs indicator.[12]

2.2 Preliminary evidence on GVCs and inflation

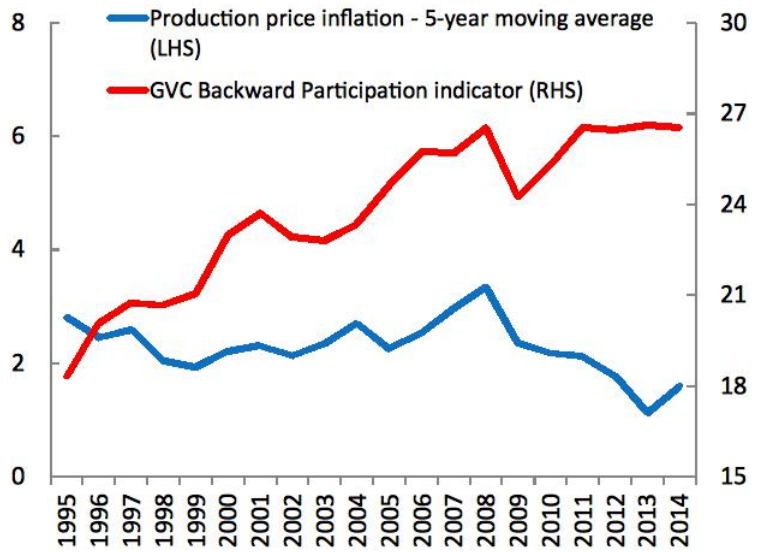
Basic descriptive statistics from our combined database (Table 1), show that industry-level producer price inflation averaged about 2% per year during our sample period, while GVCs have expanded by about 1.4% per year. Figure 1 shows that GVC integration – as measured by the Backward Participation indicator – expanded significantly from the mid-1990s until the Great Recession, while inflation remained relatively subdued. Over the post-Great Recession period, GVCs have flattened off and remained around the previous peak, while producer price inflation has fallen dramatically and remains low. Going beyond these simple correlations, Section 3 sets out our econometric framework, which controls for the potentially confounding impact of unobservable shocks at the country, industry and year level.

[11]For example, if for an industry in a particular year half the foreign value added comes from foreign country *A* with an output gap of -2 per cent, and the other half of foreign value added comes from foreign country *B* with an output gap of zero, the industry-specific foreign output gap variable will be -1 per cent.

[12]The national output gap data used to construct the foreign output gap variable covers 46 countries which includes the majority of the foreign value added content (greater than approximately 80 per cent in each year) for the countries in our sample.

Figure 1. Global value chains and inflation

Per cent

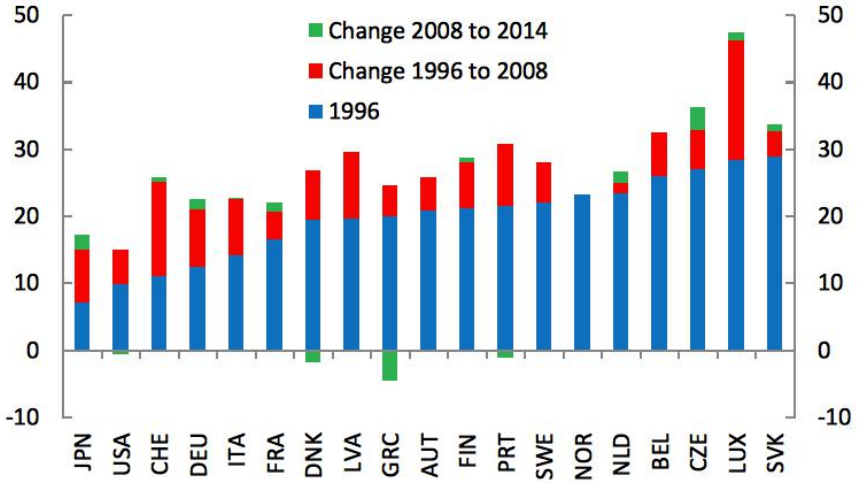


Note: Unweighted averages across all country-industry cells where data are available. Backward participation in GVCs is the foreign value added share of a sector's gross exports.
Source: OECD STructural ANalysis (STAN) database; OECD Trade in Value-Added (TiVA) database; OECD TiVA Nowcast; and authors' calculations.

We see significant differences in the level of GVC participation across countries (Figure 2) and industries (Figure 3). For example, large economies with significant internal markets, such as the United States, are characterized by lower GVC integration, whereas smaller European economies generally have the largest share of foreign value added in their own exports. Across industries, manufactured goods have much higher GVC participation than services sectors. This industry composition also contributes to the country aggregate differences. As for the time series profile, we observe upward trends for most countries and industries from the mid-1990s up to the Great Recession. Among the major advanced economies, Germany and Japan have seen a significant *percentage* increase in their share of foreign value added inputs. Regarding industries, those with the largest *relative* increases in GVC participation include the telecommunications and chemicals sectors. Since the Great Recession, GVC participation has plateaued or slightly declined in most industries due to weak global trade and declined in some countries which suffered large downturns (e.g. Greece and Portugal).

Figure 2. Global Value Chain Backward Participation indicator by country

Per cent

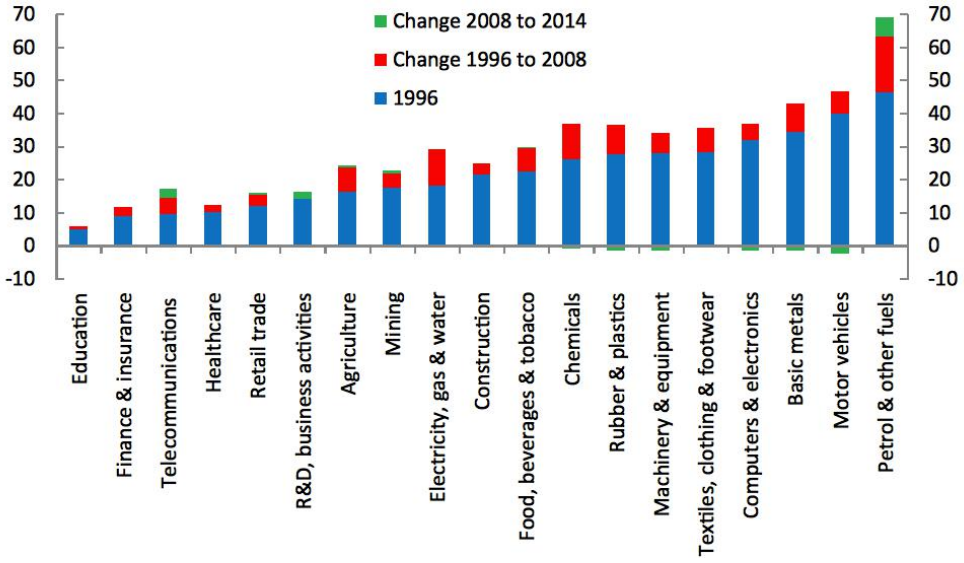


Note: Unweighted average across sectors in each country. Backward participation in GVCs is the foreign value added share of a sector's gross exports. For LVA, change for 2008 to 2014 is not available. 1996 data are not available for MEX, POL and SVN.

Source: OECD Trade in Value-Added (TiVA) database; OECD TiVA Nowcast; and authors' calculations.

Figure 3. Global Value Chain Backward Participation indicator by sector

Per cent

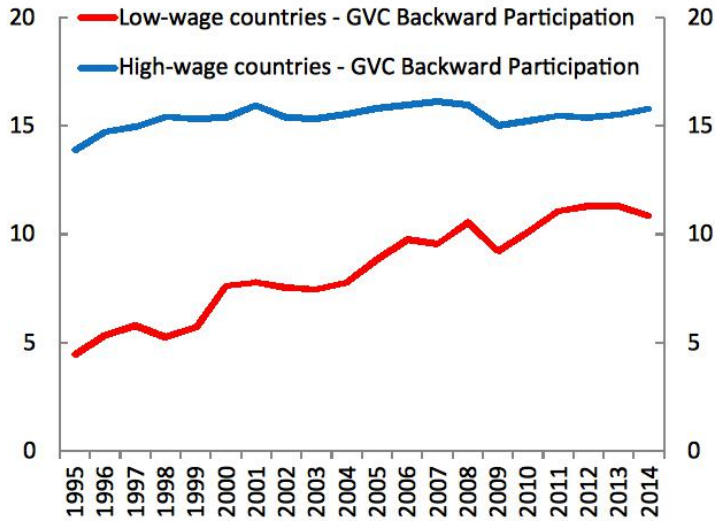


Note: Unweighted average across countries in each sector. Backward participation in GVCs is the foreign value added share of a sector's gross exports. The figure shows a subset of industries out of the total 33 industries in our sample.

Source: OECD Trade in Value-Added (TiVA) database; OECD TiVA Nowcast; and authors' calculations.

Figure 4. Countries with lower wages have been contributing more to GVCs

By source country groups, Per cent



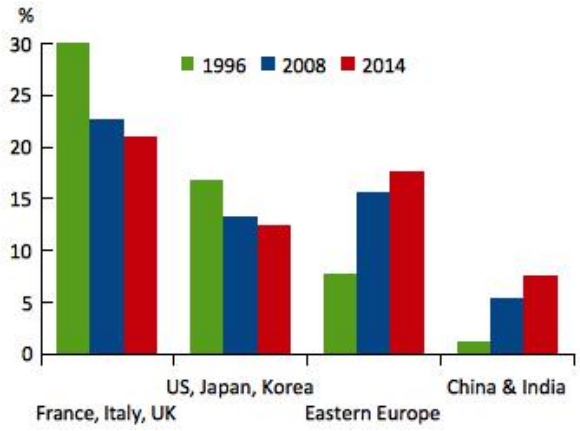
Note: "High-wage countries" are those that are part of the EU-15 (EU members prior to 2004) plus Australia, Canada, Japan, New Zealand, Norway, Switzerland and the United States; "Low-wage countries" are all other countries in the TiVA database. Unweighted average across all country-industry cells where data are available. Backward participation in GVCs is the foreign value added share of a sector's gross exports.
Source: OECD Trade in Value-Added (TiVA) database; OECD TiVA Nowcast; and authors' calculations.

The TiVA data allow for differentiating by the *partner countries* from where the intermediate inputs are purchased. Doing so reveals an important shift in the composition of GVCs, with low-wage countries becoming increasingly integrated into global supply chains since the mid-1990s (Figure 4). We also highlight two examples of this change in the country composition of foreign value added. Focusing on the motor vehicles industry in Germany, Figure 5 (Panel A) shows that Eastern Europe, China and India's share of total imported foreign value added content in exports has increased by about 16 percentage points between 1995 and 2014. The corollary is a decrease in the reliance on more traditional trading partners, both within Europe (e.g. France, Italy and the United Kingdom), and further abroad (e.g. the United States, Japan and Korea). Panel B documents similar patterns in the Italian textile industry, with the increasing role of China and India particularly prominent. Importantly, this shift in the composition of GVCs toward low-wage countries continued from 2008, which potentially implies further disinflationary impacts of GVCs, even if the

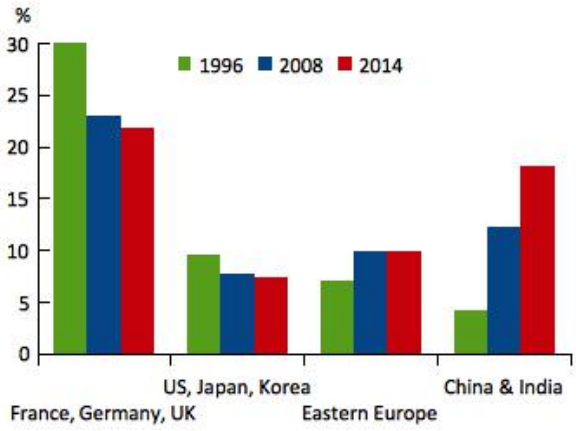
aggregate indicator has remained largely unchanged after then (as shown in Figure 1).

Figure 5. The composition of foreign value added by source country groups – two examples

A. Germany – motor vehicles



B. Italy – textiles



Note: The category "Eastern Europe" in the figures contains the following countries: Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovak Republic, Slovenia and Russia. "Motor vehicles" is the industry "Motor vehicles, trailers and semi-trailers" (ISIC Rev.3 code 34) and "Textiles" is the industry "Textiles, textile products, leather and footwear" (ISIC Rev.3 codes 17, 18 and 19). *Source:* OECD Trade in Value-Added (TiVA) database; OECD TiVA Nowcast; and authors' calculations.

3 Econometric framework

3.1 Baseline model

To more rigorously explore the link between inflation and global value chain integration, we estimate the following long difference specification:

$$\Delta^{ld} Y_{c,s,t} = \beta_0 + \beta_1 \Delta^{ld} GVC_{c,s,t} + \sum_j \gamma_j \Delta^{ld} X^j_{c,s,t} + \delta_{c,t} + \delta_s + \varepsilon_{c,s,t} \quad (1)$$

where: Δ^{ld} denotes the long difference operator, corresponding to five years in the baseline specification[13]; $Y_{c,s,t}$ denotes producer prices in the baseline estimation; $GVC_{c,s,t}$ the GVC

[13]The results are not particularly sensitive to the choice of the length of the long difference window.

Backward Participation indicator, where all variables are measured in log terms; and when appropriate, we include control variables (contained in the vector $X^j_{c,s,t}$) in long differences, such as ICT intensity and product and labor market regulations. We use an overlapping five-year long difference specification (e.g. 2014-2009, 2013-2008, etc.)[14] to maximize the use of our data and to reduce the influence of short-term fluctuations in industry prices and GVC participation, since we are interested in the structural (medium- to long-term) relationship. Given we use an overlapping five-year difference specification, we cluster robust standard errors at the country-industry pair level (Bloom, Draca and Van Reenan 2015).

The baseline model includes interacted country-year fixed effects ($\delta_{c,t}$) to control for omitted time-varying country-specific shocks (e.g. macroeconomic shocks, exchange rate fluctuations, macroeconomic and structural policy changes) and industry fixed effects (δ_s) to control for time-invariant industry factors (e.g. technological differences in market structure). This choice of fixed effects structure implies that we are identifying off within-industry changes in GVC participation once we have purged the data of time-varying aggregate shocks.

While including a rich set of fixed effects arguably leads to cleaner identification, it may also mean that we abstract from certain macro-level channels through which GVC integration affects inflation, implying that our estimates can be considered a lower-bound. For example, our country-year fixed effects could absorb any moderating influence on wage growth – and by implication, inflation – that may arise from a general perception among workers that they face greater competition from foreign labor. In a similar vein, our coefficient estimates will abstract from the potential for higher GVC integration to reduce inflation expectations over the long-run. As noted earlier, technological advances – especially digitalization – have enabled the expansion of GVCs so we are not solely picking up the effect of globalization on inflation and wages. For completeness, we also run specifications including industry-year fixed effects ($\delta_{s,t}$) to control for omitted time-varying sector-specific shocks (e.g. global commodity price cycles, sector-specific technology shocks) and country-industry fixed effects ($\delta_{c,s}$) to control for time-invariant country-industry specific factors.

Finally, our main parameter of interest is β_1. If the dependent variable ($Y_{c,s,t}$) is producer prices (as in our baseline specification) and $\beta_1 < 0$, then an expansion of GVC integration

[14] We find similar results using non-overlapping five-year differences.

– i.e. imported inputs are used more intensively in a given country's exports – is associated with lower inflationary pressure. Given the extensive set of fixed effects capture virtually all important suspects for omitted factors (country business cycles, industry-wide commodity price fluctuations and technological changes), the risk of endogeneity is limited. It is also difficult to point to a mechanism that would lead to a negative relationship between backward GVC participation and producer price inflation – other than the channel we are interested in (i.e. more competition through imported intermediates).[15]

3.2 Channels and other extensions

To better understand the channels through which GVC integration is linked to industry inflation, we carry out a number of tests. First, we run a series of regressions where the dependent variable in Equation 1 pertains to unit labor costs, wages or labor productivity. Second, we explore the extent to which our baseline results are driven by GVC integration with low-wage countries using the indicators described in Section 2. Finally, Section 4.3 investigates whether a higher level of GVC integration dampens the impact of domestic aggregate slack relative to global economic slack (the methodology is described there).

4 Empirical results

4.1 GVC expansion and producer price inflation

Table 2 shows the baseline estimates for the five-year long difference specification (Equation 1) for producer prices. Regardless of the fixed effects structure – which becomes increasingly burdensome as we move across columns – the change in the industry producer prices is negatively related to the change in GVCs and the coefficient is statistically significant at the 1% level. This suggests that within industries, increasing integration in GVCs has been associated with lower producer price inflation over the sample period.

[15]Still, it might happen that productivity improvements lead to both lower prices and more imports in cases when new technologies require more types of intermediates that are only available from abroad. We include ICT capital services as a proxy for country-industry specific technological change among our robustness tests and find similar results. However, since it is only a proxy and incomplete measure for technological improvements, we avoid the use of causal language when interpreting the results.

The negative relationship between the change in GVCs and producer prices uncovered in Table 2 is robust to a number of tests. First, we re-estimate using pre-Great Recession data only to further control for the impact of large shocks on inflation and trade (Appendix Table A.2).[16] Second, we use non-overlapping five-year changes and find the coefficients remain significant and of very similar magnitude (Table A.3). Third, we use price changes one year ahead as the dependent variable to capture a potential delay in the effect of changes in GVCs on industry prices (Table A.4). Fourth, we control for within-country industry-level variation in product market regulations, employment protection legislation and the ICT capital share to address the concern that our baseline estimates are simply picking up structural reforms or the role of technology (Table A.5).[17] Fifth, the GVC term remains negative and significant when we control for the traditional trade openness measures such as change in the import share of production (Table A.6). Indeed, once the role of GVCs is taken into account, we find that this conventional measure of trade openness has limited power in explaining the structural link between globalization and domestic producer price inflation, consistent with Auer et al.'s (2017) findings based on aggregate data.[18]

Finally, the negative relationship between GVC integration and prices is robust to using alternative measures of GVC integration such as foreign value added in domestic final demand (Table A.7). These measures are more likely to be directly affected by cyclical demand factors and relative price shifts than our baseline backward participation in GVCs indicator, as domestic demand shocks for foreign final goods lead to a positive correlation between industry output prices and these types of final demand-based GVC measures (see Section 3). This could explain why their negative coefficients are less pronounced (i.e. smaller in absolute value) than those for our baseline GVC measure.

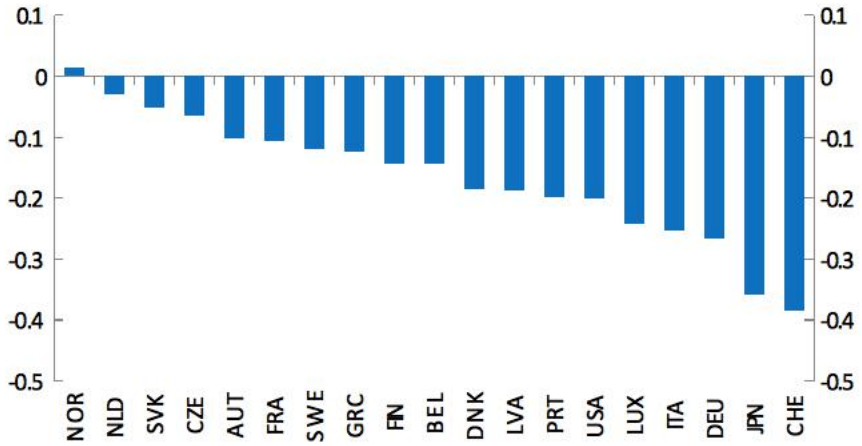
[16]The baseline results are also robust to excluding very small globally-integrated economies, such as Luxembourg and Switzerland.

[17]The ICT capital share is admittedly a somewhat limited measure of technological change. Exploring this important issue further is outside the scope of this paper.

[18]This could be driven by the stronger sensitivity of the import share of production measure to commodity price shocks, which in turn can induce a positive correlation between industry output prices and import intensity (e.g. imported oil price increases leading to price hikes in automotive fuel).

Figure 6. Lower inflation with GVC expansion over 1996-2008

Estimated relationship between GVCs and average annual producer price inflation, percentage points



Note: The figure shows the annual change in producer price inflation based on the estimated relationship between the production deflator and GVCs using the coefficient estimate in column 1 of Table 2 and the observed increase in GVCs in each country. The estimates are the unweighted averages over industries in each country from 1996 to 2008. MEX, POL and SVN not shown as data on GVCs are not available for 1996.
Source: Calculations using estimation results from Table 2 and the OECD Trade in Value-Added (TiVA) database.

To estimate the economic significance of the baseline results, Figure 6 performs a counterfactual exercise of the implied reduction in producer price inflation associated with the observed rise in GVC participation from 1996 to 2008, relative to a situation where GVC participation remained at 1996 levels.[19] On average across countries, annual producer price inflation is estimated to have been 0.15 percentage points lower on average over 1996-2008 than if GVC participation had not risen.[20] The results vary across countries because of differences in the level and change in GVC participation. For example, in Germany – where the level of GVC integration almost doubled (Figure 2) – annual producer price inflation was

[19]The assumption behind this *ceteris paribus* counterfactual exercise is that the increase in GVC participation in certain sectors did not affect producer prices in sectors where GVCs remained constant. Consistent with this is the admittedly simplistic assumption that monetary policy is held constant (i.e. would not have reacted differently), thus allowing for average producer price inflation to change. See more discussion on this in Section 5.

[20]During this period annual producer price inflation averaged 2.5 per cent in our dataset.

on average 0.25 percentage points lower. This figure conceals considerable variation across industries within Germany, however, with the disinflationary link equivalent to around 0.6 percentage points in the telecommunications industry (where GVC participation increased by more than threefold) and 0.2 percentage points in the motor vehicles industry (where GVC participation increased by 50 per cent).

4.2 Channels: GVC expansion and labor costs

Stronger integration into GVCs can lead to lower domestic prices via several channels (see Section 1). It can put downward pressure on wage growth through the use of foreign workers embodied in inputs who thus become more direct competitors to domestic workers (increased substitution and contestability on input markets). Moreover, a wider pool of foreign suppliers enables domestic firms to access better quality and/or cheaper imported inputs that may further decrease output prices. Stronger GVC integration can also raise productivity, which together with lower wages, reduces unit labor costs. While an exact decomposition of these channels would require a more structural approach – since wages and productivity are interrelated – we shed some light on these issues using our econometric framework. Accordingly, Table 3 shows the baseline estimates for the five-year long difference specification (Equation 1) for unit labor costs by sector with the similar fixed effects structure. In each case, the change in the industry unit labor costs is negatively related to the change in GVCs and the coefficient is statistically significant, suggesting that cost reduction is an important part of the mechanism.

To provide further evidence on this, we next explore how prices, wages and labor productivity in advanced economies are shaped by backward GVC integration with "high-wage" and "low-wage" countries. If the input cost reducing effects from such integration are important, then we would expect that using inputs from low-wage countries will have a stronger price-moderation effect. Column 1 of Table 4 indeed shows that the change in the industry producer prices is negatively related to the change in both GVC variables, but only for GVCs with low-wage countries is the coefficient statistically significant. This indicates that GVC integration with low-wage countries is especially strongly linked with reduced inflation. Focusing on industry real wages (column 2) yields similar results with the coefficient on the

low-wage countries GVC term negative and statistically significant when controlling for labor productivity (which is strongly correlated with real wages).[21] This is consistent with the hypothesis that GVCs in advanced economies exert a stronger downward pressure on domestic wages due to the threat of using foreign suppliers (outsourcing). Column 3 shows that for the change in industry labor productivity – for both GVCs with high-wage and low-wage countries – the coefficient is positive and statistically significant. This implies that industries with greater GVC integration either with high-wage or with low-wage countries are both associated with larger increases in labor productivity. This provides support for the idea that both cheaper and better quality inputs can play a positive role for the productivity of domestic sectors.

4.3 Propagation of shocks: the level of GVCs and the global economic cycle

4.3.1 Methodology

In this section we explore how the level of GVC participation is related to the propagation of domestic and global economic slack in foreign product and labor markets on domestic inflation. Specifically, if foreign output gaps are negative so there is less pressure in global factor markets, does this weigh on inflation more in industries with greater GVC integration? As described in Section 2.1, global slack is measured by the country-industry-year specific foreign output gap variable $ForeignYGap_{c,s,t}$, building on Borio and Filardo (2007) and Ihrig et al. (2010) and adapting it to the industry level. We first rely on continuous variation in the output gap variables (Equation 2). This specification relates the log change in producer prices to the log level of GVCs and interactions of GVCs with the country-year specific

[21] The significant impact of GVCs on labor productivity and the strong relationship between wages and productivity motivates including labor productivity in the wage equation as a control variable. Doing so reveals that there is a separate, additional effect of GVC integration on wages, beyond the indirect impact through productivity.

domestic output gap and country-industry-year specific foreign output gap:

$$\begin{aligned}\Delta P_{c,s,t} = \beta_0 + \beta_1 \Delta GVC_{c,s,t} + \beta_2 ForeignYGap_{c,s,t} + \beta_3 ForeignYGap_{c,s,t} \times GVC_{c,s,t} \\ + \beta_4 DomesticYGap_{c,t} \times GVC_{c,s,t} + \delta_{c,t} + \delta_s + \varepsilon_{c,s,t}\end{aligned} \tag{2}$$

Our working hypothesis is $\beta_3 > 0$, that is for higher GVC integration, a more negative foreign output gap will put greater downward pressure on inflation. This would indicate that global economic slack is more important for domestic price changes with high GVC participation. In this exercise, we exploit the annual variation in domestic and foreign output gaps and over the course of the business cycle to explore how the level of GVC integration shapes the propagation of foreign – relative to domestic – slack onto domestic producer price inflation. As in the baseline model, the fixed effects structure controls for unobserved time-varying country-specific shocks ($\delta_{c,t}$) and time-invariant industry (δ_s) factors.[22] Finally, robust standard errors are clustered at the country-industry level. We then test for potential asymmetries (Equation 3) by defining a dummy variable pertaining to "foreign slack" when there is a negative foreign output gap (i.e. $ForeignSlack = 1$ when $ForeignYGap < 0$). This allows us to test the hypothesis that foreign inputs are used more heavily when there is slack in those foreign source country-sectors, captured by:

$$\begin{aligned}\Delta P_{c,s,t} = \beta_0 + \beta_1 \Delta GVC_{c,s,t} + \beta_2 ForeignYGap_{c,s,t} + \beta_3 ForeignYGap_{c,s,t} \times GVC_{c,s,t} \\ + \beta_4 ForeignSlack_{c,s,t} + \beta_5 ForeignSlack_{c,s,t} \times GVC_{c,s,t} \\ + \beta_6 DomesticYGap_{c,t} \times GVC_{c,s,t} + \delta_{c,t} + \delta_s + \varepsilon_{c,s,t}\end{aligned} \tag{3}$$

4.3.2 Results

Table 5 (column 1) shows the estimates for Equation 2 of industry producer price changes and GVC integration via foreign and domestic output gaps including country-year fixed effects and separate industry fixed effects. Column 2 adds country-industry fixed effects. In both specifications, the change in the industry producer prices is positively related to the interaction between the foreign output gap and the GVC indicator, and the coefficient is statistically significant at the 1% level. This provides industry-level evidence that globaliza-

[22]Note that the separate domestic output gap term is absorbed by the country-year fixed effects.

tion and global economic slack affect domestic producer price inflation, consistent with the country-aggregate results of Bianchi and Civelli (2015) and Auer et al. (2017).

Table 5 (column 3) also shows the estimates for Equation 3, which includes a dummy variable for foreign slack, i.e. taking a value of 1 when the foreign output gap variable is negative, indicating that activity in a country's source markets are currently below potential output. We find that the presence of foreign slack is associated with downward pressure on producer prices and that GVCs are linked to the propagation of shocks via foreign slack from the additional interaction term. When adding country-industry fixed effects (column 4), the coefficient estimates and standard errors are close to the simpler specification of column 3. This provides evidence that GVC integration creates an option for firms to exploit cheaper intermediates abroad, and that they exercise this option when it makes sense to do so – i.e. when there is slack in foreign product and labor markets, as opposed to tightness.[23] Taken together, these results imply that weak global demand (as indicated by large negative foreign output gaps) is related to lower inflation when GVC participation is higher.

The coefficient estimates are robust to restricting the sample to the pre-Great Recession period (Table A.8, column 6) and to using alternative measures of GVC integration that rely on foreign value added embodied in domestic final demand – and not in exports (Table A.8, columns 1-4). Similarly to when testing for the level of GVCs alone (Table A.7), the size of the coefficient of our baseline GVC measure (Table A.8, column 5) is the largest among the alternative measures, reflecting a more accurate measurement of foreign inputs in production.

Figure 7 performs a counterfactual exercise of the implied reduction in inflation given the expansion of GVCs and negative foreign output gap for each country at the end of our sample period in 2014 (when the average foreign output gap was -1.5 per cent).[24] This exercise suggests that the rise in GVCs from 1996 to 2014 is associated with 0.25 percentage points lower annual producer price inflation in 2014, on average across our sample countries.[25] The

[23]Including a further variable and interaction term to examine variation in the *magnitude* of the negative foreign output gap and its interaction with GVCs indicates that, in addition to the effect of the foreign output gap and foreign slack dummy variables, the magnitude of the negative foreign output gap is not significant.

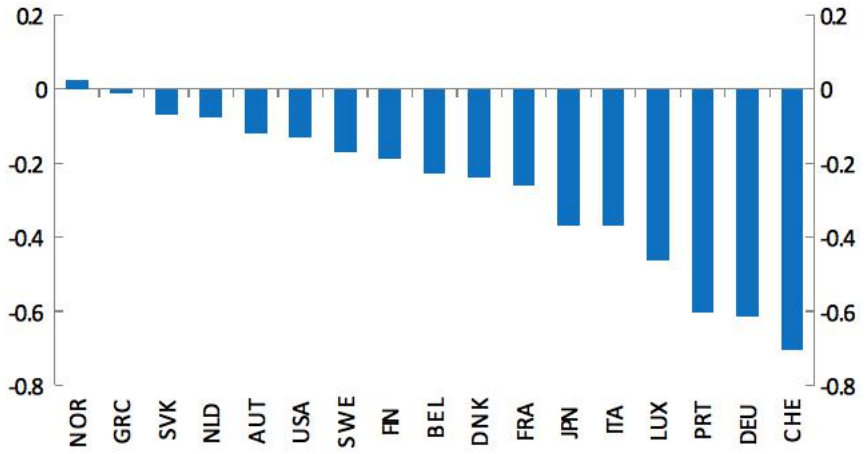
[24]This *ceteris paribus* exercise rests on the same assumptions as described at the end of Section 4.1.

[25]We use the same country-specific 2014 foreign output gap (unweighted average across sectors) and the 2014 vs. 1996 average level of GVC integration in each country.

negative relationship with inflation is larger for those countries with a greater increase in the level of GVC participation and/or facing a larger foreign output gap in 2014. For instance, in Germany, given a foreign output gap of -2 per cent, the actual rise in GVC integration is associated with 0.6 percentage points lower producer price inflation in 2014, relative to a counterfactual where GVCs remained at 1996 levels. These results are significant because even though GVC integration stopped rising after 2008, the higher level of GVC integration today is still associated with a stronger relationship of domestic inflation with global economic slack, consistent with the findings of Auer et al. (2017).

Figure 7. Lower inflation in 2014 with larger global slack and the expansion of GVCs since 1996

Estimated relationship between foreign slack through greater GVCs and producer price inflation in 2014, percentage points



Note: The figure shows the annual change in producer price inflation in 2014 that is correlated with the change in the level of GVCs since 1996 and the interaction of GVCs with the foreign and domestic output gaps, based on the coefficient estimates in column 1 of Table 7. The GVC estimates are the unweighted averages over industries in each country for 1996 and 2014. MEX, LVA, POL and SVN not shown as data on GVCs are not available for 1996 or 2014.
Source: Calculations using estimation results from Table 5, the OECD Trade in Value-Added (TiVA) database and OECD TiVA Nowcast.

5 Conclusion

This paper explores the impact of GVC participation and competition on inflation by drawing together a range of recent industry-level data sources. We provide evidence that rising integration in GVCs is linked with downward pressure on domestic producer prices at the industry level. Controlling for a range of time-varying country-specific and global shocks, we estimate that the rise in GVCs – at its peak – is associated with lower annual producer price inflation by 0.15 percentage points on average, but this magnitude is more than double in some OECD countries. We also find that rising GVC integration within industries is related to lower unit labor costs and wages. The links to prices and wages are especially strong when low-wage countries are more intensively integrated in supply chains, implying that further shifts in the composition of GVCs toward low-wage countries could continue to dampen inflation. Taken together, our analysis supports the conjecture that GVC expansion has increased the ability of firms to substitute domestic inputs with cheaper foreign equivalents, thereby putting downward pressure on prices.

We also present industry-level evidence in support of the notion that higher GVC integration reduces inflation via the propagation of global economic slack. Given an average foreign output gap of -1.5 per cent in 2014, we estimate that annual producer price inflation was on average 0.25 percentage points lower in 2014 associated with the actual rise in GVC integration since 1996. But this relationship rises above 0.5 percentage points for countries that experienced a particularly large rise in GVC participation over this period.

Regarding the implications for monetary policy, our identification strategy relies on within-country industry-level variation, hence one could argue that we essentially obtain a relative and not an overall price effect. However, as Bernanke (2007) stresses, the impact of monetary policy is not immediate but it operates with a lag, and has limited information in real time about the exact sources of price pressures. Therefore, it is useful and important to study not only the long-term, monetary drivers but also short- to medium-term, real factors when analyzing the structural drivers of inflation. Our study fits with the latter set of medium-term drivers, without attempting to contribute to the literature on the optimal conduct of monetary policy in the face of persistent supply shocks (such as increasing

global integration). Nevertheless, translating producer price changes which we examine to consumer price effects is an important challenge left for future work.

References

Andrews, D. and F. Cingano (2014), "Public Policy and Resource Allocation: Evidence from firms in OECD countries", *Economic Policy*, Issue 74 April.

Auer, R., C. Borio and A. Filardo (2017), "The globalization of inflation: The growing importance of global value chains", *BIS Working Papers*, No. 602, January.

Auer, R. and A. Fischer (2010), "The effect of low-wage import competition on US inflationary pressure", *Journal of Monetary Economics*, 57(4), 491-503.

Auer, R. and A. Levchenko and P. Sauré (2019), "International Inflation Spillovers Through Input Linkages", *Review of Economics and Statistics*, 101(3), 507-521.

Baldwin, R. (2013), "Trade and Industrialization after Globalization's Second Unbundling: How Building and Joining a Supply Chain Are Different and Why It Matters," NBER Chapters, in: *Globalization in an Age of Crisis: Multilateral Economic Cooperation in the Twenty-First Century*, pages 165-212 National Bureau of Economic Research, Inc.

Ball, L.M. (2006), "Has globalization changed inflation?" NBER Working Paper 12687.

Bernanke, B. (2007) "Globalization and monetary policy," Speech 262, Board of Governors of the Federal Reserve System (U.S.).

Bianchi, F. and A. Civelli (2015), "Globalization and inflation: evidence from a time varying VAR", *Review of Economic Dynamics*, 18(2), 406-433.

Borio, C., and A. Filardo (2007), "Globalization and Inflation: New Cross-Country Evidence on the Global Determinants of Domestic Inflation", *BIS Working Papers*, No. 227, May.

Bourlès, R., G. Cette, J. Lopez, J. Mairesse and G. Nicoletti (2013), "Do Product Market Regulations in Upstream Sectors Curb Productivity Growth?: Panel Data Evidence for OECD Countries", *Review of Economics and Statistics*, 95(5), 1750-1768.

Bloom, N., M. Draca and J. Van Reenen (2015), "Trade Induced Technical Change? The Impact of Chinese Imports on Innovation, IT and Productivity", *Review of Economic Studies*, 83(1), 87-117.

Carney, M. (2017), "[De]Globalisation and inflation", IMF Michel Camdessus Central Banking Lecture, 18 September.

Chen, N., J. Imbs, and A. Scott (2009), "The dynamics of trade and competition", *Journal of International Economics*, No.77, 50-62.

Draghi, M. (2016), "How central banks meet the challenge of low inflation", Marjolin Lecture, Frankfurt, 4 February.

ECB (2017), "Domestic and global drivers of inflation in the euro area", *Economic Bulletin*, Issue 4.

Égert, B. and I. Wanner (2016), "Regulations in services sectors and their impact on downstream industries: the OECD 2013 REGIMPACT indicator ", *OECD Economics Department Working Papers*, No 1303.

Hummels, D., J. Ishii and K.M. Yi (2001), "The Nature and Growth of Vertical Specialization in World Trade", *Journal of International Economics*, No. 54, 75–96.

Ihrig, J., S. Kamin, D. Lindner and J. Marquez (2010), "Some Simple Tests of the Globalization and Inflation Hypotheses", *International Finance*, vol. 13 (Winter), 343-75.

Imbs, J., E. Jondeau and F. Pelgrin (2011), "Sectoral Phillips curves and the aggregate Phillips curve", *Journal of Monetary Economics*, 58(4), 328-44.

IMF (2006), "How Has Globalization Affected Inflation?", Chapter 3 in *World Economic Outlook*, April, pp. 97–134, Washington D.C., IMF.

Jäger, K. (2017), "EU KLEMS Growth and Productivity Accounts 2017 release - Description of Methodology and General Notes", The Conference Board, September 2017.

Johnson, R. and G. Noguera (2012), "Accounting for intermediates: Production sharing and trade in value added", *Journal of International Economics*, No.86, 224-236.

Melitz, M. and G. Ottaviano (2008), "Market size, trade, and productivity", *Review of Economic Studies*, 75(1), 295–316.

OECD (2013), "Protecting jobs, enhancing flexibility: A new look at employment protection legislation", in *OECD Employment Outlook* 2013, OECD Publishing, Paris.

OECD (2017), "Nowcast TiVA Estimates: Methodology", Paris, OECD.

Rogoff, K. (2003), "Globalization and global disinflation", Paper presented for Federal Reserve Bank of Kansas 2003 Jackson Hole Conference.

Tootell, G.M. (1998), "Globalization and US inflation", *New England Economic Review*, 98, 21–33.

Tables

Table 1. Summary Statistics for Production Deflator and GVC Backward Participation Indicator

Unit of observation: country × industry × year

	$P_{c,s,t}$	$GVC_{c,s,t}$	$\Delta^{ld}P_{c,s,t}$	$\Delta^{ld}GVC_{c,s,t}$
Mean	456.762	23.937	0.108	0.072
Median	95.350	21.84	0.092	0.071
St. dev.	2040.526	14.563	0.141	0.196
N	11,903	11,797	8,492	8,492

Note: Δ^{ld} denotes five-year long differences of the log of the variables.

Table 2. Prices and global value chains

Estimation method – five-year long differences

	$\Delta P_{c,s,t}$		
	(1)	(2)	(3)
$\Delta GVC_{c,s,t}$	-0.0574***	-0.0540***	-0.0460***
	(0.0148)	(0.0165)	(0.0173)
Country×Year fixed effects	Y	Y	Y
Industry fixed effects	Y	N	N
Industry×Year fixed effects	N	Y	Y
Country×Industry fixed effects	N	N	Y
Observations	8,492	8,492	8,492
Adj R-squared	0.578	0.645	0.802

Note: Cluster robust standard errors (at the country-industry level) in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The price level and GVC indicator are measured in log terms. The time period is in principal 1995-2014.

Table 3. Unit labor costs and global value chains

Estimation method – five-year long differences

	Δ Unit labor costs$_{c,s,t}$		
	(1)	(2)	(3)
$\Delta GVC_{c,s,t}$	-0.231***	-0.215***	-0.192***
	(0.0378)	(0.0406)	(0.0392)
Country×Year fixed effects	Y	Y	Y
Industry fixed effects	Y	N	N
Industry×Year fixed effects	N	Y	Y
Country×Industry fixed effects	N	N	Y
Observations	8,122	8,122	8,122
Adj R-squared	0.362	0.379	0.527

Note: Cluster robust standard errors (at the country-industry level) in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Both unit labor costs and the GVC indicator are measured in log terms. Unit labor costs are measured as compensation of employees divided by real output. The time period is in principal 1995-2014.

Table 4. Prices, wages and labor productivity in advanced economies by source country

Estimation method – five-year long differences

	$\Delta P_{c,s,t}$	$\Delta W_{c,s,t}$	Δ Labour Productivity$_{c,s,t}$
	(1)	(2)	(3)
$\Delta GVC_{c,s,t}$ (Low-wage countries)	-0.0368***	-0.0254*	0.0994***
	(0.0131)	(0.0151)	(0.0351)
$\Delta GVC_{c,s,t}$ (High-wage countries)	-0.0166	-0.0216	0.117***
	(0.0152)	(0.0216)	(0.0324)
Controlling for labour productivity	N	Y	n/a
Country×Year fixed effects	Y	Y	Y
Industry fixed effects	Y	Y	Y
Observations	6,172	6,172	6,172
Adj R-squared	0.527	0.409	0.332

Note: Cluster robust standard errors (at the country-industry level) in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. All indicators are measured in log terms. Subset of our full sample restricted to advanced economies (AUT, BEL, CHE, DEU, DNK, FIN, FRA, GRC, ITA, JPN, LUX, NLD, NOR, PRT, SWE and USA). GVCs (High-wage countries) is the foreign value added share in exports of those countries that are part of the EU-15 (EU members prior to 2004) plus AUS, CAN, CHE, JPN, NOR, NZL and USA; GVCs (Low-wage countries) is the foreign value added share in exports of all other countries. Real wages are measured as nominal wages and salaries per employee deflated by the economy-wide production deflator. Labor productivity (output per worker) is the volume of production per employee. The time period is in principal 1995-2014.

Table 5. Inflation, global slack and global value chains

Estimation method – annual

	$\Delta P_{c,s,t}$			
	(1)	(2)	(3)	(4)
$GVC_{c,s,t}$	-0.00090	-0.00002	0.00280	0.00370
	(0.00314)	(0.00628)	(0.00420)	(0.00743)
Foreign YGap$_{c,s,t}$	0.00327	0.00345	0.00234	0.00267
	(0.00233)	(0.00237)	(0.00250)	(0.00257)
Foreign YGap$_{c,s,t} \times GVC_{c,s,t}$	0.00468***	0.00468***	0.00312***	0.00327***
	(0.00085)	(0.00088)	(0.00089)	(0.00093)
Foreign Slack$_{c,s,t}$			-0.00729*	-0.00608
			(0.00374)	(0.00394)
Foreign Slack$_{c,s,t} \times GVC_{c,s,t}$			-0.00683**	-0.00611
			(0.00340)	(0.00372)
Domestic YGap$_{c,t} \times GVC_{c,s,t}$	-0.00024	-0.00028	-0.00025	-0.00028
	(0.00034)	(0.00036)	(0.00033)	(0.00036)
Country×Year fixed effects	Y	Y	Y	Y
Industry fixed effects	Y	N	Y	N
Country×Industry fixed effects	N	Y	N	Y
Observations	11,026	11,026	11,026	11,026
Adj R-squared	0.248	0.249	0.249	0.249

Note: Cluster robust standard errors (at the country-industry level) in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. *YGap* measured as per cent of a country's estimated potential output. $YGap < 0$ (or >0) for an economy that is below (or above) potential output. $Foreign\ Slack = 1$ when $Foreign\ YGap < 0$. Industry producer price inflation is the annual change in the log of the industry production deflator. GVC indicator measured in log terms and demeaned by the sample average. The time period is in principal 1995-2014.

Appendix

A.1 Data construction and coverage

Our final database covers the following OECD countries: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Italy, Japan, Luxembourg, Latvia, Mexico, Netherlands, Norway, Poland, Portugal, Slovenia, Slovak Republic, Sweden, Switzerland and the United States. The country coverage is somewhat smaller for the policy variables.

We address the industry classification mismatch between the TiVA data – which is measured with international classification system ISIC Rev.3 at the 2-digit level – and the 2017 release of the STAN database, which conforms to the ISIC Rev.4 classification. To this end, STAN data were converted to the equivalent ISIC Rev.3 industries using the generic concordance presented in Table A.1 in order to ensure alignment with the TiVA data. Where multiple 2-digit industries in ISIC Rev.4 are combined in this process of conversion to ISIC Rev.3, aggregated production in volume terms or the price indices are calculated by applying the real growth rate for individual industries based on their time-varying nominal weights.

For the final three years of our sample (2012-2014), we rely on the TiVA Nowcast data, which uses a slightly different construction than the regular TiVA database (1995-2011). In particular, rather than using a new inter-country input-output (ICIO) table as for a regular TiVA update, the Nowcast projections are based on the latest 2011 OECD ICIO table and use more recent national input-output industry tables, national accounts and bilateral trade data (OECD 2017). Importantly, the Nowcast annual projections are made in volumes terms (to account for differential price movements and changes in exchange rates) which are then iteratively reflated and balanced using official volume and current price activity and trade data to ensure comparability. However, given the underlying ICIO tables are not fully updated, we cannot rule out that there may have been greater shifts in structure of the international production process which are not fully reflected in the TiVA Nowcast data.

Table A.1. ISIC Rev.4 to ISIC Rev.3 industry concordance table

Industry	**ISIC Rev.3**	**ISIC Rev.4**
Agriculture, hunting, forestry and fishing	01t05	01t03
Mining and quarrying	10t14	05t09
Food products, beverages and tobacco	15t16	10t12
Textiles, textile products, leather and footwear	17t19	13t15
Wood and products of wood and cork	20	16
Pulp, paper, paper products, printing and publishing	21t22	17, 18, 58
Coke, refined petroleum products and nuclear fuel	23	19
Chemicals and chemical products	24	20t21
Rubber and plastics products	25	22
Other non-metallic mineral products	26	23
Basic metals	27	24
Fabricated metal products except machinery and equipment	28	25
Machinery and equipment n.e.c.	29	28
Computer, electronic and optical products	30, 32, 33	26
Electrical machinery and apparatus n.e.c.	31	27
Motor vehicles, trailers and semi-trailers	34	29
Other transport equipment	35	30
Manufacturing n.e.c.; recycling	36t37	31t33
Electricity, gas and water supply	40t41	35, 36
Construction	45	41t43
Wholesale and retail trade; repairs	50t52	45t47, 95
Hotels and restaurants	55	55t56
Transport and storage	60t63	49, 50, 51, 52, 79
Post and telecommunications	64	53, 61
Finance and insurance	65t67	64t66
Real estate activities	70	68
Renting of machinery and equipment	71	77
Computer and related activities	72	62t63
Research and development; Other Business Activities	73t74	69t75, 78, 80t82
Public admin. and defense; compulsory social security	75	84
Education	80	85
Health and social work	85	86t88
Other community, social and personal services	90t93	37t39, 59t60, 90t93, 94, 96

Source: OECD.

A.2 Further results

Table A.2. Prices and global value chains for pre-Great Recession period

Estimation method – five-year long differences

	$\Delta P_{c,s,t}$		
	(1)	(2)	(3)
$\Delta GVC_{c,s,t}$	-0.0628***	-0.0651***	-0.0436**
	(0.0199)	(0.0222)	(0.0195)
Country×Year fixed effects	Y	Y	Y
Industry fixed effects	Y	N	N
Industry×Year fixed effects	N	Y	Y
Country×Industry fixed effects	N	N	Y
Observations	3,722	3,722	3,722
Adj R-squared	0.591	0.611	0.867

Note: Cluster robust standard errors (at the country-industry level) in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The price level and the GVC indicator are measured in log terms. The time period is in principal 1995-2006.

Table A.3. Prices and global value chains with non-overlapping periods

Estimation method – five-year long differences

	$\Delta P_{c,s,t}$		
	(1)	(2)	(3)
$\Delta GVC_{c,s,t}$	-0.0524**	-0.0607***	-0.0468*
	(0.0216)	(0.0221)	(0.0264)
Country×Year fixed effects	Y	Y	Y
Industry fixed effects	Y	N	N
Industry×Year fixed effects	N	Y	Y
Country×Industry fixed effects	N	N	Y
Observations	2,116	2,116	2,116
Adj R-squared	0.516	0.608	0.700

Note: Cluster robust standard errors (at the country-industry level) in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The data are the changes for 1995-2000, 2000-2005, 2005-2010 and 2010-2014 (the latter being the four-year long difference given the end of the sample period in 2014). The price level and the GVC indicator are measured in log terms.

Table A.4. Prices and global value chains, with prices changes one period ahead as the dependent variable

Estimation method – five-year long differences

	$\Delta P_{c,s,t}$		
	(1)	(2)	(3)
$\Delta GVC_{c,s,t}$	-0.0498***	-0.0378**	-0.0297*
	(0.0139)	(0.0152)	(0.0172)
Country×Year fixed effects	Y	Y	Y
Industry fixed effects	Y	N	N
Industry×Year fixed effects	N	Y	Y
Country×Industry fixed effects	N	N	Y
Observations	7,861	7,861	7,861
Adj R-squared	0.580	0.644	0.810

Note: Cluster robust standard errors (at the country-industry level) in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The price level and the GVC indicator are measured in log terms. The time period is in principal 1995-2014.

Table A.5. Prices, global value chains and structural factors

Estimation method – five-year long differences

	$\Delta P_{c,s,t}$				
	(1)	(2)	(3)	(4)	(5)
$\Delta GVC_{c,s,t}$	-0.0549***	-0.0540***	-0.0558***	-0.0549***	-0.0973***
	(0.0132)	(0.0133)	(0.0132)	(0.0133)	(0.0356)
Structural / policy indicators	None	$\Delta EPL_{c,t}\times$ Layoff$_s$	ΔRegulatory Impact$_{c,s,t}$	$\Delta EPL_{c,t}\times$ Layoff$_s$ and ΔRegulatory Impact$_{c,s,t}$	$\Delta ICT_{c,s,t}$
Country×Year fixed effects	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y
Observations	5,547	5,547	5,547	5,547	2,893
Adj R-squared	0.595	0.576	0.576	0.576	0.534

Note: Cluster robust standard errors (at the country-industry level) in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The price level, GVC indicator and foreign valued added embodied in final demand are measured in log terms. The time period is in principal 1995-2011.

Table A.6. Prices, global value chains and import share

Estimation method – five-year long differences

	$\Delta P_{c,s,t}$		
	(1)	(2)	(3)
$\Delta GVC_{c,s,t}$	-0.0557***	-0.0520***	-0.0451**
	(0.0151)	(0.0171)	(0.0187)
ΔImport share$_{c,s,t}$	-0.00596	-0.00742	-0.00293
	(0.00547)	(0.00624)	(0.00698)
Country×Year fixed effects	Y	Y	Y
Industry fixed effects	Y	N	N
Industry×Year fixed effects	N	Y	Y
Country×Industry fixed effects	N	N	Y
Observations	8,492	8,492	8,492
Adj R-squared	0.578	0.645	0.802

Note: Cluster robust standard errors (at the country-industry level) in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The price level, GVC indicator and import share are measured in log terms. The time period is in principal 1995-2014.

Table A.7. Prices and foreign valued added embodied in final demand

Robustness checks for alternative trade integration measures

	$\Delta P_{c,s,t}$				
	(1)	(2)	(3)	(4)	(5)
$\Delta GVC_{c,s,t}$	-0.0698***				
	(0.0163)				
ΔForeign value added		-0.0247**	-0.0343***	-0.0301***	-0.0278***
in final demand$_{c,s,t}$		(0.0104)	(0.00872)	(0.00833)	(0.00670)
Foreign value added in final demand as a share of:		Production	Value added	Consumption	Domestic value added in final demand
Country×Year fixed effects	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y
Observations	6,594	6,594	6,594	6,594	6,594
Adj R-squared	0.605	0.601	0.603	0.604	0.603

Note: Cluster robust standard errors (at the country-industry level) in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The price level, GVC indicator and foreign valued added embodied in final demand are measured in log terms. The time period is in principal 1995-2011.

Table A.8. Inflation, global slack and foreign valued added (FVA) embodied in final demand

Estimation method – annual

			$\Delta P_{c,s,t}$		GVC	GVC pre-Great Recession
	(1)	(2)	(3)	(4)	(5)	(6)
ΔForeign value added	-0.00268**	-0.00230*	-0.00244*	-0.00218*	-0.00223	-0.00337
in final demand$_{c,s,t}$	(0.00121)	(0.00135)	(0.00136)	(0.00120)	(0.00363)	(0.00444)
Foreign YGap$_{c,s,t}$	0.0119***	0.0115***	0.0118***	0.0120***	0.0118***	0.00953***
	(0.00294)	(0.00288)	(0.00290)	(0.00290)	(0.00278)	(0.00312)
Foreign YGap$_{c,s,t}\times$	0.00159***	0.00256***	0.00219***	0.00205***	0.00620***	0.0112***
FVA in final demand$_{c,s,t}$	(0.000496)	(0.000479)	(0.000407)	(0.000358)	(0.00115)	(0.00177)
Domestic YGap$_{c,t}\times$	-0.00038	-0.000508**	-0.000334	-0.000378*	-0.000757	0.000038
FVA in final demand$_{c,s,t}$	(0.000254)	(0.000239)	(0.000230)	(0.000201)	(0.000668)	(0.000666)
FVA in final demand as a share of:	Production	Value added	Consumption	Domestic value added in final demand		
Country$\times$Year fixed effects	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y
Observations	9,268	9,268	9,268	9,251	9,268	6,204
Adj R-squared	0.285	0.290	0.290	0.293	0.293	0.282

Note: Cluster robust standard errors (at the country-industry level) in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. *YGap* measured as per cent of a country's estimated potential output. *YGap* < 0 (or >0) for an economy that is below (or above) potential output. Industry producer price inflation is the annual change in the log of the industry production deflator. The foreign value added embodied in final demand and GVC variables are measured in log terms and demeaned by their sample average. For columns 1-5, the time period is in principal 1995-2011 and for column 6, 1995-2006.