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Misallocation and productivity effects of the Smoot–Hawley tariff ☆

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ABSTRACT

Using a newly created microeconomic archive of US imports at the tariff line level for 1930–1933, we construct industry-level tariff wedges incorporating the input–output structure of US economy and the heterogeneous role of imports across sectors of the economy. We use these wedges to show that the average tariff rate of 46% in 1933 substantially understated the true impact of the Smoot–Hawley (SH) tariff structure, which we estimate to be equivalent to a uniform tariff rate of 70%. We use these wedges to calculate the impact of the Smoot–Hawley tariffs on total factor productivity and welfare. In our benchmark parameterization, we find that tariff protection reduced TFP by 1.2% relative to free trade prior to the Smoot–Hawley legislation. TFP fell by an additional 0.5% between 1930 and 1933 due to Smoot–Hawley. We also conduct counterfactual policy exercises and examine the sensitivity of our results to changes in the elasticity of substitution and the import share. A doubling of the substitution elasticities yields a TFP decline of almost 5% relative to free trade, with an additional reduction due to SH of 0.4%.

1. Introduction

An emerging literature seeks to understand the quantitative role of microeconomic misallocation of factors of production across uses within a country for macroeconomic efficiency. Restuccia and Rogerson (2008) argue that plants may face different prices for inputs used in production due to idiosyncratic policy distortions. When plants differ in total factor productivity, policy distortions will lower aggregate total factor productivity (TFP) if governments tax more productive plants and subsidize less productive ones. The misallocation literature typically assumes that the parametric form of the neoclassical production function is common across plants up to a constant idiosyncratic total productivity factor and policy distortions are backed out from equilibrium conditions imposed on plant-level data rather than measured directly. The distortions coming out of these exercises are estimated to be large: Hsieh and Klenow (2009) calculate the dispersion of marginal products of capital across firms in India and China and argue that reducing the dispersion in these countries, to the level observed in the US would have the effect of raising productivity by 40–60% in India and 30–50% in China.

This paper seeks to understand the potential for aggregate inefficiency to arise from trade policy. Trade policy seems a very natural candidate for the types of policy distortions modeled in the misallocation literature since the intent of such

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policies is to favor less efficient domestic producers over their foreign counterparts. We have chosen a historical context when such distortions are likely to be large, namely the high-water mark of protection arising from the passage of the infamous Hawley–Smoot legislation on June 30, 1930. We model tariff distortions as affecting the two margins of choice highlighted in textbook treatments of trade policy. The first is the choice by firms between domestic and imported intermediate inputs. The second is the choice by consumers between domestic and imported final consumption goods. These two margins interact in an important way because imported intermediate inputs are used in different intensities across sectors of the economy. For example, raw sugar imported from Cuba accounted for a substantial fraction of intermediate inputs into food production whereas imported parts were trivial and thus inconsequential for cost of producing US automobiles. Consequently, sugar duties are an example of a production distortion while automobile duties are an example of a consumption distortion.

What makes the study of tariff distortions both interesting and challenging is that they exhibit considerable variation both across time and sectors. Both the mean and standard deviation (across items) increase after the passage of SH, from 30% to 40% in the case of the mean and from 22% to 26% in the case of the standard deviation. This trend continues to 1933 when the mean and standard deviation reach 46% and 35%, respectively. The continued rise in the mean is largely due to the fact that many import duties were specific (e.g., cents per pound). As such the general deflation from 1930 to 1933 increased the mean of the ad valorem equivalent rates in the tariff schedule. Relative price movements, while theoretically ambiguous in their effect on the distribution of tariffs, were such that the dispersion of tariffs across goods also increased from 1930 to 1933.

There are a number of results in the international trade literature which suggest that both the increase in the mean tariff rate and their increased dispersion would have an adverse impact on economic welfare. For example, Hatta (1977) established that tariff reforms which reduce all tariffs proportionally or reduce the highest tariff will be welfare improving under quite general conditions. On the other hand, reductions of tariffs on arbitrary goods will not necessarily be welfare increasing. Anderson and Neary (2005) show that a country's welfare is decreasing in the generalized mean of the tariff rate (if the tariff rate is positive) and decreasing in the generalized variance, where the generalized mean and variance use the normalized substitution matrix of the balance of trade function as a weighting factor. This result suggests that an increase in the "unweighted" variance of tariffs will reduce welfare if the substitution effects are similar across goods, but might not if the substitution effects are asymmetric. Thus, we need to characterize the production structure in order to determine whether the increase in dispersion of tariffs we find is also associated with a decline in welfare.[1]

Turning to the details, we build a microeconomic archive of line-item tariff and trade data and use these data to construct tariff wedges in a structural general equilibrium model of the US economy. The wedges are used to calculate the impact of changes in protection on macroeconomic variables, including employment, consumption, and domestic price indices.[2] We derive two aggregate measures of the welfare impact of tariffs. The first is their effect on total factor productivity, which we define to be the number of units of the composite consumption bundle per unit of domestic productive resources. The second is the consumption equivalent, which is the compensation needed in units of aggregate consumption to make the representative agent indifferent between allocations under free trade and those under the existing tariff structure. In our benchmark parameterization, we find that the pre-Smoot–Hawley tariff legislation had the effect of reducing total factor productivity relative to the free trade level by 1.2%. The increases in tariffs associated with the Smoot–Hawley and the deflation from 1930–1933 had the effect of reducing TFP by an additional 0.5%. We use a counterfactual exercise to show that if SH had not been passed, the effects of deflation would still have reduced TFP by 0.3% due to the widespread use of specific tariffs. The consumption equivalent measure yields effects of a similar magnitude for the benchmark parameterization. We also show the impact of the dispersion in the tariff structure across goods in the sense that the uniform tariff equivalent of the existing tariff schedule is substantially above the average tariff during this period.

Our analysis abstracts from distortions in factor markets, and focuses on the effect of sectoral tariff wedges. The reductions in total factor productivity we find as a result of sectoral misallocations due to tariff protection are of a much smaller magnitude than those associated with factor market distortions, due in part to the fact that trade accounted for a relatively small fraction of US consumption and intermediate inputs during this period of history. We provide counterfactual exercises to illustrate the sensitivity of our results to changes in the import share of consumption goods and material inputs, as well as to the assumed elasticity of substitution between imports and domestic goods. These exercises provide some perspective on the potential for misallocation effects arising from commercial policy for other time periods and other nations.

We proceed in the following manner. Section 2 presents the multisector general equilibrium model and uses it to construct measures of the effects of tariff rates on aggregate variables. Section 3 describes the construction of the panel data series from line-item tariff rates, compares the sector level panel data to the line-item data and presents model-based estimates of sector level tariff wedges. Section 4 reports the results for the aggregate effects of tariff policy, and Section 5 concludes.

[1] Harrison et al. (1993) show that Turkey could achieve most of the gains from moving to free trade by adopting a uniform tariff structure. Eslava et al. (in press) examine the effects of trade reforms in Columbia, where trade liberalization resulted in a substantial reduction in the dispersion of tariffs. They analyze firm level data and find that tariff reforms increase the responsiveness of firms to market fundamentals.

[2] Irwin (1998b) analyzes the effect of the Smoot–Hawley tariffs using aggregate data and a CGE model to estimate sectoral effects, but does not incorporate the extent of sectoral disaggregation that we do.

2. The model

Our goal in this section is to develop a tractable model that can be used in conjunction with our tariff line panel to obtain a measure of the impact of sectoral misallocation on aggregate variables. Our modeling choices are driven by two features of the data from this period. First, 75% of imports are intermediate goods according to the input–output tables for 1929 (Leontief, 1941). Therefore, we want a model that captures the substitution between imported materials and domestically produced materials in the production process. Second, there is substantial variation across tariff lines in the extent to which protection was increased during this period, as well as substantial differences across sectors in the degree to which imported inputs are used in the production process. For example, imports accounted for 75% of intermediate inputs in the sugar, glucose and starch industry, but less than 1% of intermediate inputs into the agricultural industry. This heterogeneity combined with the fact that sugar duties were much higher and varied more over time than most other agricultural duties indicates the different industry-level distortions of these respective duties. This motivates the use of a multisector model that allows for differential effects of tariff protection across the various production sectors.

2.1. The multisector production model

We consider a GE production model with N_F sectors producing non-traded final consumption goods and one sector representing exportable goods (sector 0). The N_F final goods sectors correspond to the sectors in the Leontief input–output tables. This model allows us to capture substitution by firms between domestic and imported material inputs, as well substitution by consumers between domestic and imported final consumption goods. Our model also has a block recursive structure that provides simple measures of the effects of the tariff structure on aggregate variables.

Each of the $N_F + 1$ production sectors produces final output using inputs of domestic value added and material inputs, with material inputs produced using domestic value added and imported materials. We assume that domestic capital and labor are used in the same proportions in all sectors, so that value added can be treated as a composite input whose price, p_V, is the same for all sectors. We assume a CES technology in the final goods sector j that can be characterized by the unit cost function $(a_{jV} p_V^{1-\sigma_F} + a_{jM} {p_{jM}}^{1-\sigma_F})^{\frac{1}{1-\sigma_F}}$, where p_{jM} is the price of materials to sector j and σ_F is the elasticity of substitution between value added and materials in the production of final goods (assumed common across sectors). The unit cost of production for materials in sector j is $(a_{jd} p_V^{1-\sigma_M} + a_{jm} p_{jm}^{1-\sigma_M})^{\frac{1}{1-\sigma_M}}$, where p_{jm} is the cost of a composite of line-item imported inputs used in production in sector j and σ_M is the elasticity of substitution between domestic and imported materials.

Assuming perfect competition in production of final goods and intermediates, the price of materials and final goods will equal their respective unit costs,

$$p_{jF} = \left(a_{jV} p_V^{1-\sigma_F} + a_{jM}\left(a_{jd} p_V^{1-\sigma_M} + a_{jm} p_{jm}^{1-\sigma_M}\right)^{\frac{1-\sigma_F}{1-\sigma_M}}\right)^{\frac{1}{1-\sigma_F}}, \quad j = 0, 1, \ldots, N_F. \tag{1}$$

Letting $\phi_j(p_V, p_{jm})$ denote the unit cost function of the integrated production of final goods and materials in sector j, $\theta_{jm} = (\frac{\partial \phi_j(p_V, p_{jm})}{\partial p_{jm}} \frac{p_{jm}}{p_{jF}})$ is the share of imported inputs and $\theta_{jV} = 1 - \theta_{jm}$ is the cost share of domestic inputs (direct plus indirect) in final goods sector j. The price of imported material inputs to sector j is computed by assuming that the imported material input for sector j is a composite of N_m lines of the import and tariff micro-data. Letting τ_i be one plus the ad valorem tariff rate on good i and q_i the world price of that good, the import price index for materials used by sector j will be

$$p_{jm} = \left[\sum_{i}^{N_m} b_{ji}(\tau_i q_i)^{1-\sigma_m}\right]^{\frac{1}{1-\sigma_m}}, \quad j = 0, 1, \ldots, N_F, \tag{2}$$

where σ_m is the elasticity of substitution between tariff lines, and the b_{ji} are parameters that reflect the intensity with which good i is used as an input into the production of sector j. The share of imports of tariff line i in the expenditure of activity j on imported inputs is given by $\alpha_{ji} = b_{ji}(\frac{q_i \tau_i}{p_{jm}})^{1-\sigma_m}$. Note that our specification allows for differential impacts of trade policies across sectors due to differences in the intensity of use of imported inputs, as reflected in the $\{a_{jV}, a_{jM}, a_{jm}\}$, as well as to differences in the composition of imports (the b_{ji}). We discuss below how tariff line data and the Leontief input–output tables can be used to construct values for these coefficients.

For a given vector of world prices, $\mathbf{q}$, the system of equations (1) can be solved recursively for a given vector of import tariffs, $\boldsymbol{\tau}$, using (2). The zero profit condition for the exportable sector can be inverted to solve for the return to domestic value added as a function of the price of imported goods used in the exportable sector, $p_V^*(p_{0m})$. This solution for p_V can then be inserted into the remaining zero profit conditions to solve for the prices of the N_F non-traded consumption goods. An increase in tariffs imposed on importables raises the cost of imports to produce exportables, which requires a reduction in p_V to maintain the competitiveness of home exports on world markets. For the non-traded goods, an increase in tariffs has two conflicting effects: the cost of domestic value added rises but the price of imported inputs will rise. Which of these effects dominates depends on the intensity of use of imported inputs relative to the export sector and the extent to which the tariff increases fall on imports used by the sector.[3]

In the case of a small open economy, **q** is exogenously given and there will be complete pass-through of tariffs to prices paid by the domestic purchasers of imports. The treatment of the US as a small open economy merits some discussion. This assumption ensures that all of the distorting effects of the tariff are borne by the US, and thus can be thought of as representing an upper bound on the aggregate productivity effects of trade barriers.[4] If the US is a large country, then tariffs will improve the terms of trade by reducing the world price of imports, and some of the cost of the tariff would be borne by foreign countries. This could be captured in our analysis by allowing for incomplete pass-through of tariffs to domestic prices. However, there is little evidence of negative effects of tariff rate changes on world prices in our tariff line data.[5] The absence of a significant correlation seems consistent with the fact that US imports were only $4.4 billion in 1929, which represented approximately 12% of world trade. Also, tariff retaliation by foreign countries would have the effect of mitigating the terms of trade improvements that the US experienced on account of its own tariff rate increases. An equivalent outcome to our assumptions would arise if the US were modeled as a large country with foreign retaliation exactly offsetting the impact of US tariffs on world prices. For the large country case, our results will overstate (understate) the US welfare loss in the case where the net effect of US tariffs and foreign retaliation is to improve (worsen) the US terms of trade.

We conclude our discussion of the production side of the model with the production function for domestic value added,

$$V = AK^{1-\beta}L^{\beta}, \tag{3}$$

where K is the input of capital, L is the input of labor, and A is the productivity level. We will undertake a short run analysis in which the capital stock is assumed to be fixed. The market wage will be determined by the marginal productivity condition,

$$\frac{w}{p_V} = A\beta\left(\frac{K}{L}\right)^{1-\beta}. \tag{4}$$

For a given K/L, protection will lower the wage rate because it lowers $p_V = p_V^*(p_{0m})$. The level of labor input will be determined as part of the household decision problem, to which we now turn.

2.2. Household decisions and market equilibrium

The preferences of households are assumed to take the following form:

$$U = \frac{C^{1-s}}{1-s} - \frac{\nu L^{\gamma}}{\gamma} \tag{5}$$

where

$$C = \left(\sum_{j=1}^{N_F} a_{cj}^{\frac{1}{\sigma_C}} C_j^{\frac{\sigma_C - 1}{\sigma_C}} + a_{cm}^{\frac{1}{\sigma_C}} C_m^{\frac{\sigma_C - 1}{\sigma_C}}\right)^{\frac{\sigma_C}{\sigma_C - 1}},$$

where the intertemporal elasticity of substitution in consumption is given by $\frac{1}{s}$ and the Frisch elasticity of labor supply by $\frac{1}{\gamma-1}$. The consumption levels C_j are demands for the final goods from the production sectors $j = 1, \ldots, N_F$, C_m is the consumption of imports, and σ_C is the elasticity of substitution between all consumption goods, domestic and imported. Households face a budget constraint given by $\sum_{j=1}^{N_F} p_{jF} C_j + p_{cm} C_m = wL + rK + T$, where T is the amount of tariff revenue transferred to households, with p_{cm} and p_{jF} determined from the production sector by (2) and (1), respectively.

The household consumption allocation between domestic and imported goods can be solved using two stage budgeting. The necessary conditions for choice of C and L yield

$$C^s L^{\gamma-1} = \frac{w}{\nu P_C} \tag{6}$$

[3] Our assumption of a single export sector is made to be consistent with our assumptions of a single (composite) domestic factor input and exogenously given world prices. The latter assumptions ensure that national income can be maximized by specializing in the traded good that yields the highest return to the domestic factor of production.

[4] We should note however that the effects could be larger in a dynamic model, where tariffs affect capital accumulation.

[5] If US tariffs have a significant effect on world prices, then the world price of goods on which the US imposes higher tariffs should fall relative to other goods. To test this, we regressed changes in world prices on changes in tariff rates, allowing for differential coefficients based on whether goods had ad valorem or specific tariffs. We did not find a significant negative effect of tariff changes on prices for either type of protection.

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where

$$P_C = \left(\sum_{j=1}^{N_F} a_{cj} p_{jF}^{1-\sigma_C} + a_{cm} p_{cm}^{1-\sigma_C} \right)^{\frac{1}{1-\sigma_C}}.$$

P_C is the price index for consumption, and we can express the share of expenditure on domestic goods by $\mu_j = a_{cj}(\frac{p_{jF}}{P_C})^{1-\sigma_C}$ for $j = 1, \dots, N_F$ and the share of consumption on imports by $\mu_m = a_{cm}(\frac{p_{cm}}{P_C})^{1-\sigma_C}$.

In order to determine the level of tariff revenue, we need to derive demands for the imported products at the tariff line level. The value of imports in tariff line i will be the sum of the value of imports for final consumption, $\alpha_{ci}\mu_m P_C C$, and the value of imports for intermediate use from the various production activities, $\sum_{j=0}^{N_F} \alpha_{ji}\theta_{jm} p_{jF} Y_{jF}$. Using the market clearing conditions for non-traded goods markets and for value added, we obtain an expression for tariff revenue as a function of value added and aggregate consumption:

$$T = \Gamma_V p_V V + \Gamma_C P_C C \tag{7}$$

where

$$\Gamma_V = \sum_{i=1}^{N_m} \left(\frac{\tau_i - 1}{\tau_i} \right) \alpha_{0i} \left(\frac{\theta_{0m}}{\theta_{0V}} \right),$$

$$\Gamma_C = \sum_{i=1}^{N_m} \left(\frac{\tau_i - 1}{\tau_i} \right) \left(\sum_{j=1}^{N_F} \left(\alpha_{ji}\theta_{jm} - \frac{\alpha_{0i}\theta_{0m}\theta_{jV}}{\theta_{0V}} \right) \mu_j + \alpha_{ci}\mu_m \right).$$

The terms Γ_V and Γ_C capture the effect of an increase in value added and consumption on tariff revenue. An increase in V, given C, will result in an increase in production of exportable goods and a corresponding increase in imported inputs for the exportable sector. Γ_V captures the effect of this on tariff revenue, which must be non-negative if $\tau_i \geqslant 0$ for all i. An increase in C will have two conflicting effects on imports. Higher consumption raises the demand for imports to produce imported consumption goods and non-traded goods, but it will also draw resources from production of the exportable good and reduce the usage of imported inputs in that sector. This leads to an ambiguous effect of an increase in aggregate consumption on tariff revenue, since tariff revenue could actually fall if exports are intensive in the use of intermediate inputs relative to other production and consumption activities and/or tariffs are relatively high on imports to the exportable sector.

Substituting (7) into the budget constraint yields a convenient expression for the level of the C that can be obtained from a given resource bundle V, which can be interpreted as a measure of total factor productivity,

$$\frac{C}{V} = TFP(\boldsymbol{\tau}, \mathbf{q}) = \frac{p_V(1 + \Gamma_V)}{P_C(1 - \Gamma_C)}. \tag{8}$$

The numerator is the social return to value added, which is the market return plus the additional tariff revenue generated from an additional unit of value added. The denominator of this expression is the social cost of consumption, which is the market cost less the tariff revenue generated by additional imports (which could be negative). It can be shown that this expression is maximized at free trade, and that proportional increases in all tariffs will be welfare reducing. The percentage reduction in TFP from the free trade level, $(\frac{TFP(\boldsymbol{\tau},\mathbf{q})}{TFP(1,\mathbf{q})} - 1) * 100$, provides a convenient measure of the efficiency loss resulting from tariff protection.

In addition to its impact on the efficiency of resource use, protection will also distort labor supply and consumption decisions. Substituting (6) into (8) and using the fact that $wL = \beta p_V V$, we obtain a solution for the equilibrium level of employment

$$L(\boldsymbol{\tau}, \mathbf{q}) = \left(\frac{\beta}{\nu} \frac{p_V}{P_C} \left(AK^{1-\beta} \right)^{1-s} (TFP)^{-s} \right)^{\frac{1}{\beta(s-1)+\gamma}} \tag{9}$$

where $\beta(s-1) + \gamma > 0$ for all $s \geqslant 0$ since $\gamma \geqslant 1$. The existence of tariff protection will reduce both $\frac{p_V}{P_C}$ and TFP relative to the free trade level. The former effect reduces the relative price of labor, which is a substitution effect that results in a reduction in L. The latter is a wealth effect, which results in an increase in L. Thus, tariff protection will have an ambiguous effect on employment relative to the free trade level. The equilibrium level of consumption is obtained by substituting from (9) and (4) into (6), which yields

$$C(\boldsymbol{\tau}, \mathbf{q}) = \left(\left(\frac{\beta}{\nu} \frac{p_V}{P_C} \right)^{\beta} \left(AK^{1-\beta} \right)^{\gamma} (TFP)^{\gamma-\beta} \right)^{\frac{1}{\beta(s-1)+\gamma}}. \tag{10}$$

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Table 1
Scope of the cross sections (source data).

	Number of observations			Proportion available		
	Pre-SH	Post-SH	1933	Pre-SH	Post-SH	1933
Tariff lines	4861	5280	5629	1.00	1.00	1.00
Value imported	4750	5001	5302	0.98	0.95	0.94
Quantity imported	4388	4685	5007	0.90	0.89	0.88
Price	4290	4422	4690	0.88	0.84	0.83
Duty	4018	4321	4487	0.83	0.82	0.80
Ad valorem rate	3980	4207	4345	0.82	0.80	0.77

Consumption will be increasing in $\frac{p_V}{p_C}$ and *TFP*, so tariff protection will unambiguously reduce consumption relative to the free trade level.

The solutions to (10) and (9) can be substituted into (5) to construct the indirect utility function

$$W(\boldsymbol{\tau},\mathbf{q}) = \frac{C(\boldsymbol{\tau},\mathbf{q})^{1-s}}{1-s} - \frac{\nu L(\boldsymbol{\tau},\mathbf{q})^{\gamma}}{\gamma}. \tag{11}$$

(11) will be maximized at free trade in the small country case. To calculate the effect of a given tariff structure, $\boldsymbol{\tau}_0$, on welfare we can calculate the level of consumption that would lead to the same welfare as at free trade, given the distorted labor supply. This consumption equivalent value, which we denote C^E, is the solution to

$$U\big(C^E, L(\boldsymbol{\tau}_0,\mathbf{q})\big) = W(1,\mathbf{q}). \tag{12}$$

The expressions (8) and (12) can be used to measure the aggregate effects of tariff protection on resource allocation and welfare. If the tariff structure does not affect aggregate employment, then aggregate value added will be constant and the loss in consumption due to tariff protection will coincide with the reduction in TFP. When tariff protection reduces (raises) employment, the loss in consumption will be smaller (larger) than the reduction in TFP.

A second question of interest is the effect of the variance in the tariff structure on welfare. This question can be addressed by solving for the uniform tariff that yields the same welfare level as the existing tariff structure. Letting $\boldsymbol{\tau}_0$ be an initial tariff vector and $\mathbf{q}_0$ the vector of world prices of importable goods, the uniform tariff vector $\boldsymbol{\tau}^U$ that yields the same domestic welfare will be the solution to

$$W\big(\boldsymbol{\tau}^U,\mathbf{q}_0\big) = W(\boldsymbol{\tau}_0,\mathbf{q}_0).$$

This measure corresponds to the trade restrictiveness index (TRI) constructed by Anderson and Neary (2005).

3. The tariff line data and sectoral price indices

Three volumes of the FTNUS have been painstakingly converted from the historical text source to an electronic data archive in order to construct a panel consisting of three cross sections. The first cross section records imports during the first six months of 1930 when the Fordney–McCumber tariffs of 1922 were still in effect, which we will refer to as the 1930A cross section. The 1930B cross section covers the last six months of 1930 when the Smoot–Hawley tariffs were first applied to US imports. The third cross section covers the entire year 1933. We chose two post-Smoot–Hawley cross sections to illustrate how the tariff structure changed as a result of the effect of price deflation on sectors with specific tariffs. The year 1933 was chosen for the second post-SH cross section for two reasons. First, it is the trough of the US business cycle and captures the maximum change in imports resulting from the collapse in aggregate demand over the business cycle contraction phase. Second, 1933 also coincides with the price level trough. This is important for our study of the relationship between imports and tariffs because many customs duties were specific. Thus, the price level trough also coincides with the peak ad valorem equivalent rates of duty for many imported goods. As far as we know, this is the only archive of US imports and duties in existence at the line-item level for the 1930s.

Table 1 provides a sense of the scope of our cross sections. The number of line items from the original FTNUS source document increases from 4861 to 5280 and then to 5629 as we move across the three cross sections. The larger increase in 1930, despite the shorter time interval, is largely due to the expansion of the scope and level of detail in the tariff schedules themselves. Relative to these maximums, the fraction of available data varies across the measures of value imported, quantity imported, import price, duty collected and the ad valorem equivalent tariff rate. The value imported is available for more than 95% of the line items. The quantity data are next most abundant, available for about 90% of the line items. The price data are imputed as unit values, taking the ratio of value imported to the physical quantity imported and thus require availability of both measures. As such, they are available for fewer line items than either value or quantity, 85% typically. Since some items are duty free, the duty and tariff columns also have fewer entries than the value column. In sum, the cross sections represent the complete record of US trade flows at the line-item basis.

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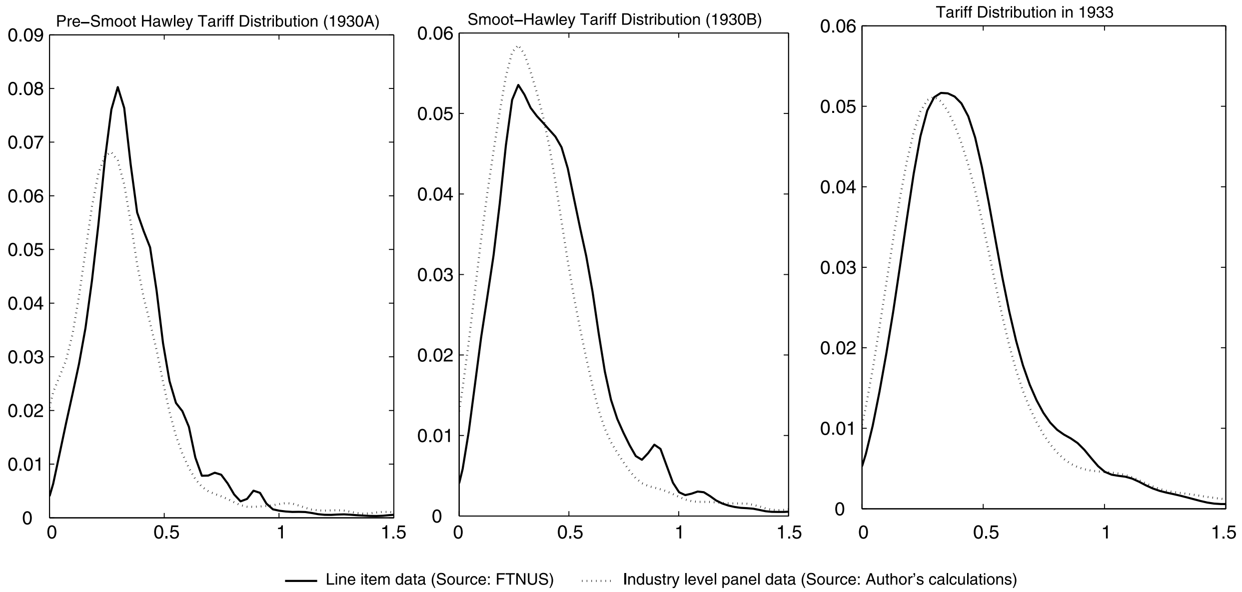

Fig. 1. Ad valorem tariff comparisons. The solid line is density estimate of original ad valorem equivalent tariffs in the FTNUS archive, while the dashed line presents the same estimate from the panel data.

3.1. Construction of panel data

Conducting research in an environment with enormous heterogeneity in the products and the tariff levels across them poses some unique challenges. To measure the change in the quantity imported in response to a good-specific tariff change requires careful control of the quality of the matches of goods across time. Attention must also be paid to the fact that tariff lines are sometimes split or combined. This makes some rudimentary aggregation necessary to avoid excluding a significant number of entry-level items.

To match goods across time, we employed a text-matching algorithm to tariff lines in 1930A with those in the 1930B and 1933 cross sections. Since there was both splitting and aggregation of tariff lines during the period, the text-matching algorithm did not provide one to one matches in many cases. In these cases, we constructed an aggregated line-item series by taking a weighted average of the individual line items using the 1930A import values as weights. This procedure resulted in a balanced panel of 495 line items, accounting for 18% of trade in 1930A and 25% of trade in 1933. The reduction in the number of tariff lines occurs for two reasons. First, aggregation naturally reduces the number of individual tariff lines and due to a large degree of re-organization between 1930A and 1930B/1933; it is common for two or more line items to be matched to the same line item in a later cross section. Second, aggregation exacerbates missing data issues. Any set of line items which is matched to any individual observation with missing data have to be discarded since the aggregation cannot be performed.[6]

We can provide a sense of how representative our balanced panel is of the underlying cross sections by comparing their distributions and reporting key statistics. Arguably one of the most important distributions is the microeconomic distribution of ad valorem equivalent tariff levels across goods. Fig. 1 plots kernel estimates of the distributions of tariffs before Smoot–Hawley was passed, after Smoot–Hawley was passed and in 1933. The solid line is the raw (source) micro-data and the dashed line is the balanced panel data. It is quite evident that the balanced panel is representative of the underlying line-item tariff data. The tariff levels are underestimated by the panel, but the differences are quite minor, the largest difference being the pre-Smoot–Hawley panel where the median ad valorem equivalent rate is 0.31 compared to 0.37 in the full archive. Table A.1 of Appendix A reports additional comparisons of the full cross section and panel.

A second concern about the reliability of our panel data is the extent to which we have successfully matched industries over time. Recall that variation in ad valorem equivalent tariff rates may arise due to changes in tariff rates at dates of legislative amendment or due to changes in import prices that alter the ad valorem equivalent rate associated with a specific duty.

To see this clearly, let $\tilde{\tau}_{it}$ denote one plus the legislated ad valorem tariff and let w_{it} denote the legislated nominal specific tariff, for import i, both recorded based upon the legislated tariff schedule in place at time t. The ad valorem equivalent tariff rate is the sum of the legislated pure ad valorem rate and the ad valorem equivalent of the legislated

[6] A detailed discussion of the quality of the matches from the text-matching algorithm, as well as further discussion of the aggregation procedure, is provided in Appendix A.

specific duty:

$$\tau_{it}(q_i) = \tilde{\tau}_{it} + \frac{w_{it}}{q_i}. \tag{13}$$

Clearly, for cases in which the specific duty is not zero, the ad valorem equivalent tariff rate moves inversely with the import price of the good.

The tariff rates under the Fordney–McCumber Act were in effect for the first 6 months of 1930, which is denoted as $t = 0$ (the 1930A cross section). The Smoot–Hawley tariff schedule was in effect for the second 6 months of 1930 (the 1930B ($t = 1$) cross section), and also for the 1933 ($t = 2$) cross section. Note that variation in line-item tariffs between $t = 1$ and $t = 2$ will only arise for imports that are subjected to specific duties. The vector of ad valorem equivalent tariff rates at time t is $\tau_t(q_t)$. We will also use (13) to construct the tariff vector $\tau_0(q_t)$ for $t = 1, 2$ which represents the counterfactual ad valorem equivalent tariff rates that would have been observed if the Smoot–Hawley legislation had not been passed.

If we are not matching industries correctly over time, this will introduce a measurement error into our comparisons of tariff rates over time. Since the tariff legislation did not change between the 1930B and 1933 samples, a crude measure of the quality of a match is the difference between the tariff rate (whether ad valorem or specific) for 1930B and 1933. For ad valorem tariff rates, 75% are within 1% of the base period rate, 77% are within 5% of the base period rate, and 91% are within 25% of the base period rate. The average base period (1930B) tariff rate was 16 percent. For specific tariff rates, 81% are within 1% of the base period duty, 84% are within 5% of the base period duty, and 89% are within 25% of the base period duty. The average base period (1930B) specific duty was 25 cents.

3.2. Construction of sectoral price indices

The import price indices defined in (2) represent ideal price indices for the cost of imports to the $N_F + 1$ production sectors and final consumption. Our tariff line panel provides the values of τ_{jt} and q_{jt} required for construction of these indices, but we also need to obtain values for the taste parameters, b_{ji}, and the elasticities of substitution, σ_m.

The expression for the share of imports from tariff line i by activity j, $\alpha_{ji}(\frac{q_i\tau_i}{p_{jm}}) = b_{ji}(\frac{q_i\tau_i}{p_{jm}})^{1-\sigma_m}$, can be used to express the b_{ji} in terms of observables at time t and the elasticity of substitution,

$$b_{ji} = \alpha_{jit}\left(\frac{q_{it}\tau_{it}}{p_{jm}(\mathbf{p}_t)}\right)^{\sigma_m - 1}. \tag{14}$$

Note that since the α_{jit} are homogeneous of degree 0 in the vector of coefficients b_j, the system of equations (14) determines the b_{ji} vector only up to a multiplicative constant. We can determine unique values, given σ_m, by choosing a normalization of base period price, $p_{im0}(\mathbf{p}_0) = 1$.

The tariff line data provide the total value of imports in the tariff line i, v_{it}, but not the allocation of these imports across the final goods sectors as required for the α_{jit}. However, we are able to construct a proxy for the budget shares in the base year, α_{ji0}, using the Leontief tables and the tariff line data by making two assumptions. The first assumption is that final good industry i's share of consumption of imports from tariff lines associated with final goods sector k is equal to its share of consumption of domestically produced intermediates from final goods sector k. Letting v_{ij0} denote imports by industry i in tariff line j in the base year, J_k denote the index set of tariff lines associated with industry k, and β_{ki} the share of industry k's output that is sold as intermediate goods to sector i, this assumption implies that $\sum_{j\in J_k} v_{ij0} = \beta_{ki}\sum_{j\in J_k} v_{j0}$. The second assumption is that the imports of final goods sector i from final goods sector j are allocated across tariff lines in proportion to their share in total imports from industry k, which requires $\frac{v_{ij}}{\sum_{j\in J_K} v_{ij}} = (\frac{v_j}{\sum_{j\in J_K} v_j})$. Together these assumptions imply that $v_{ij} = \beta_{ki}v_j$ for all $j \in J_k$, so that the base year budget shares can be expressed as

$$\alpha_{ij0} = \frac{v_{ij0}}{\sum_j v_{ij0}} = \frac{\beta_{ki}v_{j0}}{\sum_k\sum_{j\in J_k}\beta_{ki}v_{j0}}, \quad i = 1, \ldots, N_C;\ j = 1, \ldots, N_m. \tag{15}$$

The base year budget shares are calculated using Leontief's 1929 input–output tables for the β_{ki} and the 1930 (pre-HS) tariff line data for the v_{j0}.

To complete the construction of the import price indices, we calibrate the values of σ_m and σ_C to match the change in imports between 1930A and 1930B in response to the changes in tariffs and world prices. We can express the demand for imported materials by sector j from tariff line i as $m_{ji} = \alpha_{ji}(\frac{q_i\tau_i}{p_{jm}})\theta_{jm}(p_V, p_{jm})\mu_j(\frac{p_{jF}}{P_C})P_C C$. Totally differentiating this expression and defining $\hat{x} = \frac{dx}{x}$, we have

$$\hat{m}_{ji} = -s^{\tau}_{ji}(\hat{\tau}_i + \hat{q}_i) + s^V_{ji}\hat{p}_V + s^F_{ji}\hat{P}_{iF} + s^V_{ji}\hat{P}_C + \hat{C} \tag{16}$$

where the coefficients s^k_{ji} are functions of the elasticities of substitution, $(\sigma_C, \sigma_F, \sigma_M, \sigma_m)$, and the cost shares. A similar expression can be derived for $\hat{m}_{ci}$, and the model's prediction of the change in imports from tariff line i, $\hat{m}_i$, will be an import share weighted sum of the $\hat{m}_{ji}$. Assuming that $\sigma_F = 1$, $\sigma_m = \sigma_M$, and that $\hat{p}_V = \hat{p}_{jF} = \hat{p}_C = \hat{w}$ are given by the rate

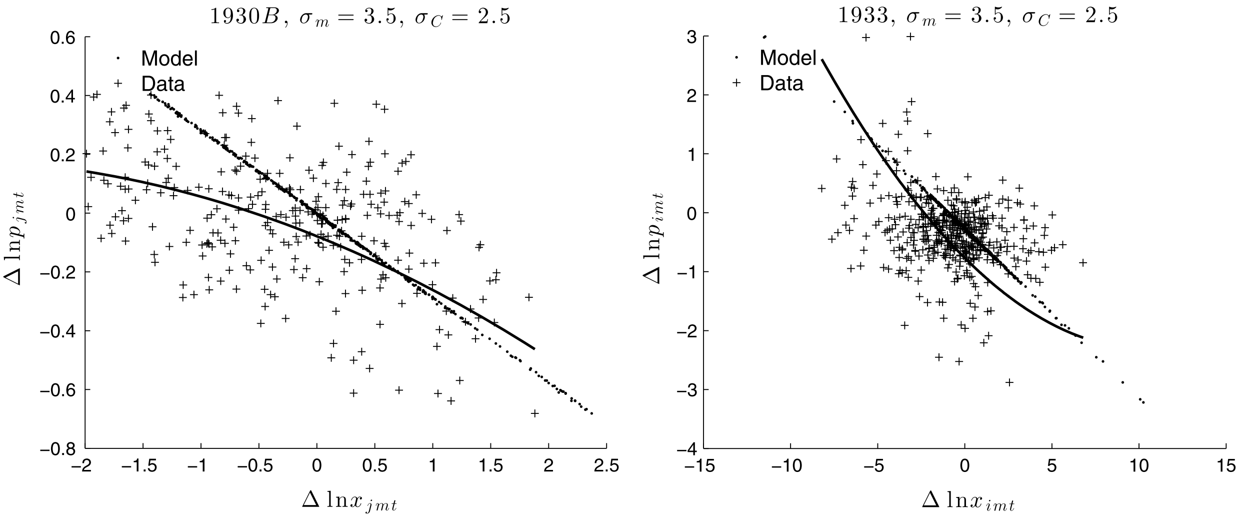

Fig. 2. Predicted vs actual changes in import prices and quantities across line-item goods in the panel data. The crosses represent individual data points. The dotted line is the model's predicted changes, while the solid line is fitted values of a quadratic regression on the actual data.

of change in the GDP deflator, we obtain an expression for the change in imports in tariff line i as a function of σ_C and σ_m. We choose the values σ_C and σ_m to match price and quantity movements in the data between the 1930A and 1930B cross sections. We then compare the change in imports between the 1930A and 1933 cross sections with the predictions based on our calibrated parameters as an out-of-sample check on our parameter choices. The results for the 1930B and 1933 cross sections are displayed in the two panels of Fig. 2.

Fig. 2 displays the model predicted data (dots), the actual data (crosses) and a quadratic regression of actual import prices changes on import quantity changes. We observe that the relationship between import price and quantity changes in 1933 is nearly linear. Further, setting $\sigma_m = 3.5$ and $\sigma_C = 2.5$, we find that the model matches the data very closely. In 1930 we observe a less linear relationship between prices and quantities. In particular, there are a number of goods for which we observe large declines in import quantities in response to moderate import price increases. This is arguably reasonable if the legislated tariff increases were foreseen by importers, who were in turn able to increase imports in the first half of 1930 before the tariff changes took effect. Nonetheless, overall the model matches the data relatively well.[7]

Given our benchmark parameterization, we can use our constructed import price indices to measure the impact of the SH policy on the cost of imported goods across industries and over time. Specifically, we calculate the tariff wedges for each industry in year t to be

$$\frac{p_{jm}(\mathbf{p}_t)}{p_{jm}(\mathbf{q}_t)} = \left[\frac{\sum_i^{N_m} \alpha_{ji0}(\frac{q_{it}\tau_{it}}{q_{i0}\tau_{i0}})^{1-\sigma_m}}{\sum_i^{N_m} \alpha_{ji0}(\frac{q_{it}}{q_{i0}\tau_{i0}})^{1-\sigma_m}}\right]^{\frac{1}{1-\sigma_m}}, \quad j = 0, \ldots, N_F \text{ and } C$$

given the individual tariff line-item data, the Leontief share data and our parameterization of σ_m. The results are presented in Fig. 3 where we have sorted the tariff wedges from lowest to highest based the 1930A, pre-SH tariff wedge.

Fig. 3 demonstrates a striking degree of heterogeneity in the tariff wedges across industries and over time. Even before the SH policy was implemented (the solid line) we observe that tariff wedges range from a low of 1.01 (leather shoes) to a high of 1.91 (sugar, glucose, and starch). Both the average tariff wedge and the variance of the wedge across industries increase with the passage of the SH tariff and the propagation of the Great Depression. As expected, after passage of the SH duties (line labeled 1930B) trade barriers increase in 37 of 41 industries, with many of the largest increases occurring in industries that already had large tariff wedges before the change in policy. By 1933 the wedges range from a low of 1.11 (leather shoes) to a high of 2.73 (sugar, glucose and starch). These are enormous increases in trade barriers. At the low end, the leather shoe industry experiences a 10 percent increase from the pre-SH period, which is not small by historical standards. However, it seems minute relative to the 82 percent increase the sugar, glucose and starch industry over the same period.

Fig. 4 shows the decomposition of the change in tariff wedges between the 1930A and 1933 cross sections into a legislated impact and a price-induced effect. The legislated component of the tariff change is the change in ad valorem

[7] These parameter values yield a price elasticity of import demand that averages 3.1. Our estimates of the elasticity parameters are relatively low compared to those presented elsewhere in the trade literature. For instance, Eaton and Kortum (2002) suggest an elasticity of substitution across imports near 8, while Simonovska and Waugh (2011) suggest that an improved estimate would be closer to 4. We note that increasing σ_m from our benchmark estimate results in higher tariff wedges a larger role for tariff policy in determining trade flows. In light of our relatively conservative elasticity estimate, we also consider a counterfactual exercise with larger elasticities.

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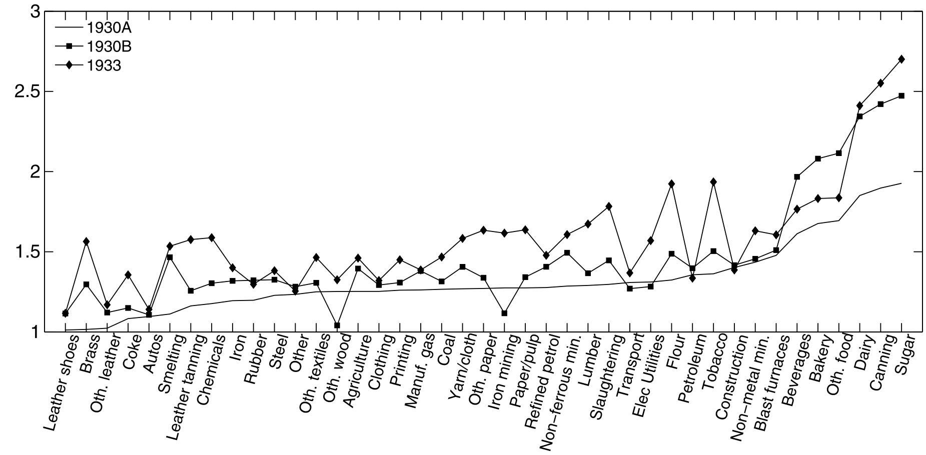

Fig. 3. Industry-specific import tariff wedges in 1930A (solid line), 1930B (squares) and 1933 (diamonds). The import tariff wedges are sorted from lowest to highest based on the 1930A, pre-SH tariff wedge.

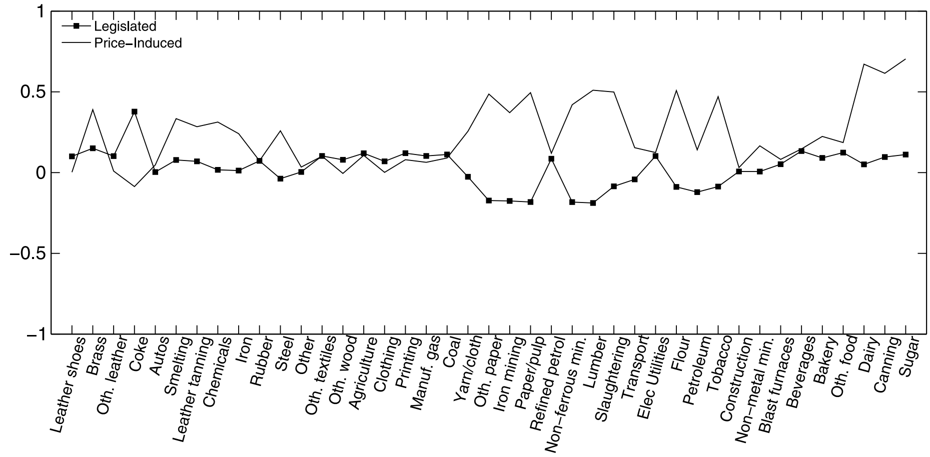

Fig. 4. This figure plots the decomposition of the change in import tariff wedges between 1933 and 1930A. The solid line represents the total change in industry-specific import tariff wedges due to deflation. The line with squares captures the total change due to the change in legislated tariff rates.

Table 2
Tariff wedge moments.

	1930A	1930B	1933
Mean	1.32	1.46	1.59
Variance	0.0486	0.124	0.116
Mean absolute deviation	0	0.156	0.268

Notes: The mean absolute deviation is relative to 1930A.

equivalent tariff rates between 1930A and 1933 that would have occurred if prices remained at the 1930A level, $\log \tau_{i2}(q_{i0}) - \log \tau_{i0}(q_{i0})$. The price-induced change is the impact of the price level changes between 1930A and 1933 on tariff rates, $\log \tau_{i2}(q_{i2}) - \log \tau_{i2}(q_{i0})$. The price-induced changes were of considerable magnitude, and their impact differed significantly across sectors.[8]

Table 2, provides a summary of the effect of the Smoot–Hawley legislation on the mean and variance of the tariff wedges. The mean tariff wedge prior to SH was equivalent to a 32% tariff on imported inputs. The SH legislative increase combined with deflation during 1930 increased the mean tariff wedge to 46%, and the subsequent deflation further increased it to 59% at the trough of imported prices in 1933. In addition to increasing the mean of the tariff wedges, the SH legislation also raised the cross-sectional variance of tariff rates substantially from 5% prior to SH to 12% in 1933. It should also be noted

[8] The significant role played by price level changes in the effective tariff rate has been emphasized by Crucini (1994) and Irwin (1998a). The correlation between the legislated impact and the price-induced effect is −0.049.

Table 3
Benchmark case.

	1930A	1930B	1933
Tariff structure			
Mean tariff ($\tau - 1$)	30.8	38.8	45.7
Variance of tariffs	0.052	0.072	0.125
Uniform tariff equivalent ($\tau - 1$)	47.3	55.8	68.2
Percentage change in:			
Value added deflator (p_V)	−2.0	−2.0	−2.6
Consumption deflator (p_C)	0.0	0.1	−0.1
Total factor productivity ($TFP(\boldsymbol{\tau}, \mathbf{q}) = \frac{p_V(1+\Gamma_V)}{P_C(1-\Gamma_C)}$)	−1.2	−1.4	−1.7
Employment (L)	0.1	0.2	0.2
Real consumption (C)	−1.1	−1.3	−1.5
Consumption equivalent ($U(C^E, L(\boldsymbol{\tau}_0, \mathbf{q})) = W(1, \mathbf{q})$)	1.1	1.4	1.6

Note: Parameter values: $s = 2$, $\gamma = 2.5$, $\beta = 0.667$, $\sigma_M = \sigma_m = 3.5$, $\sigma_C = 2.5$, $\sigma_F = 1$.
Percentage change in is calculated relative to free trade, $\Delta x = 100(\frac{x(\tau,q)}{x(1,q)} - 1)$.

that the price-induced changes between 1930B and 1933 resulted in a substantial increase in the dispersion of tariff rates relative to the 1930A tariff rates, as indicated by the fact that the mean absolute deviation nearly doubled over the period.

4. Aggregate effects of the tariff structure

The analysis of the previous section documented the wide range of sectoral distortions resulting from the SH tariff legislation and subsequent deflation. In this section we examine the impact of these distortions on aggregate consumption, employment, and welfare using the measures derived in Section 2.

The first exercise we conduct is to calculate the aggregate impact of protection using the tariff rate $\tau_t \equiv \tau_t(q_t)$ in time period t, which is calculated from (13) using the tariff schedule from period t and evaluating the ad valorem equivalent of the specific tariffs using world prices at time t. We thus incorporate both legislated changes in tariff rates and price level induced changes in tariff rates for each period, which results in an increase in the mean tariff rate from 30.8% in 1930A to 45.7% in 1933 and an increase in the variance from 0.052 to 0.125. In order to abstract from terms of trade changes, we solve for the equilibrium values assuming that prices remain constant at the 1930A levels, so that consumers and producers are assumed to be facing the tariff-laden price vector $\tau_t q_0$ at t.[9]

Table 3 reports the values for some of the key the aggregate variables from the model, with each variable reported as a percentage change relative to its free trade variable. Thus, the effect of the pre-SH tariffs is to reduce the return to domestic value added by about 2% relative to the free trade level. This is due to the fact that the pre-SH tariffs increased the price of importables to the production of exports by about 25%, and these imports accounted for approximately 3% of the cost of the exportable good in the base period. Subsequent tariff increases due to SH and deflation had little impact on the return to value added. Similarly, the cost of the aggregate consumption bundle was unchanged relative to free trade at the pre-SH tariffs, and changed relatively little over the remainder of the period. The aggregate effect of tariff protection on TFP at the peak of tariffs in 1933 was to reduce it by 1.7% relative to the free trade level. Note that more than 2/3 of the effect of tariff protection on TFP was due to the pre-SH tariffs, with SH and the subsequent deflation reducing aggregate productivity by approximately 0.5% compared with the pre-SH level.

In order to calculate the effects on employment and consumption, we choose the utility function parameters $s = 2$ and $\gamma = 2.5$. These choices yield an intertemporal elasticity of substitution of 0.5 and a Frisch elasticity of labor supply of 2/3, which are within the range of values obtained from micro studies.[10] With these parameter choices, tariff protection leads to a decrease in consumption of about 1.5% and an increase in employment of about 0.2%. As noted in the discussion of (10), tariff protection will decrease consumption relative to free trade because reductions in both *TFP* and $\frac{p_V}{P_C}$ work to reduce consumption. The effects of these two changes on employment are conflicting, and with our chosen parameter values the net effect is a small increase in employment.[11] The equivalent consumption effect indicates that at the peak of tariff protection, consumption would need to be increased by 1.6% to raise welfare to the free trade level. This is essentially equal to the TFP effect due to the minimal effect of protection on the level of employment.[12]

The comparison between the uniform tariff equivalent and the mean tariff shows that although the mean tariff was 45.7% at its peak, the overall effect of the tariff structure was equivalent to that of a uniform tariff of 69.7%. The increase

[9] The cost function parameters (a_{0d}, a_{0V}, a_{0m}) and p_{V0} are the values that satisfy the zero profit condition and match the cost shares $(\theta_{0d}, \theta_{0V}, \theta_{0m})$ from the input–output tables. The (a_{jd}, a_{jV}, a_{jm}) are then solved to match the respective cost shares given p_{V0} for $j = 1, \ldots, N_F$. A similar procedure is used to solve for the a_{cj} from the μ_j in the data.

[10] Chetty et al. (2011) argue a Frisch elasticity of 0.75 is the upper bound of values that are consistent with micro. Elasiticities of intertemporal substitution in the range of 0.5 to 1 are typically obtained in studies using household data on consumption (e.g. Attanasio et al., 2002).

[11] If we choose $s = 1$ and $\gamma = 1$, we obtain a small reduction in employment as a result of tariffs. However, the consumption equivalent is similar in this case.

[12] It can be shown that the measures reported in Table 3 are independent of the parameters ν, A, and K.

Table 4
No Smoot–Hawley.

	1930A	1930B	1933
Tariff structure			
Mean tariff ($\tau - 1$)	30.8	33.1	38.4
Variance of tariffs	0.052	0.072	0.125
Uniform tariff equivalent ($\tau - 1$)	49.0	55.0	61.6
Percentage change in:			
Value added deflator (p_V)	−2.0	−2.1	−2.1
Consumption deflator (p_C)	0.0	0.1	0.1
Total factor productivity ($TFP(\boldsymbol{\tau}, \mathbf{q}) = \frac{p_V(1+\Gamma_V)}{p_C(1-\Gamma_C)}$)	−1.2	−1.3	−1.5
Employment (L)	0.1	0.2	0.2
Real consumption (C)	−1.2	−1.2	−1.3
Consumption equivalent ($U(C^E, L(\boldsymbol{\tau}_0, \mathbf{q})) = W(1, \mathbf{q})$)	1.2	1.3	1.5

Notes: See Table 3.

Table 5
Double substitution elasticities.

	1930A	1930B	1933
Uniform tariff equivalent ($\tau - 1$)	65.3	71.9	84.5
Percentage change in:			
Value added deflator (p_V)	−6.8	−6.3	−6.9
Consumption deflator (p_C)	2.7	3.2	2.9
Total factor productivity ($TFP(\boldsymbol{\tau}, \mathbf{q}) = \frac{p_V(1+\Gamma_V)}{p_C(1-\Gamma_C)}$)	−7.4	−7.7	−8.1
Employment (L)	2.2	2.4	2.5
Real consumption (C)	−6.2	−6.3	−6.6
Consumption equivalent ($U(C^E, L(\boldsymbol{\tau}_0, \mathbf{q})) = W(1, \mathbf{q})$)	8.1	8.4	8.9

Notes: Parameter values: $\sigma_C = 5$, $\sigma_m = \sigma_M = 7$, rest as in benchmark.

in the variance of tariffs thus had a significant effect in increasing the distortion associated with the protective structure as measured by the uniform tariff equivalent. However, as already noted, the effects on aggregate productivity and welfare were relatively small.

How would the outcome have differed if Smoot–Hawley had never been passed? We can address this question by solving the model using the effective tariff rates associated with the pre-SH tariff legislation for all three periods of the panel, $\tau_0(q_t)$. This exercise captures the effect of the decline in world prices on the ad valorem equivalent tariff rates for goods that had specific tariffs under the pre-SH legislation. As in the benchmark case, we assume world prices remain fixed at the initial level. The results for this counterfactual exercise on the aggregate measures are reported in Table 4. Since the pre-SH tariff included a number of specific tariff rates, the decline in prices still yielded an increase in the mean tariff rate for the 1930B and 1933 cross sections that was about half that arising from the Smoot–Hawley legislation. Interestingly, the variance of tariffs in 1933 would have been comparable to that under SH. This is consistent with the observation from Fig. 4 that deflation was a major factor in the rise in dispersion of tariff rates over the period. As a result, the increase in the uniform tariff equivalent is almost 2/3 of that occurring with SH. The decline in TFP in the absence of SH would have been 1.5% relative to the free trade level, and the required consumption increase to compensate for the decline in tariff protection would have been 1.5% as well. These results indicate that if Smoot–Hawley had not been passed, the increase in the tariff distortion would have been more than half of that which occurred under SH, because deflation would have been responsible for a substantial increase in both the mean and dispersion of tariff rates.

In order to test the sensitivity of these results to our parametric assumptions, we also consider a case where we double the elasticities to $\sigma_m = \sigma_M = 7$ and $\sigma_C = 5$. In competitive trade models, the change in welfare resulting from a change in tariffs is proportional to the tariff weighted change in import volumes. This occurs because the marginal social benefit of importing a good exceeds its marginal social cost in the presence of a tariff, so decreases in imports of tariff-laden goods will reduce welfare. Since the responsiveness of import flows is larger when elasticities of substitution are higher, these parameter values are likely to affect the magnitude of the welfare effects. In addition, it seems likely that import volumes would be more responsive to increases in the dispersion of tariffs (as occurred in our sample) when the elasticity of substitution between types of imports are higher. In order to keep our exercise consistent with the data, we also adjust the taste parameters in the model so that they generate the observed trade flows at the higher elasticity values. This has the effect of increasing the taste for imports as the elasticity of substitution rise.

The results for this exercise are reported in Table 5. TFP now declines by 7.4% relative to free trade with the pre-SH tariffs with the higher substitution elasticities, which is almost 6 times that in the benchmark case. A higher substitution elasticity results in a greater change in import volumes, both because of the increased responsiveness of imports to trade barriers and because of the correspondingly higher taste for imports required to match the trade data at higher substitution

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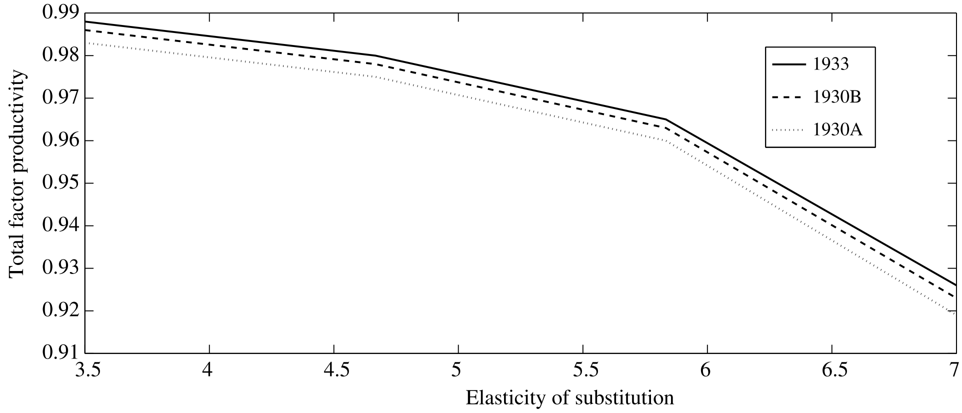

Fig. 5. This figure plots the losses in TFP due to tariffs in each cross section. TFP is maximized under free trade at 1. The vertical axis measures losses (relative to free trade) from tariffs as we vary substitution elasticities along the horizontal axis.

elasticities. The greater change in import volumes exacerbates the productivity loss.[13] In addition to a larger effect on productivity, the higher elasticity also results in a substantially larger impact on employment, which now rises by 2.2%. As a result of the increase in employment, the amount of consumption required to reach the free trade level (8.1%) exceeds the TFP effect (6.8%) in magnitude. The subsequent SH tariffs and deflation (1933) reduce TFP by an additional 0.7% relative to the free trade level. Finally, we note that increasing the elasticity of substitution between importables also has the effect of increasing the uniform tariff equivalent of the tariff structure. The greater substitution elasticities raise the distortion associated with variance in the tariff structure, and thus tends to raise the uniform tariff equivalent.[14]

These results suggest that the aggregate cost of tariff protection can be sensitive to the assumptions made regarding the elasticities of substitution. Fig. 5 elaborates on this point by showing how the loss in TFP varies with the value of the substitution elasticities for each of the cross sections, with elasticities $(\sigma_m, \sigma_M, \sigma_C)$ evaluated at 1, 4/3, 5/3 and 2 times their benchmark values. For each cross section, the magnitude of the total loss from tariff protection relative to free trade is non-linear in the substitution elasticity. Interestingly, however, the incremental loss moving from 1930A to 1933 due to the SH tariffs is in the 0.5–0.7% range for all of the elasticity values. This indicates that the biggest impact of elasticity differences is occurring for tariff distortions below those associated with the initial 1930A tariff levels, so that much of the substitution away from imported goods is occurring at relatively lower tariff levels.

Our results can be compared with two recent papers that consider the relationship between trade costs and welfare. Arkolakis et al. (2012) consider models where trade costs take the form of real resource costs, and show that knowledge of the elasticity of imports with respect to trade costs and the change in market share of domestic producers will be sufficient to calculate the welfare effects of changes in trade barriers for a variety of different trade models. A key difference between our results and theirs is that when trade barriers represent real resource costs, the impact of changes in trade barriers on welfare in competitive models is determined by the volume of imports. In contrast, the impact of tariff changes on welfare at constant terms of trade is determined by the tariff weighted change in import volumes. Thus, although the elasticity of imports with respect to trade costs plays a role in our model as well, the channel through which it operates is different. In particular, the existence of dispersion in tariff rates means that it is important to know the change in composition of imports in order to obtain the change in welfare. The change in domestic market share will not be sufficient to capture the welfare effect of trade cost changes. Atkeson and Burstein (2010) also consider the effect of changes in trade costs using a model of monopolistically competitive firms and an R&D sector, and find that the magnitude of firm level responses has little impact on the aggregate welfare change. Their model differs from ours in significant ways. They consider trade costs that are real resource costs, as in the case of Arkolakis et al., so the first order effect of changes in trade costs on welfare

[13] The importance of the role of the endogenous taste parameters can be seen by considering a symmetric two country endowment model, where each country has an endowment of a single good and preferences are CES. If taste parameters are held constant, the distorting effects of tariffs go to 0 as $\sigma \to \infty$, because domestic goods become a perfect substitute for imports. This yields a non-monotonic relationship between the elasticity of substitution and the welfare loss from tariffs. If the taste parameter is adjusted to maintain a constant import share, as in our counterfactual, the distorting effects of tariffs are increasing in σ and approach a positive upper bound as $\sigma \to \infty$. In the latter case, the preferences parameter for domestic goods becomes arbitrarily small in the limit in order to match a finite import share.

[14] To provide further insight about the role of the elasticities in our model, we did two additional exercises. The first was to double σ_C and σ_M while holding σ_m constant at the benchmark level. This exercise increases the substitutability between domestic and imported goods (both as final consumption goods and as material inputs), while holding the substitutability between different categories of imported inputs constant. This exercise had an effect that was approximately half of that obtained when all 3 of the elasticities are doubled. We then considered a doubling of the elasticity between imported goods, σ_m, while holding the other elasticities constant at the benchmark levels. This exercise emphasizes substitutability between different types of imports, while holding substitution between imports and domestic goods constant. The impact of this change was approximately one fourth of that obtained by doubling all elasticities. These exercises illustrate that all three of the elasticities play a role in the amount of deadweight loss, and that their impacts are complementary.

Table 6
Double all import shares.

	1930A	1930B	1933
Uniform tariff equivalent	44.7	52.8	65.6
Percentage change in:			
Value added deflator (p_V)	−4.3	−4.4	−5.5
Consumption deflator (p_C)	−0.3	−0.1	−0.7
Total factor productivity ($TFP(\boldsymbol{\tau}, \mathbf{q}) = \frac{p_V(1+\Gamma_V)}{P_C(1-\Gamma_C)}$)	−2.4	−2.9	−3.4
Employment (L)	0.3	0.4	0.6
Real consumption (C)	−1.9	−2.2	−2.6
Consumption equivalent ($U(C^E, L(\boldsymbol{\tau}_0, \mathbf{q})) = W(1, \mathbf{q})$)	2.5	2.9	3.5

Notes: See Table 3.

operates through a different channel. In addition, the elasticity of substitution in their model identifies substitution between all brands, rather than the substitutability between domestic and imported goods.

As a final exercise, we consider the impact of a doubling of the US import share using the benchmark elasticity assumptions. That imports were a small fraction of GDP is one factor in explaining why the aggregate impact of tariff protection is relatively small in our benchmark case. This raises the question of how large import shares must be in order to have significant effects on aggregate productivity and welfare. Table 6 considers a counterfactual exercise of doubling the US import share from its 1930 levels. This change has the effect of doubling the impact of tariffs on the price of value added. The effect of the pre-SH tariffs on TFP is approximately double that in the benchmark case, since TFP now decreases by 2.4% from the pre-SH tariffs. Doubling the import share more than doubles the percentage increase in consumption required to compensate for the effect of the tariff structure relative to free trade, because the employment effects are somewhat larger in this case. Note that although the aggregate effects are increased substantially in this counterfactual, there is only a minor effect on the uniform tariff equivalent. This is because the uniform tariff equivalent captures the effect of tariffs on one import category relative to another. Doubling the import volume increases the effects on all import categories proportionally, and thus has a minimal effect on this aggregate measure.

5. Conclusions

We have constructed a panel of tariff lines to quantify the effect of the Smoot–Hawley legislation on the mean and dispersion of tariff rates. The panel shows that the mean effective tariff rate increased from 31% to 46% between 1930 and 1933, and that the variance of tariff rates at the tariff line level more than doubled over the same period. We used this panel to construct industry tariff wedges reflecting the increased price of imported materials used for domestic production. The mean of these wedges increased by more than the mean tariff, from 32% to 59%, and the variance across industries more than doubled. The role of dispersion on tariff rates was captured by the fact that the uniform tariff rate equivalent exceeded the average tariff rate by 18% under the pre-SH tariffs in 1930, and this differential increased to 24% by 1933. Thus, the tariff structure was substantially more distorting than suggested by the average tariff rate, and the increased variance in tariff rates from SH raised the differential between the uniform tariff equivalent and the average tariff.

Although our tariff line analysis indicated the existence of substantial sectoral distortions, our general equilibrium model indicated that the impact of these distortions at the aggregate level was relatively modest in the benchmark parameterization. The pre-SH tariff protection reduced TFP by 1.2% relative to free trade, and the SH legislation was responsible for a further 0.5% decline in TFP. We also showed that if SH had not been passed, the presence of specific tariffs in the existing tariff legislation would have reduced TFP by 0.3% between 1930 and 1933 due to declining world prices. This conclusion is consistent with previous findings of Crucini (1994) and Irwin (1998a) that deflation was responsible for a significant portion of the increase in ad valorem equivalent tariff rates that occurred following the passage of the SH legislation.

Two caveats should be kept in mind in interpreting our results on the aggregate effects of the SH tariffs. First, the aggregate effects could be larger if the true substitution elasticities are larger than the ones used in our benchmark analysis. Our counterfactual exercise showed that a doubling of the elasticities of substitution led to a six-fold increase in the effect of pre-SH tariffs on TFP. In addition, larger elasticities resulted in more significant effects on labor markets. Note however, that the incremental effect of the SH legislation and decline in world prices on TFP from 1930–1933 was quite robust across the different elasticity assumptions. This suggests the value of investigating the tariff policies over the entire interwar era to better capture the aggregate impacts of commercial policy during the Great Depression.

Second, we assume that tariffs have no effect on world prices. Such an assumption is appropriate when the country in question is a small country, or when retaliation by foreign countries offsets any effects of tariffs on the terms of trade. The existence of a favorable terms of trade effect for the tariff imposing country would reduce the magnitude of the loss in productivity, or could even lead to a higher productivity level. However, our data did not suggest the presence of significant reductions in world prices as a result of the Smoot–Hawley tariffs.

Our analysis could be extended to incorporate additional effects of tariff protection. Our analysis does not incorporate the additional negative effects of tariff protection on aggregate capital accumulation emphasized by Crucini and Kahn (1996). Tariff protection could also lead to larger effects on productivity if it leads firms to increase markups. Such an outcome could occur if firms are imperfectly competitive and tariffs make firm demand curves less elastic, or if protection facilitates the formation of cartels. These represent important areas for future work.

Appendix A

The matching algorithm takes two arrays of text descriptions as inputs. The output is a matrix of scores in which the ijth element is a number between zero and 1 for the quality of a match between row i from the first data set and row j from the second. A score of 1 means that the text descriptions are identical and a score of zero means they have no characters in common. For example, in the 1930A and 1930B cross sections (pre- and post-SH) a minimum threshold of 0.8, yields 1800 matches and the number of matches falls to about 1690 where the match is for all intents and purposes 'perfect,' a matching score of 0.97.

While the matching algorithm is an invaluable tool, it does not resolve the issue of eight scenarios involving line-item splitting, aggregation or re-organization across periods. For example, our matching procedure does not rule out more than one 1930A line item being matched to the same 1930B (or 1933) line item. We must account for this type of aggregation in the data. To do this we collect the set all best matches which are connected to each other through one or more line-item aggregations. We then construct an aggregated line-item series by creating a weighted average of the individual line items where the 1930A import values are used as weights. After completing the construction of a balanced panel, the size of our cross section shrinks to 495 line items. This occurs for two reasons. First, aggregation naturally reduces the number of individual tariff lines and due to a large degree of re-organization between 1930A and 1930B/1933; it is common for two or line items to be matched to the same line item in a later cross section. Second, aggregation exacerbates missing data issues. Any set of line items which is matched to any individual observation with missing data have to be discarded since the aggregation cannot be performed.

Table A.1
Moments of source data and balanced panel.

	Pre-Smoot–Hawley		Post-Smoot–Hawley		1933	
	Source	Panel	Source	Panel	Source	Panel
Value imported						
Mean	359	723	282	784	276	918
Median	6	47	6	22	5	29
Std. dev.	3292	3404	3066	5426	2926	6578
Quantity imported						
Mean	3842	9109	3352	9720	5437	10,233
Median	6	69	7	47	9	67
Std. dev.	51,787	82,835	47,230	99,545	75,885	84,489
Price (unit value)						
Mean	23.85	2.05	40.25	1.98	19.17	1.55
Median	0.89	0.44	0.81	0.40	0.50	0.31
Std. dev.	367.48	9.84	833.04	10.34	323.62	8.87

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